KILOMUX-2000

Data, Voice, Fax and LAN Integrating Multiplexer

Installation and Operation Manual

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For further information contact RAD Data Communications at the address below or contact your local distributor.

RAD data communications
Headquarters
12 Hanechoshet Street
Tel Aviv 69710 Israel
Tel: 972-3-6458181
Fax: 972-3-6498250
E-mail: rad@rad.co.il

RAD data communications
US East
900 Corporate Drive
Mahwah, NJ 07430 USA
Tel: (201) 529-1100
Fax: (201) 529-5777
E-mail: market@radusa.com

RAD data communications
US West
3631 South Harbor Boulevard
Suite 250
Santa Ana, CA 92704
Tel: (714) 850-0555
Fax: (714) 850-1555

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Publication No. 420-200-06/99

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INTRODUCTION

This manual describes the technical characteristics, applications, installation and operation of the Data, Voice, Fax and LAN Integrating Multiplexer System, KILOMUX-2000.

This manual contains two parts:

Part I **KILOMUX-2000 SYSTEM** - presents the system characteristics and applications, installation and operation procedures for the basic KILOMUX-2000 chassis.

Part II **I/O MODULES** - consists of separate sections for each individual I/O module, Main Link module or System module available for the KILOMUX-2000. Each section presents the technical characteristics, basic applications and specific installation and operation procedures for the specific module.

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Telecommunication Safety

1. The unit should be installed within 1.5m (5 ft) of a grounded, easily accessible AC outlet. If the protective earth connection is not guaranteed by the mains supply, the unit must be externally connected to a reliable protective earth. DC powered units must be connected only to power sources which conform to the relevant safety standard.
2. In order to guarantee an unobstructed flow of cooling air, allow at least 15 mm clearance above and below the unit. The maximum permitted temperature of the surrounding is 45°C.
3. Vacant slots must always be covered with blank covers. This is necessary in order to guarantee a proper air flow and to prevent access inside the equipment.
4. The safety status of each of the ports on the KILOMUX-2000 is declared according to EN 41003 and is detailed in the table below.

Ports	**Safety Status**	
RS-530, X.21, V.24, V.35, V.36, LAN, Unbalanced E1, E&M	SELV	Circuit operating with Safety Extra-Low Voltage
ISDN, Balanced E1, T1, G.703, DDS	TNV-1	Circuit whose normal operating voltage is within the limits of SELV, on which overvoltages from Telecommunications Networks *are* possible.
FXS	TNV-2	Circuit whose normal operating voltage exceeds the limits of SELV, but is *not* subject to overvoltages from Telecommunications Networks.
FXO	TNV-3	Circuit whose normal operating voltage exceeds the limits of SELV, on which overvoltages from Telecommunications Networks *are* possible.

Additional conditions concerning the safety of connection to telecommunication networks:

- The unit must be earthed prior to connection to telecommunication networks.
- The signal ground of the SELV circuits is connected at the factory to the protective earth. Interrupting this connection may invalidate the safety of the connection to telecommunication networks.
- The FXS interface is suitable for connection of a telephone set, but is not intended for a direct connection to the PSTN.
- The E&M interface is suitable for direct connection to an Approved PABX but is not intended for direct connection to the PSTN. The BGND of the E&M signalling is usually connected to protective earth.

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Warning per EN 55022

This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

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Declaration of Conformity

Manufacturer's Name: RAD Data Communications Ltd.

Manufacturer's Address: 12 Hanechoshet St.
Tel Aviv 69710
Israel

Declares that the product: **KILOMUX-2000**

Conforms to the following standard(s) or other normative document(s):

EMC:	EN 55022 (1994)	Limits and methods of measurement of radio disturbance characteristics of information technology equipment.
	EN 50082-1 (1992)	Electromagnetic compatibility - Generic immunity standards for residential, commercial and light industry.
Safety:	EN 60950 (1992/93)	Safety of information technology equipment, including electrical business equipment.

Supplementary Information:

The product herewith complies with the requirements of the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC. The product was tested in a typical configuration.

Tel Aviv, September 18th, 1996

Haim Karshen
VP Quality

European Contact: RAD Data Communications GmbH, Lyoner Strasse 14, 60528 Frankfurt am Main, Germany

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Part I.

KILOMUX-2000 SYSTEM

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Part II.

I/O MODULES

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Chapter 1
General Information

1.1 Functional Description

The KILOMUX-2000 is an advanced, highly versatile user-configurable modular TDM (Time Division Multiplex) multiplexer system. The KILOMUX-2000 provides an efficient and cost-effective method for transmitting data, voice and fax over digital data services. Access to these services is provided over a variety of standard interfaces (V.35, RS-530/V.36, RS-232/V.24, X.21, Standard DDS, codirectional G.703, ISDN, fiber-optic, T1, and E1), at data rates ranging from 9.6 to 768 kbps. Bandwidth utilization efficiency is 98.5%.

Main System Features

The KILOMUX-2000 system can be equipped with various types of input/output (I/O) modules that provide the required interface for the user data, fax, and voice channels. The range of available KILOMUX-2000 modules is continuously expanding.

The currently-available series of I/O modules includes:

- High-speed synchronous data interface modules operating at a rate of 2.4 thru 614.4 kbps – the KHS series of modules.
- Sub-multiplexer modules for low-speed (300 bps to 57.6 kbps or 64 kbps) synchronous and asynchronous data channels, including statistical multiplexing modules – the KLS series of modules.
- ISDN interface modules - the KHS.U series.
- 2W and 4W multiple voice channel interface modules that can directly connect to PABX lines and two-wire telephone sets – the KVC series of modules.
- 2W and 4W voice/fax low bit rate interface modules – the KVF.1 through KVF.4 series of modules.
- T1 and E1 PABX trunk interface modules - the KVF.5 series of modules.
- Token ring extender module, KTRE.
- Elementary Ethernet bridge module, KMBE.
- Bypass and multidrop module, KDI.

Detailed information on the KILOMUX-2000 modules is presented in Part II of this manual.

Figure 1-1 illustrates the basic capabilities of the KILOMUX-2000 system.

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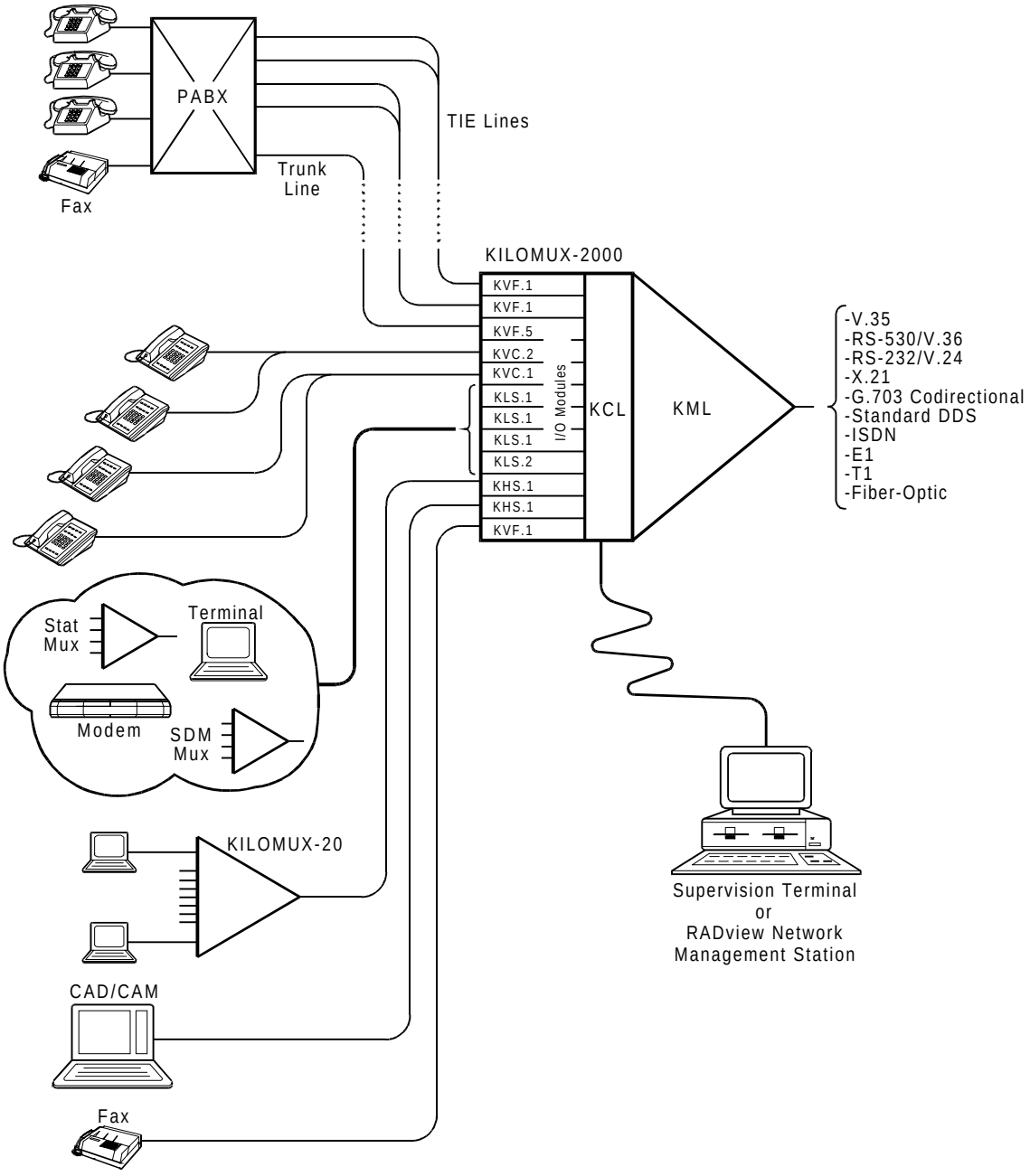

Figure 1-1. KILOMUX-2000 System Applications

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The KILOMUX-2000 system can be equipped with two main link modules. The two main link modules can be used in several ways:

- To provide hot-standby redundancy (backup) for the main link, with automatic or manual switch-over in case one of the links fails. For maximum flexibility, the KILOMUX-2000 allows the preparation of a different configuration for use on the backup link. The backup link can also use a switched data circuit. The switched circuit can be established on a PSTN line, using analog modems, or on an ISDN line using an S or U interface.
- To provide two independent links from the same KILOMUX-2000 enclosure. The two links can operate at different data rates. The dual-link mode can also be used for providing the equivalent of hot standby protection to critical data channels (by enabling the priority bumping feature).
- To provide multidrop and bypass capabilities (using a dedicated KDI module).

In addition to main link redundancy, system reliability can be further enhanced by installing an additional power supply unit in the enclosure. The power supplies share the load current, therefore when one of them fails or its input voltage is disconnected, the other takes over the full load without disturbance to KILOMUX-2000 operation.

The KILOMUX-2000 system provides flexible system timing options, with several main link, and channel timing modes:

- The main link timing modes are DTE, DCE, and external DCE. In the DCE and external DCE modes, the timing reference source can be selected by the user:
  - Internal oscillator.
  - External (timing locked to one of the data channels).
  - The other main link module (provided a KDI module is installed).

  In addition to the main timing source, a fallback source can be selected. When the timing mode is DTE or external DCE, buffers are inserted in the main link signal paths, to absorb the expected jitter and timing instabilities. Normal buffer size is ±8 bits; for operation over satellite links, the receive buffer size can be increased to ±256 bits.
- The timing modes available for the data channels are programmable, thereby permitting each channel to be configured as either DCE (supplies receive and transmit clocks to the user's equipment), DTE1 (supplies the receive clock and accept a transmit clock), or DTE2 (accepts receive and transmit clocks from the user's equipment), with buffered retiming of the received data. Connection to the national network and to common-carrier data lines is also supported, with the external clock selectable as the source for system timing.
- For modules with ISDN, T1, E1, and fiber-optic interfaces, a loopback timing mode is available. This mode enables locking the KILOMUX-2000 timing to the accurate timing provided by the network is which the interface is connected.

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System Supervision and Configuration

The KILOMUX-2000 system is designed for unattended operation. The configuration of the KILOMUX-2000 system and of each of its modules, that is, the complete collection of the operating parameters, are determined by a data base stored in the non-volatile memory of the KILOMUX-2000 control module. The KILOMUX-2000 can store two different data bases, and can be programmed to switch automatically between the data bases in accordance with a predetermined daily schedule ("day/night" operation), or to use one of the data bases only in case of switching to a backup link.

Most of the KILOMUX-2000 supervision and configuration functions are performed from its front panel, using three push-buttons and an LCD display. The configuration is menu-driven: the LCD display guides the operator in the execution of the desired operations, provides information concerning the current system configuration and operating mode, and lists the values available for each programmable parameter. In case of operator errors, the KILOMUX-2000 displays a message that explains the error and helps the operator take the correct action.

The KILOMUX-2000 stores alarms detected during its operation in a buffer. The buffer serving the front panel LCD can store one alarm of each type, whereas the buffer for alarms to be sent to a supervision terminal can hold up to 100 alarms. During regular operation, a front panel indicator lights to indicate if there are any alarms in the alarm buffer, to notify the local operator that alarm conditions have been detected. The local operator can then review the contents of the alarm buffer on the front panel LCD display, and can delete old alarms related to events that are no longer present in the system.

In addition to the alarm buffer, the front-panel LED indicators display in real time the main link and power supply status and alert when test loops are present in the system. Another set of indicators can be used to monitor on-line a selected user channel. The monitored functions are transmit and receive data activity, and the state of the RTS and DCD control lines (or E and M lines for voice channels).

The operation of the KILOMUX-2000 can also be controlled via a RS-232 supervisory port. The supervisory port allows full control over KILOMUX-2000 operation, remote reading of alarm messages, and remote monitoring of KILOMUX-2000 operation from a standard ASCII data terminal, or from a RADView network management station. A separate dial-out port enables automatic reporting of alarms to a remote location by means of a Hayes™ or compatible dial-up modem.

When two KILOMUX-2000 units are connected in a link, a master-slave control configuration can be used, whereby one of the units selected as master downloads the configuration to the remote unit defined as slave. When this option is used, the communication with the remote KILOMUX-2000 unit takes place through a low-rate management channel carried by the main link.

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Since the KILOMUX-2000 supports two independent links, the operator can select the main link that will carry the management channel, but only when using a dual link V configuration with independent links.

Diagnostic Capabilities

The KILOMUX-2000 system provides extensive diagnostics, supervision and maintenance capabilities for easy maintenance and rapid detection and location of faults.

The KILOMUX-2000 diagnostics include automatic self-test upon power-up, and on-line monitoring of critical functions. The system generates time-stamped alarm messages that cover all the significant system events. The time stamp is provided by a real-time clock with battery backup. The system operator can then perform comprehensive testing on each type of module, to determine the cause of the alarm messages and return the system to normal operation.

Various types of test loops are provided, including modem loops 2 and 3 per ITU-T Rec. V.54 for rapid isolation of the fault area, tone injection for rapid testing of voice interface modules, and pseudo-random sequence transmission test for checking the proper operation of data interface modules, and detection of bit errors.

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1.2 Physical Description

The KILOMUX-2000 system consists of a 19" 3U enclosure that contains the control subsystem, the main link (aggregate) interface subsystem, the system power supplies, and has 12 slots for the installation of I/O modules. In addition, the enclosure has one slot for an options module.

All the modules are inserted from the rear. The cable connections are also made at the rear.

The front panel includes a control section with three push-buttons and a two-row LCD display (16 characters per row), and indicators for the common modules and for monitoring the main interface lines of a selected channel.

Figure 1-2 shows a general view of a KILOMUX-2000, and identifies the functions of the enclosure slot.

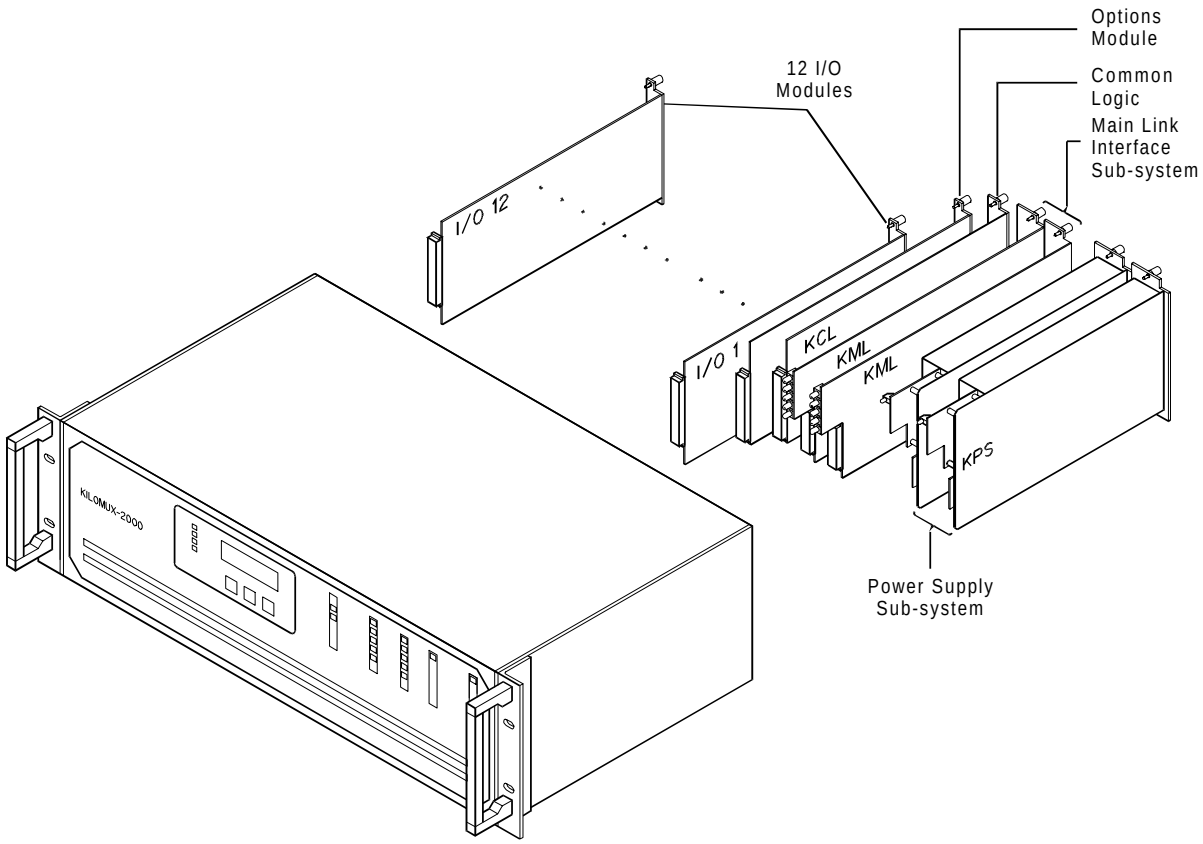

Figure 1-2. KILOMUX-2000 Enclosure, General View

Control Logic Modules

The KILOMUX-2000 enclosure requires one common logic module, type KCL.1. The main functions of the KCL.1 module are control of multiplexing/demultiplexing operations, system management, and interfacing with the optional external system management.

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Module KCL.1 stores the KILOMUX-2000 data base in non-volatile memory (NVRAM). The configuration information stored in the NVRAM is downloaded to the module installed in the KILOMUX-2000 upon turn-on or after system reset. Therefore, during troubleshooting activities, it is possible to temporarily remove the KCL.1 module from the enclosure without disrupting system operation. If it is necessary to replace the KCL.1 module, the data base can be transferred to a new module by installing the NVRAM taken from the original module in the replacement module.

Main Link Modules

The KILOMUX-2000 enclosure can accept one or two main link interface modules, type KML. In addition to main link interfacing, the KML module performs the multiplexing and demultiplexing functions and provides the timing signals used by the other modules installed in the enclosure. Two KML modules are necessary for dual link configurations and for main link redundancy.

The following main link interface modules are available:

- **KML.1** - V.35 main link interface module.
- **KML.2** - V.24/RS-232 main link interface module.
- **KML.3** - V.36/RS-422/RS-530 main link interface module.
- **KML.4** - X.21 main link interface module.
- **KML.5** - G.703 codirectional main link interface module.
- **KML.6** - Standard DDS CSU/DSU main link interface module.
- **KML.7** - T1 main link interface module.
- **KML.8** - E1 main link interface module.
- **KML.10** - ISDN main link interface module. The module can be ordered in two versions:
  - KML.10/S, with ISDN S-type interface. The "S" interface operates as Terminal Adaptor (TE side), intended for connection to standard Network Termination (NT) unit.
  - KML.10/U, with ISDN U-type interface. The "U" interface operates as Network Termination (NT side) unit, intended for connection to standard Line Termination (LT) unit.
- **KML.F** - Fiber-optic main link interface module. The module can be ordered with various types of optical interfaces (laser or LED transmitters for single-mode and multi-mode fiber-optic cable).

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Power Supply Modules

The KILOMUX-2000 enclosure can accept one or two power supply modules, type KPS. Several types of power supply modules are available:

- **KPS.1** - 30 W power supply module for 115 VAC mains.
- **KPS.2** - 30 W power supply module for 230 VAC mains.
- **KPS.3** - 25 W power supply module for -48 VDC power.
- **KPS.4** - 50 W power supply module for 100 to 240 VAC mains.
- **KPS.5** - 25 W power supply module for -24 VDC power.
- **KPS.6** - 56 W power supply module for 100 to 240 VAC mains.
- **KPS.7** - 56 W power supply module for -48 VDC mains.

Two KPS modules are necessary for redundancy: when both modules are operational, they share the load, whereas in case of failure or loss of input power the remaining module continues to supply the power alone. Switch-over is thus automatic and does not disturb normal operation.

In addition to power supply modules, the KILOMUX-2000 enclosure supports one KM-RINGER module, for providing line feed and ring voltages for voice channels and phantom feed for ISDN lines. This module is available in AC (115 VAC or 230 VAC) and DC (-24 VDC or -48 VDC) input voltage versions. The KM-RINGER can be installed as a plug-in module for the KILOMUX-2000, or located on shelves or desktops.

Option Modules

The KILOMUX-2000 enclosure can accept two types of options module:

- **KAI** - Alarm indication module for installation in the options position, or in any I/O slot. The KAI includes indicators similar to those located on the KILOMUX-2000 front panel. These indicators repeat all the relevant KILOMUX-2000 front panel indications on the rear panel, and thus complement the indicators available on the rear panels of the other modules. Maintenance activities are thus expedited, as all the KILOMUX-2000 indications become readily available on one side of the equipment.
- **KDI** - Bypass and multidrop module. The KDI module can be installed in the option slot, or in any I/O slot. The KDI module enables direct transfer (bypassing) of a group of main link frame bits, in both directions, between the two main links of the KILOMUX-2000. Channels that are not bypassed are connected to I/O modules of the KILOMUX-2000.
  To further increase functionality, the KDI module is available in two versions:

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- KDI version: supports only the bypassing function.
- KDI/M version: also includes a data channel interface for one multidrop channel. The multidrop channel is compatible with the data channels of the KLS.1/NEW low-speed data module, and supports data rates in the range of 0.3 to 64 kbps. As is standard practice in a multidrop application, the receive path of the local multidrop channel continuously receives the data transferred in its allocated bandwidth on the desired main link (the same data is also bypassed to the other link, to make it available downstream), but its transmit path is connected to the main link only when the RTS line in the local interface is asserted.

I/O Modules

The KILOMUX-2000 supports up to 12 user-selected I/O modules. The KILOMUX-2000 can accept any combination of the following types of I/O modules:

- **KVC.1** - ADPCM or PCM voice interface module, provides two voice channels. Coding method and rate is selectable in accordance with the main link rate and the number of channels (note that the KVC.1 module is not supported for main link rates of 768 kbps). The KVC.1 module is available in three models:
  - KVC.1/E&M: four-wire or two-wire interface with E&M signaling per RS-464 Types I, II, III and V, and British Telecom SSDC5.
  - KVC.1/FXS: two-wire interface for direct connection to a telephone set. The KVC.1/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages. RAD offers two options for providing the required voltages: the stand-alone RINGER-2000 unit (intended for shelf and rack mounting), or the KM-RINGER.
  - KVC.1/FXO: two-wire interface for direct connection to a PABX extension line.

  The KVC.1/FXS and KVC.1/FXO modules are intended for operation in a link, with the KVC.1/FXS on the subscriber side and KVC.1/FXO on the PABX side.
- **KVC.1M** - ADPCM or PCM voice interface module, provides one or two voice channels and support error-free fax transmission. Coding method and rate is selectable in accordance with the main link rate and the number of channels. The KVC.1M replaces the KVC.1, and provides additional functions. The following models are available:
  - KVC.1M/E&M: two voice channel with four-wire or two-wire interface with E&M signaling per RS-464 Types I, II, III and V, and British Telecom SSDC5. The KVC.1M/E&M module generates a -12 VDC signaling voltage, which is sufficient for connection to PABX lines, as well as for many short line length applications.

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- KVC.1M/E&M48: similar to the KVC.1M/E&M, except that it requires an external -48 VDC source to supply the signaling voltage for increasing the maximum allowed line length. The signaling voltage can be supplied by a RINGER-2000 or KM-RINGER unit, offered by RAD.
- KVC.1M/FXS: two voice channels with two-wire interface for direct connection to a telephone set. The KVC.1M/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages, which can be supplied by a RINGER-2000 or KM-RINGER unit, offered by RAD.
- KVC.1M/FXSP: similar to KVC.1M/FXS, except that it has an internal ringer and line feed supply. The internal ringer provides a nominal ring voltage of 23 VRMS, and the nominal line feed voltage is -42 VDC at a line current of 25 mA. These voltages are sufficient for connection to PABX lines, as well as for many short line length applications.
- KVC.1M/FXSW: one voice channel similar to the voice channels of the KVC.1M/FXS, and one two-wire interface operating with FXO signaling, intended for connection to the PSTN, or to a PABX extension line.
- The local subscriber connected to the FXS interface can access the multiplexed voice channel, as well as the PSTN/PABX line, and receives all incoming calls from either the multiplexed voice channel or from the PSTN/PABX line. The PSTN/PABX port cannot access the multiplexed link.
- KVC.1M/FXO: two voice channels with two-wire interface and FXO loop start signaling for direct connection to a PABX extension line.
- The KVC.1M/FXS, /FXSP, and /FXSW modules, and the KVC.1M/FXO module are intended for operation in a link, with the KVC.1M/FXS, /FXSP, and /FXSW module, respectively, on the subscriber side and the KVC.1M/FXO module on the PABX side.
- KVC.1M/FXS16K and KVC.1M/FXO16K: similar to the KVC.1M/FXS and the KVC.1M/FXO, respectively, except that they are intended for the connection of pay phones to exchanges, and therefore it includes dedicated circuits for the generation of polarity reversal and of 16 kHz metering pulses.
- KVC.1M/FXS12K and KVC.1M/FXO12K: similar to the KVC.1M/FXS16K and KVC.1M/FXO16K, for pay phone systems using 12 kHz metering pulses.

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- **KVC.2** - Low-bit rate voice module, provides one or two high-quality compressed voice channels. Channel digitizing rate is selectable: 6.4, 7.2, 8, or 9.6 kbps. The 7.2 kbps digitizing rate is not supported for main link rates of 256, 384, and 768 kbps. The module is available in three models:
  - KVC.2/E&M: four-wire interface with E&M signaling per RS-464 Types I, II, III and V, and British Telecom SSDC5.
  - KVC.2/FXS: two-wire interface for direct connection to a telephone set. The KVC.2/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages, which can be provided by the RINGER-2000 or KM-RINGER units offered by RAD.
  - KVC.2/FXO: two-wire interface for direct connection to a PABX extension line.

  The KVC.2/FXS and KVC.2/FXO modules are intended for operation in a link, with the KVC.2/FXS on the subscriber side and the KVC.2/FXO on the PABX side.
- **KVC.3** - ADPCM or PCM voice interface module, provides one or two voice channels and support error-free fax transmission. The KVC.3 module utilizes the MPMLQ digitizing algorithm, in accordance with ITU-T Rec. G.823, that generates high-quality voice at user-selectable data rates. The available rates are 4.8, 6.4, 7.2, and 9.6 kbps (7.2 kbps is not supported whenthe main link rate is 256 or 384 kbps). This bandwidth includesin-band E&M signaling and synchronization overhead.
  When operating at a digitized voice data rate of 6.4, 7.2, and 9.6 kbps, the end-to-end voice performance is near toll quality, with a delay of 108 ms. To improve the perceived link quality, the KVC.3 modules include an adaptive echo canceler, that handles near-end reflections (echo delay less than 8 milliseconds) such as reflections caused by a nearby hybrid used for 2W/4W conversion. The echo canceler convergence time is better than ITU-T Rec. G.165 requirements.
  The following KVC.3 models are available:
  - KVC.3/E&M: two voice channels with four-wire or two-wire interface with E&M signaling per RS-464 Types I, II, III and V, and British Telecom SSDC5. The KVC.3/E&M module generates a -12 VDC signaling voltage, which is sufficient for connection to PABX lines, as well as for many short line length applications.
  - KVC.3/FXS: two voice channels with two-wire interface for direct connection to a telephone set. The KVC.3/FXS module requires the connection of external line feed
    (-48 VDC) and ring (+72 VDC) voltages, which can be supplied by a RINGER-2000 or KM-RINGER unit, offered by RAD.

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- KVC.3/FXSP: similar to KVC.3/FXS, except that it has an internal ringer and line feed supply. The internal ringer provides a nominal ring voltage of 23 VRMS, and the nominal line feed voltage is -42 VDC at a line current of 25 mA. These voltages are sufficient for connection to PABX lines, as well as for many short line length applications.
- KVC.3/FXSW: one voice channel similar to the voice channels of the KVC.3/FXS, and one two-wire interface operating with FXO signaling, intended for connection to the PSTN, or to a PABX extension line. The local subscriber connected to the FXS interface can access the multiplexed voice channel, as well as the PSTN/PABX line, and receives all incoming calls from either the multiplexed voice channel or from the PSTN/PABX line. The PSTN/PABX port cannot access the multiplexed link.
- KVC.3/FXO: two voice channels with two-wire interface and FXO loop start signaling for direct connection to a PABX extension line. The KVC.3/FXS, /FXSP, and /FXSW modules, and the KVC.3/FXO module are intended for operation in a link, with the KVC.3/FXS, /FXSP, and /FXSW module, respectively, on the subscriber side and the KVC.3/FXO module on the PABX side.
- KVC.3/S0: one ISDN basic rate access type "S" interface per ITU-T Rec. G.723 for direct connection to an ISDN PABX. This version enables extending voice and fax access to locations at which direct access to the ISDN facilities is not available, or is not cost-effective. The extension is provided over the KILOMUX-2000 data link, by converting the PCM-coded voice channels carried by the two B channels of the "S" interface to low bit rate voice channels that can be effectively transmitted over the data link.

The KVC.3/S0 module can be configured to operate in the TE (terminal equipment) mode, e.g., when connected to an ISDN switch, or the NT (network termination) mode, e.g., when connected to the user's terminal equipment.

- **KLS.1** - Low-speed RS-232 data sub-multiplexer module. The KLS.1 module provides two low-speed RS-232/V.24 synchronous or asynchronous data channel interfaces with tail-end capabilities. The RS-232 sub channel data rates are in the range of 300 to 64 kbps (up to 64 kbps for synchronous operation).
- **KLS.2** - Low-speed RS-232 four-channel asynchronous statistical data sub-multiplexer module. The sub-channel data rates are in the range of 300 bps to 19.2 kbps, and the composite data rate is up to 19.2 kbps. The KLS.2 module is fully compatible with the RAD STM-4 Four Channel Statistical Multiplexer.

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- **KHS.1** - High-speed data interface module, provides two high-speed V.35, RS-530, RS-449/RS-422 or X.21 data channels. Channel data rates are user-selectable: 32, 48, 56, 64, 128 or 192 kbps, in accordance with the main link rate.
- **KHS.2** - Two-channel synchronous data module. The module provides two synchronous data channels with independently selectable data rates. The supported channel data rates, as well as the total data rates, depend on the data rate of the KILOMUX-2000 main link, and cover the range of 2.4 to 614.4 kbps. Both channel interfaces are configured as DCE, and can be independently configured for either V.35/RS-530, V.36/RS-530, V.24/RS-232, or X.21 operation.
- **KHS.U** - Data interface module, provides one or two ISDN basic access rate type "U" interfaces. The KHS.U module enables the extension of ISDN lines over non-ISDN facilities. The module is available in two versions:
  - KHS.U/S with one "U" interface.
  - KHS.U/D with two "U" interfaces.

  Each "U" interface carries two B (64 kbps) channels and one D (16 kbps) channel. Each channel can be independently connected to the KILOMUX-2000 main link. Each B channel can be individually configured to support payload data rates of 16, 32, and 64 kbps. Therefore, the user needs allocate main link bandwidth only in accordance with the actual payload carried by the module channels. The KHS.U modules can operate over main link data rates up to 384 kbps.

  The KHS.U module can be configured to operate as NT (network termination), e.g., when connected to the ISDN switch, or as LT (line termination), e.g., when connected to the user's terminal equipment.
- **KVF.1** - Single-channel voice/fax relay module, allows the transmission of voice and standard Group III fax signals over the KILOMUX-2000 link with automatic switch-over between voice and fax modes. Requires main link bandwidth of 6.4, 7.2, 8 or 9.6 kbps. The 7.2 kbps digitizing rate is not supported for main link rates of 256, 384 and 768 kbps.
  The KVF.1 supports fax rates of 7.2, 4.8, and 2.4 kbps. Using automatic fallback to the highest usable rate, the KVF.1 also operates with 9.6 kbps machines. To improve fax transmission characteristics, an internal equalizer allows compensation for long cable runs (up to 7.2 km on typical subscriber loop cable).
  The module is available in three models:
  - KVF.1/E&M: four-wire interface with E&M signaling per RS-464 Types I, II, III and V, and British Telecom SSDC5.
  - KVF.1/FXS: two-wire interface for direct connection to a phone/fax machine. The KVF.1/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages, which can be provided by the RINGER-2000 or KM-RINGER units offered by RAD.

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- KVF.1/FXO: two-wire interface for direct connection to a PABX extension line.

The KVF.1/FXS and KVF.1/FXO modules are intended for operation in a link, with the KVF.1/FXS on the fax side and the KVF.1/FXO on the PABX side.

- **KVF.3** - Single-channel voice/fax relay module, allows the transmission of voice and standard Group III fax signals over the KILOMUX-2000 link with automatic switch-over between voice and fax modes.
  The KVF.3 provides voice signals of quality equivalent to 32 kbps ADPCM coding, while using data rates of only 6.4, 7.2, or 9.6 kbps, and still provides a high quality at 4.8 kbps (the 4.8 kbps data rate is not supported when the main link rate is 512 or 768 kbps, and the 7.2 kbps data rate is not supported when the main link rate is 256 kbps and higher).
  The KVF.3 supports fax rates of 7.2, 4.8, and 2.4 kbps. Using automatic fallback to the highest usable rate, the KVF.1 also operates with 9.6 kbps machines. To improve fax transmission characteristics, an internal equalizer allows compensation for long cable runs (up to 7.2 km on typical subscriber loop cable).
  The module is available in four models:
  - KVF.3/E&M: four-wire interface with E&M signaling per RS-464 Types I, II, III and V, and British Telecom SSDC5.
  - KVF.3/FXS: two-wire interface for direct connection to a phone/fax machine. The KVF.3/FXS module requires the connection of external line feed (-48 VDC) and ring
    (+72 VDC) voltages, which can be provided by the RINGER-2000 or KM-RINGER units offered by RAD.
  - KVF.3/FXSP: similar to KVF.3/FXS, except that it requires an external -48 VDC source to supply the signaling voltage for increasing the maximum allowed line length. The signaling voltage can be supplied by a RINGER-2000 or KM-RINGER unit offered by RAD.
  - KVF.3/FXO: two-wire interface for direct connection to a PABX extension line.

  The KVF.3/FXS, KVF.3/FXSP and KVF.3/FXO modules are intended for operation in a link, with the KVF.3/FXS or KVF.3/FXSP on the fax side and the KVF.3/FXO on the PABX side.

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- **KVF.4** - Voice/fax relay module using advanced digital signal processing (DSP) techniques to provide one or two channels for transmission of voice and standard Group III fax signals over the KILOMUX-2000 link with automatic switch-over between voice and fax modes.
  The KVF.4 provides voice signals of quality equivalent to 32 kbps ADPCM coding, while using data rates of only 6.4, 7.2, 9.6, or 12.8 kbps, and still provides a high quality at 4.8 kbps (the 4.8 kbps data rate is not supported when the main link rate is 512 or 768 kbps, and the 7.2 kbps data rate is not supported when the main link rate is 256 kbps and higher).
  The KVF.4 supports fax rates of 9.6, 7.2, 4.8, and 2.4 kbps, with automatic fallback. To improve fax transmission characteristics, an internal equalizer allows compensation for long cable runs (up to 7.2 km on typical subscriber loop cable).
  The KVF.4 module is available in following versions:
  - KVF.4/E&M: two channels with four-wire or two-wire interface with E&M signaling per RS-464 Types I, II, III and V, and British Telecom SSDC5. The KVF.4/E&M module generates a -12 VDC signaling voltage, which is sufficient for connection to PABX lines, as well as for many short line length applications.
  - KVF.4/E&M/E: similar to the KVF.4/E&M, except that it requires an external -48 VDC source to supply the signaling voltage for increasing the maximum allowed line length. The signaling voltage can be supplied by a RINGER-2000 or KM-RINGER unit, offered by RAD.
  - KVF.4/FXS: two voice channels with two-wire interface for direct connection to a telephone set. The KVC.1M/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages, which can be supplied by a RINGER-2000 or KM-RINGER unit, offered by RAD.
  - KVF.4/FXS3: similar to KVF.4/FXS, except it supports metering.
  - KVF.4/FXSP: similar to KVF.4/FXS, except that it has an internal ringer and line feed supply. The internal ringer provides a nominal ring voltage of 23 VRMS, and the nominal line feed voltage is -42 VDC at a line current of 25 mA. These voltages are sufficient for connection to PABX lines, as well as for many short line length applications.
  - KVF.4/FXSW: one channel similar to the channels of the KVF.4/FXS, and one two-wire interface operating with FXO signaling, intended for connection to the PSTN, or to a PABX extension line.
    The local subscriber connected to the FXS interface can access the multiplexed link, as well as the PSTN/PABX line, and receives all incoming calls from either the multiplexed link or from the PSTN/PABX line. The PSTN/PABX port cannot access the multiplexed link.

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- KVF.4/FXO: two channels with two-wire interface and FXO loop start signaling for direct connection to a PABX extension line.
- KVF.4/FXO3: similar to KVF.4/FXO, execpt it supports metering.

Note *The KVF.4/FXS, /FXS3, /FXSP, and /FXSW modules, and the KVF.4/FXO and /FXO3 modules are intended for operation in a link, with the KVF.4/FXS, /FXS3, /FXSP, and /FXSW modules, respectively, on the subscriber side and the KVF.4/FXO and /FXO3 modules on the PABX side.*

- KVF.4/S0: one ISDN basic rate access type "S" interface for direct connection to an ISDN PABX. This version enables extending voice and fax access to locations at which direct access to the ISDN facilities is not available, or is not cost-effective. The extension is provided over the KILOMUX-2000 data link, by converting the PCM-coded voice channels carried by the two B channels of the "S" interface to low bit rate voice channels that can be effectively transmitted over the data link.

  The KVF.4/S0 module can be configured to operate in the TE (terminal equipment) mode, e.g., when connected to an ISDN switch, or the NT (network termination) mode, e.g., when connected to the user's terminal equipment.

- KVF.4/NS0: similar to KVF.4/S0, execept it supports D channel compression.

- **KVF.5** - Voice/fax relay module with T1 or E1 sub interface, uses advanced digital signal processing (DSP) techniques (MPMLQ - Multipulse Maximum Likelihood Quantization in accordance with ITU-T Rec. G.723.1) to allow the transmission of Group III facsimile and high-quality compressed voice signals while requiring, for each channel, a bandwidth of only 4.8, 6.4, 7.2, 9.6, or 12.8 kbps on the KILOMUX-2000 main link. When operating at rates of 6.4, 7.2, 9.6, or 12.8 kbps, the voice quality provided by the KVF.5 module is equivalent to that achieved by 32 kbps ADPCM encoding; high-quality voice is maintained even at a transmission rate of 4.8 kbps.
  The KVF.5 module is available in four versions, that differ in the type of sub link interface:

  - KVF.5/T1/M: KVF.5 "master" module with balanced T1 sub link interface, for connection to PABX's with T1 interface. As an option, the T1 interface of the KVF.5/T1/M module can be equipped with a CSU.
  - KVF.5/E1/M: KVF.5 "master" module with balanced and unbalanced E1 sub link interfaces, for connection to PABX's with E1 interface. As an option, the E1 interface of the KVF.5/E1/M module can be equipped with an LTU.
  - KVF.5/T1/S: basic KVF.5 "slave" module without sub link interface. This version is intended for use together with a KVF.5/T1/M module to increase the number of compressed voice channels beyond the four channels that can be handled by a single module.

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- KVF.5/E1/S: basic KVF.5 "slave" module without sub link interface. This version is intended for use together with a KVF.5/E1/M module to increase the number of compressed voice channels beyond the four channels that can be handled by a single module.

The T1 or E1 sub link interface of KVF.5 modules enables direct connection to a digital PABX. Each KVF.5 module converts up to four consecutive time slots of the E1 or T1 sub link data stream to compressed voice/fax channels. When the number of voice channels that can be compressed is more than four, several KVF.5 modules can operate as a group. A group is formed by interconnecting the dedicated expansion ports of the KVF.5 modules.

- A group of six KVF.5 modules (one KVF.5/T1/M and five KVF.5/T1/S) can serve a full T1 trunk (24 voice channels), while using a bandwidth that is as little as 115.2 kbps (at 4.8 kbps digitizing rate), including in-band signaling and synchronization overhead. At the highest rate (12.8 kbps), the required bandwidth is still only 307.2 kbps.
- A group of eight KVF.5 modules (one KVF.5/E1/M and seven KVF.5/E1/S) can serve a full E1 trunk (30 voice channels), while using only a bandwidth of 144 kbps (at 4.8 kbps) up to a maximum of 384 kbps (at 12.8 kbps), including in-band signaling and synchronization overhead.

- **KTRE** - Token ring extender module. Two KTRE modules, installed in two KILOMUX-2000 units, allow the connection of up to 80 token ring workstations attached to a remote token ring LAN to the main LAN via the KILOMUX-2000 link. The KTRE modules support both 4 and 16 Mbps token ring LAN rates; moreover, the remote and main LAN rates can operate at different rates, e.g., a pair of KTRE modules allow the connection of 4 Mbps token ring workstations to a 16 Mbps token ring, and vice versa. The KTRE modules are fully compatible with the other token ring extenders offered by RAD: the stand-alone TRE-8 unit and the RADring TRE module. Thus, a stand-alone TRE-8 unit or a RADring TRE module, connected to a high-speed data module installed in one KILOMUX-2000, e.g., a KHS.2 module operating at the same rate as the KTRE module, can be connected to a KTRE module installed in the other KILOMUX-2000.
- **KMBE** - Elementary Ethernet bridge module. Two KMBE modules, installed in two KILOMUX-2000 units, allow the connection of up to 80 Ethernet workstations attached to a remote Ethernet LAN to the main LAN via the KILOMUX-2000 link.
  The KMBE modules are fully compatible with the MBE-8 Elementary Ethernet Bridge offered by RAD. Thus, a stand-alone MBE-8 unit, connected to a high-speed data module installed in one KILOMUX-2000, e.g., a KHS.2 module operating at the same rate as the KMBE module, can be connected to a KMBE module installed in the other KILOMUX-2000.

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1.3 Application Considerations

Basic KILOMUX-2000 System

Basic System Structure

The basic KILOMUX-2000 system consists of two KILOMUX-2000 units connected by a single link, as shown in figure 1-3.

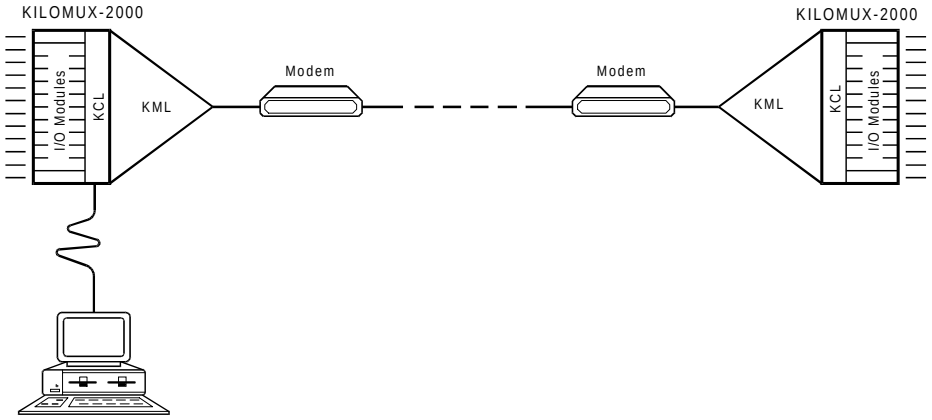

Figure 1-3. Basic KILOMUX-2000 System Structure

System Multiplexing Capabilities

To provide the flexibility necessary to support up to 12 I/O modules of various types, with each module capable of operation in several modes, the KILOMUX-2000 system uses permanent on-demand allocation of main link bandwidth. This means that bandwidth is permanently allocated to the active channels of each module when the module is inserted into the KILOMUX-2000 enclosure, and the allocation is made in accordance with the selected data rate and the end-to-end signaling requirements of each channel. The main link bandwidth is dynamically reallocated when a change occurs in the number of modules or of active module channels, or when the operating mode of the main link or of the modules are changed. For special applications, the user can disable the automatic allocation and perform manual allocation.

Although in general dynamic on-demand bandwidth allocation requires that the link is resynchronized after each change in allocation, the allocation algorithm used by the KILOMUX-2000 has been optimally designed so it does not require resynchronization, but only reallocation of time slots, thereby reducing the disruption to other channels when the bandwidth required by a module or a module channel changes. In many cases, the required changes are made even without time slot reallocation: for example, disconnecting or reducing the data rate carried by a channel never requires reallocation.

Bandwidth allocation is performed by organizing the data in frames. Frame length varies with the main link data rate, as listed in Table 1-1.

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Table 1-1. KILOMUX-2000 Multiplexing Data

Main Link Rate	Frame Length	Bandwidth Allocation Unit	Bandwidth Available to User	
			With Management Ch	Without Management Ch
9.6 kbps	24 bits	0.4 kbps	8.8 kbps (22 units)	9.2 kbps (23 units)
14.4 kbps	36 bits	0.4 kbps	13.6 kbps (34 units)	1.4 kbps (35 units)
19.2 kbps	48 bits	0.4 kbps	18.4 kbps (46 units)	18.8 kbps (47 units)
28.8 kbps	72 bits	0.4 kbps	28 kbps (70 units)	28.4 kbps (71 units)
32 kbps	80 bits	0.4 kbps	31.2 kbps (78 units)	31.6 kbps (79 units)
48 kbps	60 bits	0.8 kbps	46.4 kbps (58 units)	47.2 kbps (59 units)
56 kbps	70 bits	0.8 kbps	54.4 kbps (68 units)	55.2 kbps (69 units)
64 kbps	80 bits	0.8 kbps	62.6 kbps (78 units)	63.2 kbps (79 units)
128 kbps	160 bits	0.8 kbps	126.6 kbps (158 units)	127.2 kbps (159 units)
192 kbps	240 bits	0.8 kbps	190.4 kbps (238 units)	191.2 kbps (239 units)
256 kbps	160 bits	1.6 kbps	252.8 kbps (158 units)	254.4 kbps (159 units)
384 kbps	240 bits	1.6 kbps	381.8 kbps (238 units)	382.4 kbps (239 units)
512 kbps	160 bits	3.2 kbps	505.6 kbps (158 units)	508.8 kbps (159 units)
768 kbps	240 bits	3.2 kbps	761.6 kbps (238 units)	764.8 kbps (239 units)

The allocation of bandwidth is performed in discrete units. Unit size is 0.4, 0.8, 1.6, or 3.2 kbps, in accordance with main link data rate.

Bandwidth allocations must be made for the following uses:

- KILOMUX-2000 frame synchronization.
- Inter-unit management channel. This channel has two main functions:
  - Allows configuration downloading from a master unit to a slave.
  - Transfer of status information from slave to master.

  Therefore, when using the master-slave mode the management channel is allocated the necessary bandwidth even when downloading is disabled.
- Channel data.
- Channel end-to-end signaling.

Table 1-2 provides bandwidth allocation information. The use of the information presented in the table to calculate the bandwidth required for various operating configurations is illustrated by a numerical example that follows the table.

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Table 1-2. Bandwidth Allocations

Use	Allocation Units					Allocation Rule
Frame Synchronization	1					Mandatory
Management Channel	1					Optional (recommended)
Channel Data	Channel	Main Link Rate (kbps)				
	Rate	9.6 to 32	48 to 192	256, 384	512, 768	
All Modules	300 bps	3	3	3	3	In accordance with channel data rate. Theoretical minimum is 1 allocation unit per active channel. For low rate data (i.e., for data rates lower than the bandwidth allocation unit), oversampling is used to achieve an integer number of bit samples, e.g., when the bandwidth allocation unit is 0.8 kbps and the channel data rate is 300 bps, the effective bandwidth used is 8 times higher, 2.4 kbps. 2.4 kbps translate to 3 allocation units. Therefore, the effect of oversampling is to increase the bandwidth used to transfer low-rate channels. 64 kbps rate available only for main link rates of 128 kbps and higher
	600 bps	3	3	3	3	
	1.2 kbps	3	3	3	3	
	2.4 kbps	6	3	3	3	
	4.8 kbps	12	6	3	3	
	6.4 kbps	16	8	4	2	
	7.2 kbps	18	9	N/A	N/A	
	8 kbps	20	10	5	N/A	
	9.6 kbps	24	12	6	3	
	14.4 kbps	36	18	9	N/A	
	16 kbps	40	20	10	5	
	19.2 kbps	48	24	12	6	
	24 kbps	60	30	15	N/A	
	28.8 kbps	72	36	18	9	
	32 kbps	80	40	20	10	
	38.4 kbps	–	48	24	12	
	48 kbps	–	60	30	15	
	56 kbps	–	70	35	N/A	
	57.6 kbps	–	72	36	18	
	64 kbps	–	80	40	20	
	67.2 kbps	–	84	42	21	
	76.8 kbps	–	96	48	24	
	86.4 kbps	–	108	54	27	
	96.0 kbps	–	120	60	30	
	105.6 kbps	–	132	66	33	
	115.2 kbps	–	144	72	36	
	124.8 kbps	–	156	78	39	
	128 kbps	–	–	80	40	
	160 kbps	–	–	100	50	
	192 kbps	–	–	120	60	
	224 kbps	–	–	140	70	
	240 kbps	–	–	150	75	
	272 kbps	–	–	170	85	
	304 kbps	–	–	190	95	
	336 kbps	–	–	210	105	
	368 kbps	–	–	230	115	
KHS.2 Only	N × 2.4	N × 6	N × 3	–	–	
	N × 4.8	–	–	N × 3	–	
	N × 9.6	–	–	–	N × 3	
Channel End-to-End Control Signals	1 allocation unit per module or for each two channels of the same module, when applicable (1 allocation unit can carry up to four control signals, e.g., two signals for two channels)					For each channel that requires end-to-end signaling, including voice channels

Note *Modules which transmit the signaling information in-band, e.g., KVF.1 and KVC.2, do not require bandwidth allocation for channel end-to-end signaling.*

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Bandwidth Allocation Example

A KILOMUX-2000 enclosure equipped as follows is connected to a 256 kbps link. The following table lists the required bandwidth allocation.

Modules Installed in Enclosure	Allocation Units
Five KLS.1 with 4.8 kbps per channel (total of 10 channels); seven channels (distributed among four modules) require end-to-end signaling	30 units 4 units signaling
Two KLS.1 with 9.6 kbps per channel (total of 4 channels), no end-to-end signaling	24 units
One KLS.2 with composite data rate of 19.2 kbps	12 units
One KHS.1 with 64 kbps per channel, no end-to-end signaling	40 units
One KVC.1 module at 32 kbps per channel	40 units 1 unit signaling
Total user allocation Frame synchronization and management channel	151 units 2 units
Total capacity used	153 units
Reserve capacity	7 units (11.2 kbps)

Redundancy

The minimum KILOMUX-2000 system configuration requires only one KPS module, one KCL module and one KML module. For critical applications, system availability can be increased by installing redundant modules in the enclosure.

The redundancy capability is available for two critical functions: the main link and the power supply. A failure in either one of these functions, e.g., because of link failure or loss of power, could disable the whole system, whereas a failure in an I/O module affects only a small part of the system, and can generally be overcome by using alternate routes, putting unused capacity into service, etc.

The KILOMUX-2000 system is designed to put automatically a redundant module in service in case the corresponding module fails, thereby ensuring continuous system operation in the event of any single module failure. Moreover, redundant modules may be inserted or removed even while the system operates, without disrupting the traffic or degrading the system performance.

The utilization of the redundant modules is explained below.

KPS Module Redundancy

The KPS module supplies the operating voltages to the KILOMUX-2000. A single KPS module can provide the full power requirements of an enclosure. However, a second KPS module may be added. With a redundant KPS module, both modules are connected to power and share the load when the system is operating. If one module (or its power source) fails, the second module automatically takes up the full load.

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To maximize the protection conferred by the use of redundant power supply modules, observe the following recommendations:

- Whenever possible, connect each of the two KPS modules to a different power circuit. Thus, if the circuit breaker that protects one of the power circuits trips, the other module continues to receive power.
- If -48 VDC battery backup is available, install one DC-powered KPS.3 module and one AC-powered module. Make sure to select power supply modules with comparable ratings, e.g., KPS.6 and KPS.7.

KML Module Redundancy

The KML module serves as the connecting link between the KILOMUX-2000 unit and the communication channel. For extra protection, a second KML module, not necessarily of the same type, may be installed in parallel to the primary KML module. The two KML modules are then connected through two independent links, that may even follow different paths, to two similar modules located at the remote end of the link. In the switched backup mode, the two links can be operated at different data rates.

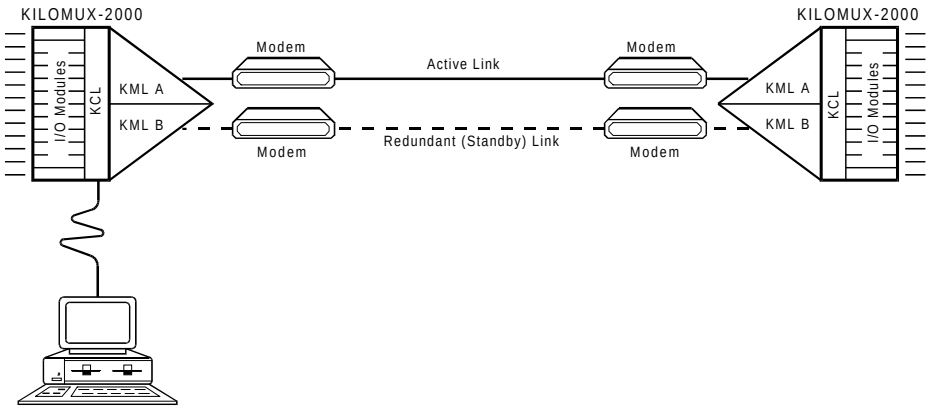

Figure 1-4. Redundant KILOMUX-2000 System

Each KML module is connected to an independent internal bus. The internal buses reach each I/O module installed in the enclosure, therefore each module has equal access to each KML module.

When redundancy is enabled, the redundant KML module is automatically programmed exactly like the primary, but its bus is electrically disconnected from the other modules installed in the enclosure. If the primary KML module (or its communication) fails, the other modules are disconnected from the bus of the failed module and connected to the bus of the redundant KML module, which then takes over.

The operator of the KILOMUX-2000 unit can select the primary (active) KML module, e.g., in order to switch back to the preferred link after redundancy switching has occurred.

This arrangement provides redundancy at both the module and the link level.

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Dual Link Operation

Basic Dual-Link Configurations

As an option, the KILOMUX-2000 allows independent operation of its two multiplexing subsystems. Therefore, by connecting two main links to one KILOMUX-2000 equipped with two KML modules it is possible to double the number of payload time slots.
Two dual-link topologies are possible:

- High capacity point-to-point link. A typical system configuration is shown in figure 1-5.
- Two independent links, as shown in figure 1-6. The two links can operate at different data rates.

Modules installed in the enclosure can be freely connected to either of the two links, the only restriction being that all the subchannels of a given module must be assigned to the same link.

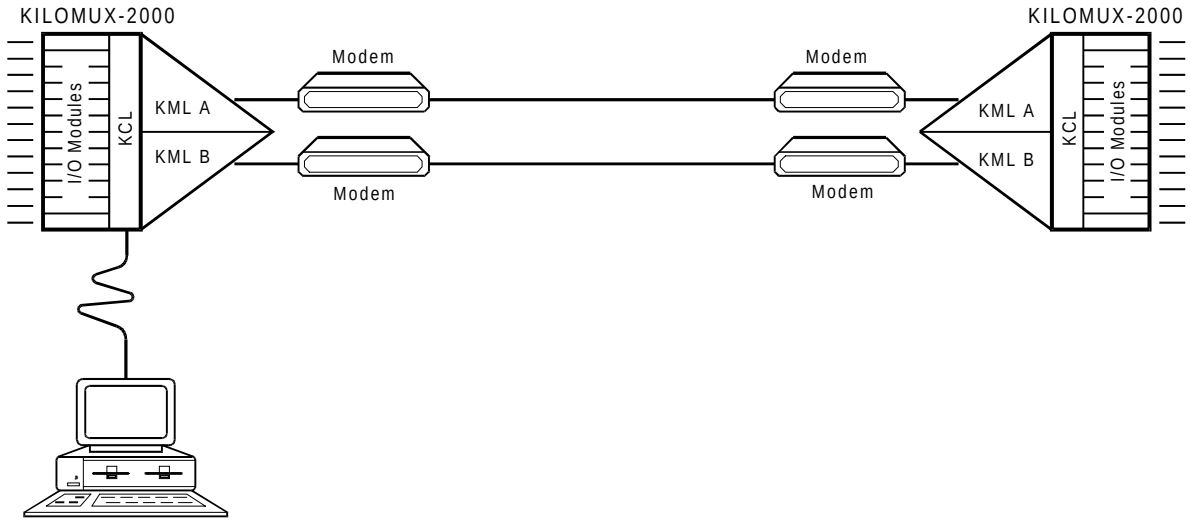

Figure 1-5. Dual Link, High Capacity Point-to-Point Application

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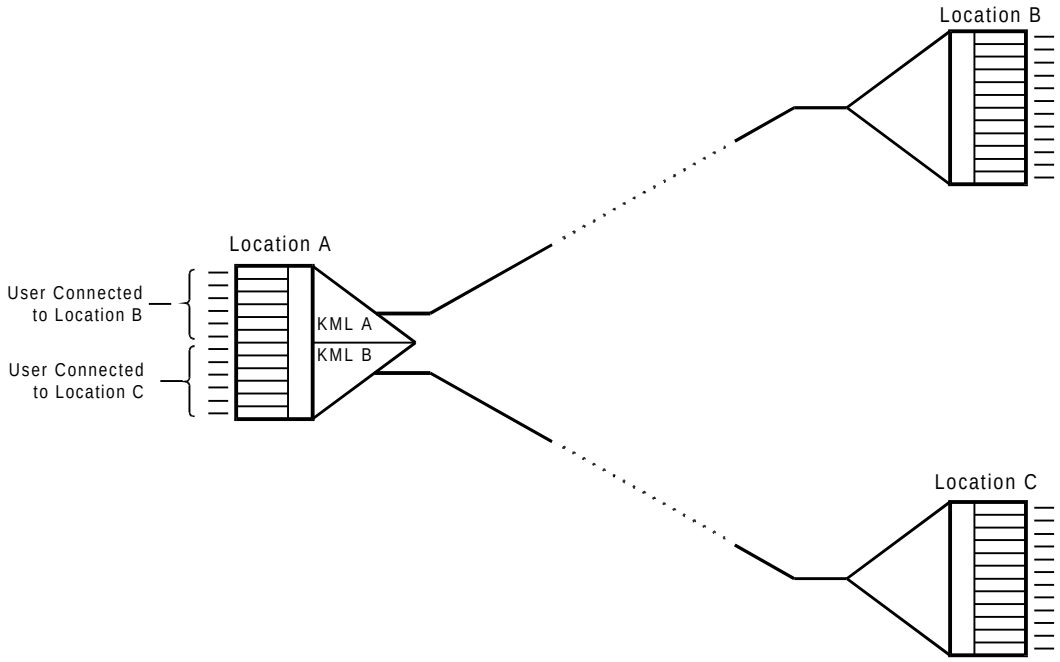

Figure 1-6. Dual Link System, Independent Link Application

Bypassing Configurations

Dual-link configurations also enable direct transfer of channel between the two links (this is called ***bypassing***). This function requires the presence of a KDI module in the KILOMUX-2000.

Figure 1-7 shows the operation of the basic bypassing configuration.

In figure 1-7, some of the users at location A are connected to users at location B, and other users at location A are connected, using the bypassing function of the KDI module, to users at location C (the connection is full duplex). As explained above, with respect to bypassing, the multidrop channel is handled either as a bypassed channel, or as a dropped channel, depending on the state of the RTS line.

The KDI module supports the bypassing of one contiguous block of bits from one link to the other. The bypassed block is specified by three parameters:

- The position of the first bit (the starting bit) of the block to be bypassed in the multiplexed frame of main link A.
- The number of bits to be bypassed (the block size).
- The position of the first bit (the starting bit) of the block in the frame of main link B. This may differ from the starting bit on main link A.

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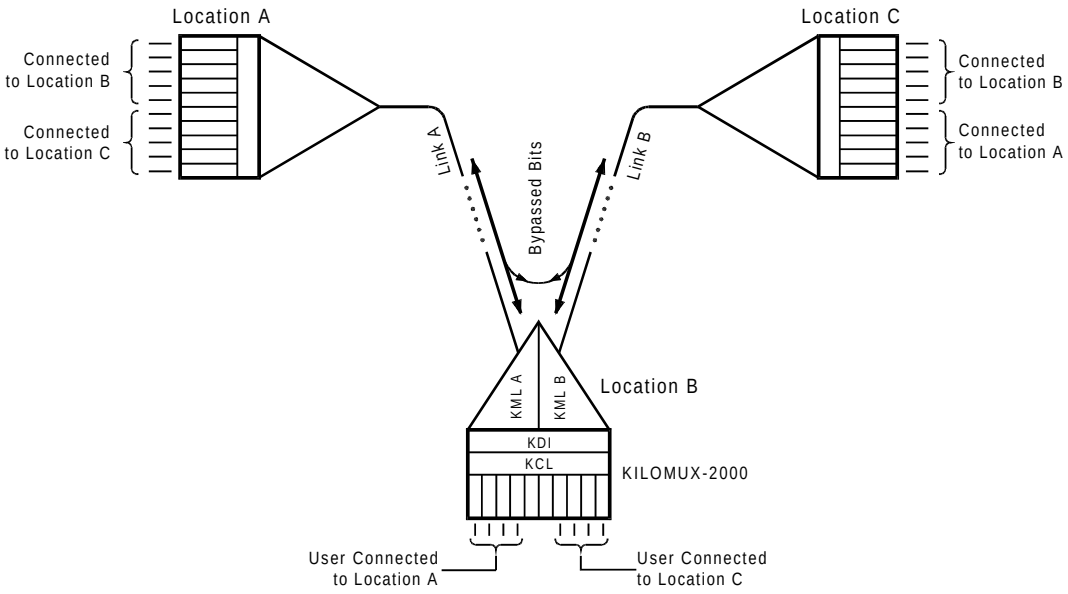

Figure 1-7. Basic Bypassing Configuration

Figure 1-8 shows an example of bit routing between the various units.

Since the bypassing is bit-oriented, the two KILOMUX-2000 links can operate at different data rates, but they must use bandwidth allocation units of equal sizes (see Table 1-1 for allowable selections). Therefore, the bypassing can be performed between links operating at rates within the same group of rates:

- 9.6, 14.4, 19.2, 28.8, or 32 kbps (0.4 kbps bandwidth allocation unit).
- 48, 56, 64, 128 or 192 kbps (0.8 kbps bandwidth allocation unit).
- 256 or 384 kbps (1.6 kbps bandwidth allocation unit).
- 512 or 768 kbps (3.2 kbps bandwidth allocation unit).

In order for the user to be able to specify the allocation of main link bits to the individual channels, the structure of the main link frame must be specified by the user. Therefore, in a bypassing application the automatic bit allocation algorithm used by the KILOMUX-2000 must be disabled, and the allocation must be manually performed. Manual allocation is required for all the participating KILOMUX-2000.

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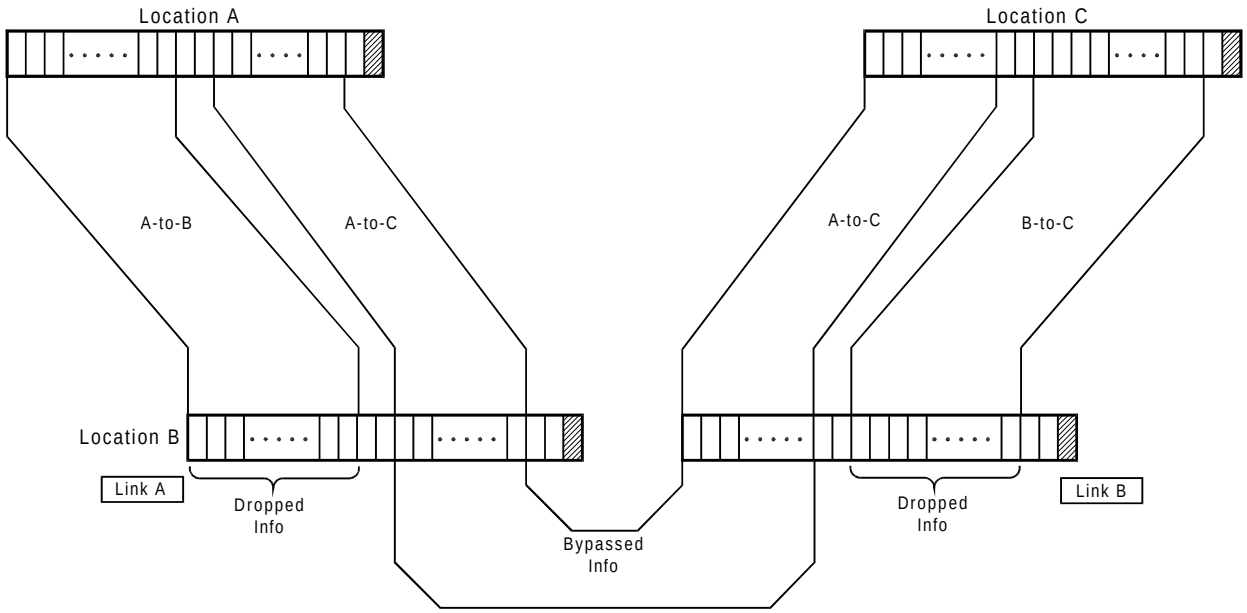

Figure 1-8. Bypassing Parameters

Note *Manual main link bit allocation can be performed only when downloading is disabled. Note that when downloading is disabled, there is no need to allocate main link bandwidth for the KILOMUX-2000/KILOMUX-2004 management channel.*

The manual allocation is performed at the level of individual channels, therefore the channels of a given I/O module can be routed to different KILOMUX-2000 units. This is however possible only if the following conditions are met:

- The I/O modules are not located at a bypassing location, i.e., are not installed in a KILOMUX-2000 unit with an active KDI module.
- The I/O modules whose channels are to be routed to different KILOMUX-2000 units do not use end-to-end transmission of control signals; otherwise, all the channels of an I/O module using end-to-end transmission of control signals must be routed to a single module (this implies that they must be bypassed or dropped together at the same KILOMUX-2000).

Figure 1-9 shows a typical bypassing application.

In the application shown in figure 1-9, two KILOMUX-2004 multiplexers, located at two branch offices, are connected to the KILOMUX-2000 located at the central site. The KDI module installed in the KILOMUX-2000 located at the central site provides a direct connection between the two KILOMUX-2004 units via the central site for selected channels. The connection is performed by transferring (bypassing) the desired group of main link frame bits between the two main link modules. For example, in figure 1-7 the bypassed time slots could be used to connect between the two KVF.1 modules identified by No. 2, which are installed in the two KILOMUX-2004 units.

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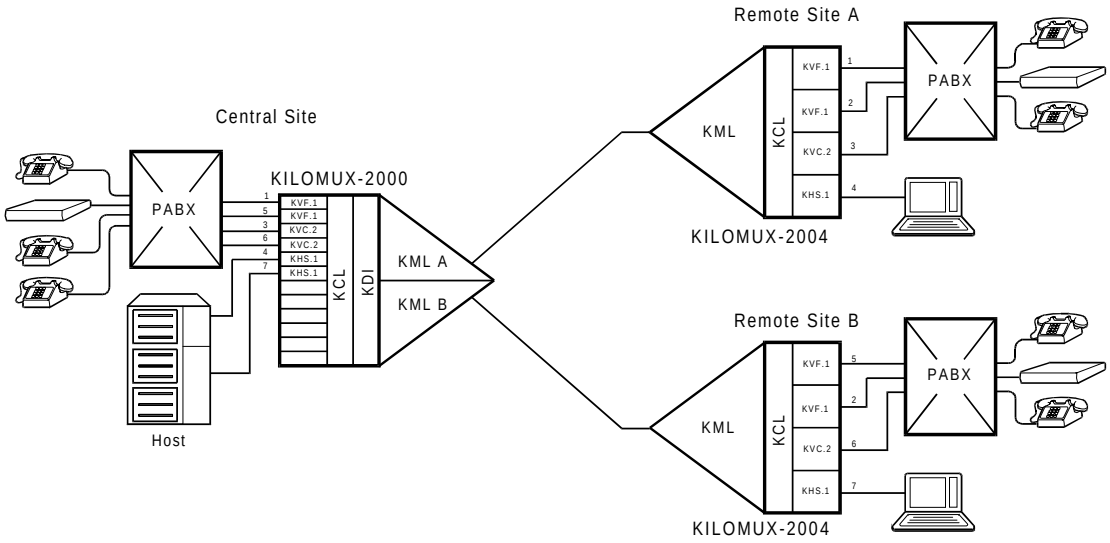

Figure 1-9. Typical Bypassing Application

Channels that are not bypassed are connected to users connected to the KILOMUX-2000 at the central site: for example, the two channels of the KVC.2 module at location A (identified by No. 3) are connected to the channels of the KVC.2 module also identified by No. 3 which is installed at the central site, and the KHS.1 module at location B (identified by No. 7) is connected to the KHS.1 module at the central site.

Fully digital transmission for bypassing voice channels is an essential requirement to the preservation of high-quality voice reproduction when low bit rate voice compression is used, because it eliminates back-to-back analog interconnections at intermediate locations, and the ensuing analog-to-digital and digital-to-analog conversions. Full digital transmission has significant advantages for data channels as well, because it does away with the cables that would otherwise be required for the connection of data channels, and provides the equivalent of an electronic cross-connect function (programmable by the same means used to control the operation of the KILOMUX-2000).

Multidrop Configurations

The KDI/M module version includes a data channel interface for multidrop configurations. The multidrop channel is compatible with the data channels of the KLS.1/NEW low-speed data module, and supports data rates in the range of 0.3 to 64 kbps.

As is standard practice in a multidrop application, the receive path of the local multidrop channel continuously receives the traffic carried in the allocated bandwidth on the desired main link, e.g., link A, and in addition the same data is also bypassed to the other link, to make it available downstream. The transmit path of the multidrop channel is connected to main link A only when the RTS line in the local interface is asserted. A typical bypassing and multidrop configuration is shown in figure 1-10.

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In the application shown in figure 1-10, the multidrop channel of the KDI module is used to connect between the host computer (connected to a data channel of a KLS.1/NEW module installed in the KILOMUX-2000 situated at the central site), and several data terminals located at other locations. The communication is based on a polled protocol, whereby the host operates as the master and arbitrates the traffic on the multidrop link by addressing the DTE's one at a time. The multidrop feature operates as follows:

- All the DTE's connected along the link can receive the data sent by the host, because all the multidrop channels of all the KILOMUX-2000 are allocated bandwidth on link A. In addition, the bandwidth allocated to the multidrop channels is also designated for bypassing to link B, to enable all the downstream DTE's to receive the host.
- When a DTE connected to a KDI/M module has data to transmit toward the host, it must assert its RTS line. The assertion of the RTS line in the multidrop channel interface changes the routing of the main link data by the corresponding KDI/M module:
  - The KDI/M module disconnects the bypassing connection of the multidrop channel data to main link B, and the channel data is dropped locally. As long as the RTS line is asserted, the DTE remains connected to main link A, just as in a point-to-point connection.
  - When the RTS line is deasserted (at the end of DTE transmission), the KDI/M module stops dropping the channel data, and the bypassing path is re-established.

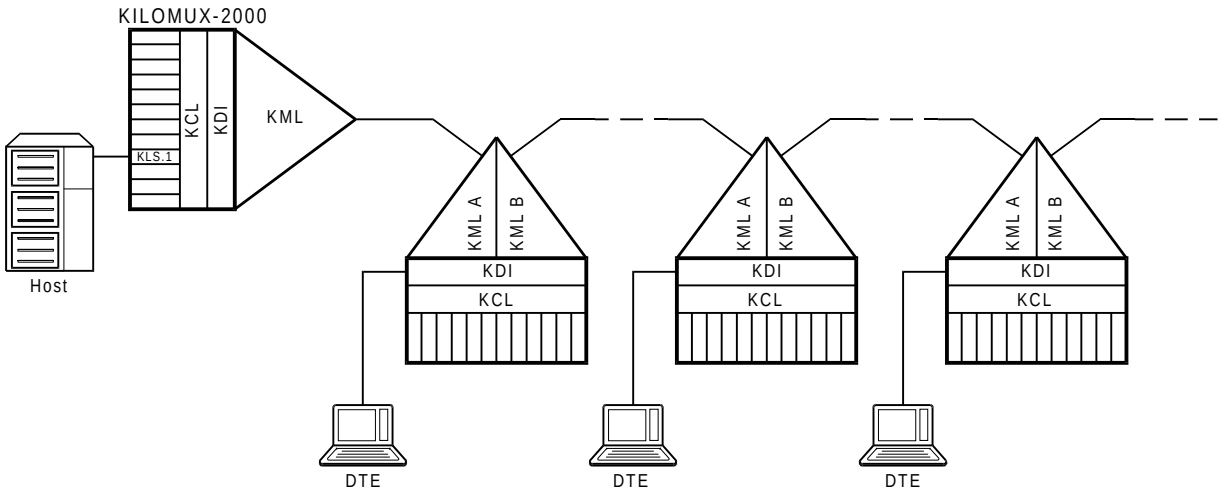

Figure 1-10. Typical KDI Bypassing and Multidrop Application

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Priority Bumping

With optional point-to-point dual-link configurations, such as shown in figure 1-5, the KILOMUX-2000 allows to provide the equivalent of hot-standby protection to critical data channels, without paying for unutilized bandwidth. This feature is called ***priority bumping.***

When priority bumping is selected, the system administrator can define the critical channels as high-priority channels. The high-priority channels can be assigned time slots on either of the two links in accordance with system requirements. Low-priority channels can then be added up to the maximum combined bandwidth of the two links.

When the two main links operate at different data rates, it is possible to select different priorities for switching, from link A to link B, and from link B to link A.

During normal operation, i.e., when both links are operational, all the channels are carried by the assigned links. When one of the links fails, the high-priority channels carried by the failed link are automatically switched over to the operational link. When the management channel is carried by a main link time slot, it is always handled as a high-priority channel.

Switched Backup Operation

The KILOMUX-2000 provides a switched backup mode of operation, that allows the use of dial-up modems operating on low-cost switched data lines (PSTN mode) or ISDN basic access lines as a backup to the main link (ISDN backup mode, based on the use of the KML.10 main link module). The KILOMUX-2000 allows flexible programming of the switched backup option on a weekly basis. For each day of the week, it is possible to define up to four different time periods, and to specify, for each period, whether the use of the switched backup function is allowed.

The backup capabilities can be determined in two ways:

- By entering the desired configuration in the alternate data base stored by the KILOMUX-2000. This method allows the system administrator to freely select which channels will be transmitted when the backup link is in use, and to specify for these channels different data rates when using the backup link. Note that in this mode the alternate data base is dedicated to the backup link, so the "day/night" configuration option cannot be used.
- By defining the channels to be carried when the backup link is used as high-priority channels. In this case, the channel data rates cannot be changed with respect to normal operation, but the backup configuration is contained in the on-line data base. Therefore, it is possible to prepare "day/night" configurations using the two KILOMUX-2000 data bases.

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Switched Backup Using Dial-up Modems

A typical PSTN switched backup configuration is shown in figure 1-11. In this configuration, one of the links is configured to carry the normal traffic, and the other link is configured to serve as the backup link.

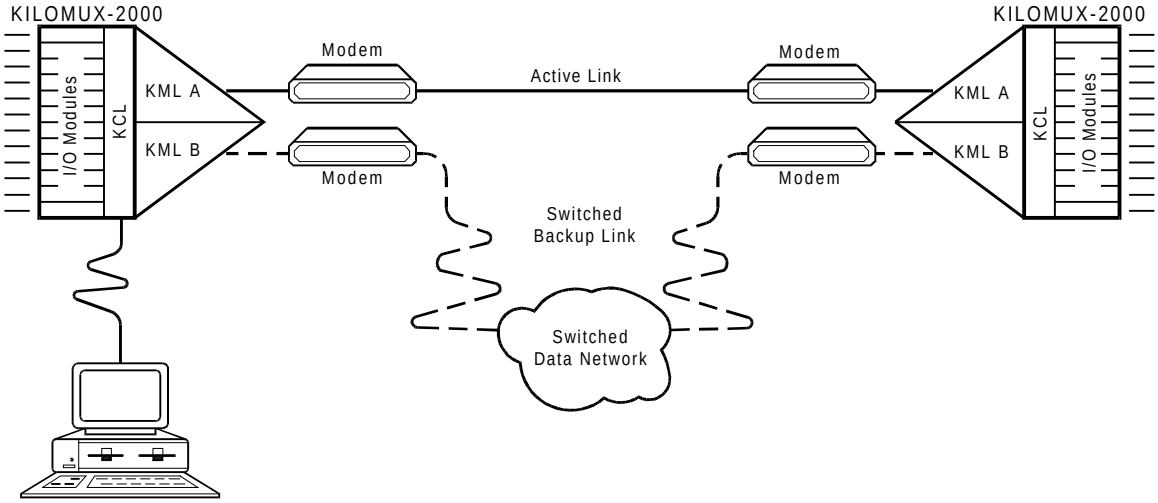

Figure 1-11. Typical Switched Backup Configuration

Since usually the data rate supported by dial-up modems does not exceed 19.2 kbps, the backup link can also be configured for operation at 9.6 or 19.2 kbps. This means that in case of a main link failure, only a fraction of the normal traffic (carried by the channels defined by the system administrator as having high priority) can still be transmitted.

When a failure occurs on the main link, a KILOMUX-2000 activates the DTR line in the backup link interface connector. The dial-up modem connected to this link dials a preprogrammed number, to set up a call to the other KILOMUX-2000. After the called destination answers, the traffic is switched to the backup link (if the call cannot be established within a predetermined interval, the attempt is aborted).

When the primary link returns to normal operation, the dial-up modem hangs up and thus disconnects the backup link.

Switched Backup Using ISDN Lines

This mode is supported when a KML.10 module is connected to a switched ISDN line. In this case, higher data rates are available for the backup link: 64 kbps (use of one B channel) and 128 kbps (use of both B channels). Figure 1-12 shows a typical switched backup application.

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RAD offers a proprietary algorithm, which enables using both B channels to obtain the 128 kbps rate even when differential delay is present. However, the use of a proprietary algorithm means that KML.10 modules must be installed at both ends of the link. This proprietary algorithm, based on the BONDING mode 1 protocol defined by the Bandwidth-on-Demand Inter-operability Group (BONDING), enables the KML.10 modules to combine the bandwidth of the two B channels while correcting for differential delays of up to 512 ms between the two channels, a delay which is sufficient to enable using links which pass through up to two satellite hops.

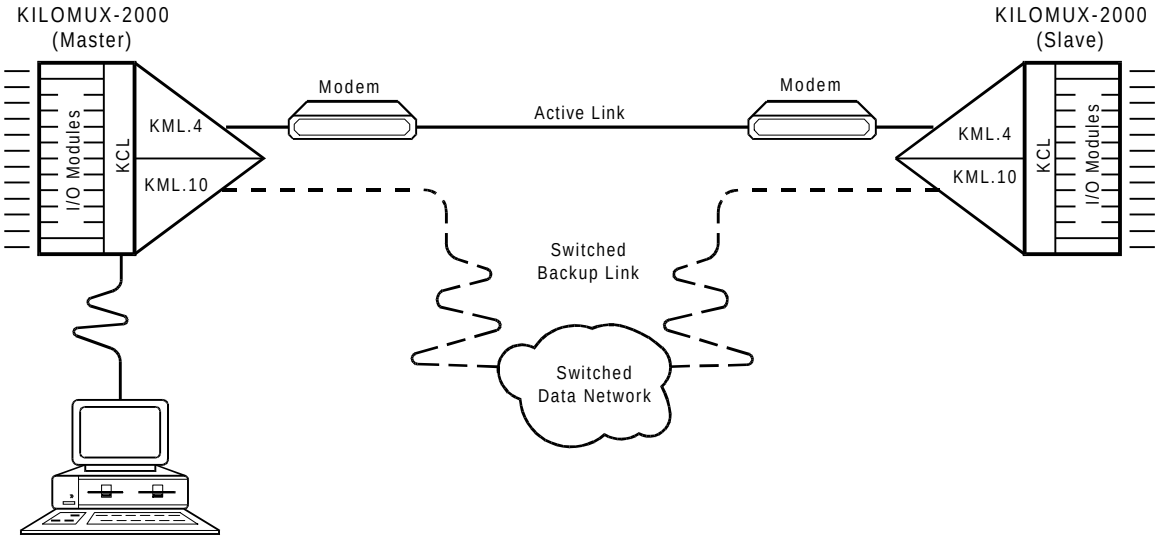

Figure 1-12. Typical ISDN Switched Backup Application

The algorithm works by automatically aligning (i.e., synchronizing and equalizing the transmission delays) the two B channels, a process which uses FIFO buffers that can store data for intervals of the same order as the maximum differential delay to be corrected. The alignment process is performed when communication is first established between the two KILOMUX-2000 units, and is repeated each time a loss of main link synchronization occurs, or one of the KILOMUX-2000 units is reset (FIFO's are also reset when one of these events occurs). Typically, the channel alignment process requires up to 20 seconds.

The KML.10 module can use various structured leased line services (S0), such as the FV0 Type 4 service available in Germany, and can be configured by the user for optimal support of the following specific ISDN implementations:

- ETSI (Euro-ISDN) NET3.
- AT&T 4ESS and 5ESS ISDN switches (custom multipoint, and point-to-point services).
- Northern Telecom DMS-100 ISDN switch.
- Bellcore ISDN switch NI1.
- NTT (Japanese ISDN version).

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System Management

Equipment Management Methods

The KILOMUX-2000 system supports two management methods:

- **Stand-alone**: The KILOMUX-2000 units are programmed to operate without a management channel (no downloading, each unit is then configured as master).
  With stand-alone management, each of the KILOMUX-2000 units connected by a link must be independently managed from its front panel, from a local supervision terminal, or from a RADView network management station (future option).
- **Master-slave**: The KILOMUX-2000 units connected by a link are programmed to operate with a management channel (downloading enabled). In such a case, one of the two KILOMUX-2000 units is configured as master, and the other is configured as slave. The configuration parameters that determine the inter-operability of the units are then controlled from a single point – the master unit.
  This is the recommended management method.

Stand-alone Management

With stand-alone management, the KILOMUX-2000 frame does not include an allocation for a management communication channel between the two units connected in a link. For regular configurations, the only advantage of stand-alone management is that it saves bandwidth the main link that connects the KILOMUX-2000 units. The stand-alone mode is however mandatory when using manual frame bit allocation.

Since there is no management channel, the two units operating in a link cannot interchange management and configuration information. If you are using automatic frame allocation, special precautions must be undertaken to ensure proper operation of the link:

- The two KILOMUX-2000 units must be identically equipped: both units must include the same modules (except KLS.1 - KLS.2 modules pairs, which are allowed), the location of the modules must be the same in both units, and their connections to main link modules must be the same.
- The modules and module channels installed in the two KILOMUX-2000 units must be identically programmed, except for parameters that control local interfacing characteristics, such as the channel interface type, the timing modes, etc.
- The two units must be reset after each change of configuration that affects the bandwidth utilization, e.g., addition of a new channel, selection of a mode that requires end-to-end signaling, etc.

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Other limitations related to the stand-alone mode are listed below:

- There is no indication for the remote loss of frame synchronization, or for the loops connected at the remote end of the link.
- Remote channel loops are activated on the local channel, therefore such loops return data toward the remote KILOMUX-2000.
- It is not possible to simultaneously activate local and remote loops.
- To perform channel tests by tone injection (voice channels) or pseudo-random sequence transmission test (data channels), it is necessary to activate a local main link loop, or to make an appropriate loopback connection at the remote end of the link.

Master-Slave Configuration

In the master-slave configuration, the following information is transmitted via the management channel between the two KILOMUX-2000 units:

- The configuration data base (transmitted from the master to the slave). This causes the slave KILOMUX-2000 unit to automatically configure itself, without operator intervention, in accordance with the master KILOMUX-2000. Nevertheless, the following parameters must be selected locally on each KILOMUX-2000:
  - Main link data rate and interface.
  - System timing reference sources (master and fallback).
  - Specific channel parameters, that depend on the local conditions: for data channels, the interface; for voice channels, the transmit and receive levels, and the out-of-service indication mode.
- The state of loops active on each unit. In addition to the display of remote loops, this allows automatic checking of compatibility between new loop activation requests and the loops already active at the remote end of the link, thereby preventing erroneous conclusions when incompatible links are simultaneously activated.
- The local frame synchronization state.
- The contents of the alarm buffer (transmitted from the slave to the master, only for display on the optional supervision terminal).

Note *In a dual-link configuration, the management channel is carried by only one main link (A). In a dual-link V configuration with independent links (see for example figure 1-6), the management channel is carried by the main link specifically selected by the user.*

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As mentioned above, when the management channel is active, it is not possible to perform manual frame allocation. With automatic allocation, the following enclosure configuration limitations must be observed:

- The two KILOMUX-2000 units must be equipped such that modules that must communicate are installed in the same slots, and are connected to the same main links.
- One of the two KILOMUX-2000 units must be defined as master, and the other – as slave (the selection is made by an internal switch located on the KCL module).
- The master KILOMUX-2000 downloading function must be enabled (this is a programmable feature). On the slave KILOMUX-2000, downloading is always enabled.
- In dual-link configurations, commands directed to a remote KILOMUX-2000 unit can be executed only on the remote unit that is connected, at the time the command is entered, to the management channel of the local KILOMUX-2000.

Note that even if the limitations listed above prevent the use of the master-slave configuration, it is still possible to use a supervision terminal connected to one of the KILOMUX-2000 units to manage both units in the stand-alone mode. This is achieved by allocating one of the low-speed channels of a data module installed in the KILOMUX-2000 to be used as a point-to-point data link by the supervision terminal. The same supervision terminal can then be connected to both the local and remote KILOMUX-2000, using a modem sharing device such as the RSD-10 offered by RAD.

Management Communication Port

The RS-232 serial management port located on the KCL module (the SP connector) can be used to manage the KILOMUX-2000 unit by means of an ASCII terminal, or by a RADView network management station (future option). The communication parameters of this port can be selected in accordance with system requirements:

- **Data rate**: 1200, 2400, 4800 or 9600 bps. The serial port supports automatic recognition of the terminal rate (Autobaud).
- **Word format**:
  – One start bit
  – Seven or eight data bits
  – Even, odd or no parity
  – One stop bit
- **Interface type**: DCE or DTE (user selectable).

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Dial-Out Communication Port

The KCL module can be ordered with an additional RS-232 serial port, the DP port.

This port is intended for connection to a Hayes™ or Hayes-compatible dial-up modem. The reporting method can be programmed by the user, in accordance with the following options:

- Always send a report whenever a new alarm or event condition is detected.
- Reporting disabled (no dial-out function).

When it is necessary to report an alarm condition, the KILOMUX-2000 initiates the call set up, and then, after the destination answers, sends the complete contents of the alarm buffer. Following the transmission of the alarm buffer contents, the KILOMUX-2000 disconnects automatically.

To increase reporting reliability, the KILOMUX-2000 enables the user to define the number of dialing retries, and an alternate directory number, to be called in case the primary directory number cannot be reached. If nevertheless the call cannot be established, the full contents of the buffer will be sent the next time a call is set up.

System Timing Considerations

One of the critical requirements of data communications networks is timing accuracy. The basic requirement is that all the equipment in the network must be synchronized to the same timing source, that is, all the equipment in the network must operate at exactly the same clock rate or at an integer sub-multiple thereof. If this condition is not met, then from time to time bits transmitted between two equipment units that operate at even slightly different clock rates will be lost, or the same bit may be read twice. Such occurrences, that lead to the loss of bit count integrity, are highly undesirable and may cause severe and periodic disruptions in network operation.

Many networks use very accurate timing sources, such as atomic clocks, to provide the primary timing signals to the main network nodes, e.g., telephone switching offices, digital switches, etc. From the nodes, the timing is disseminated via the communication links.

Since very accurate timing sources are often free-running, communication equipment usually includes "elastic" buffers that absorb small timing differences. An elastic buffer is a first-in, first-out (FIFO) memory with separate write (input) and read (output) clocks. For example, such buffers are inserted in the receive path of the KILOMUX-2000 KML modules operating in the DTE or external DCE modes.

The KILOMUX-2000 is designed to support reliable propagation of the timing information, by allowing the selection of the appropriate timing mode in accordance with system requirements and the type of main link interface module installed in the unit.

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- With KML.1, KML.2, KML.3, and KML.4 modules, three main link timing modes are available:
  - DTE
  - External DCE
  - DCE.

  When operating in the DCE or external DCE modes, the timing of the main link transmit clock can be locked to an external source (the external clock signal supplied to one of the data channels), or derived from an internal oscillator.
- With KML.5, KML.6, KML.7, KML.8, and KML.F modules, two main link timing modes are available:
  - Internal
  - Loopback.
- The KML.10 module recovers the clock from the receive line signal; the recovered clock is used for synchronizing the KILOMUX-2000. The KILOMUX-2000 must operate in the DTE timing mode.

To ensure that a reliable timing source is used even when the source selected to provide the preferred timing reference fails, the KILOMUX-2000 allows the selection of an additional fallback source. The fallback source is automatically connected when the main source fails. If both the main and fallback sources fail, the KILOMUX-2000 will switch to the internal oscillator.

The main characteristics of each main link timing mode are explained in the following sections.

DTE Timing (KML.1, KML.2, KML.3, KML.4, and KML.10 Modules)

With DTE timing, both the main link receive and transmit paths of the KILOMUX-2000 unit receive external clock signals. Figure 1-13 shows two basic network configurations that use the DTE timing mode.

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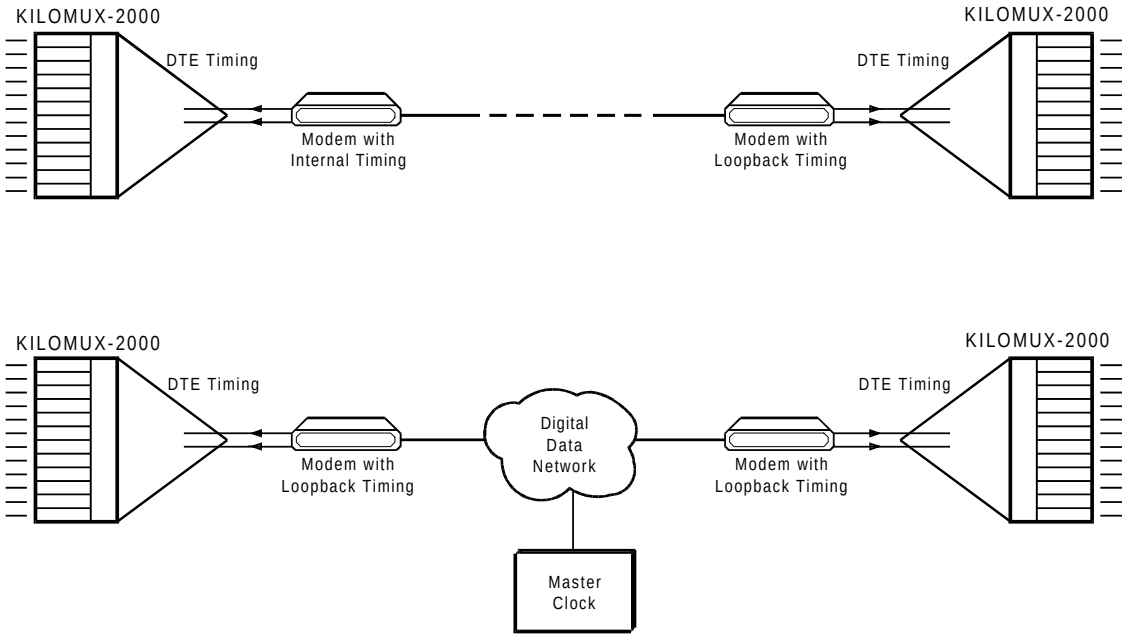

Figure 1-13. Network Configurations Using DTE Timing

- In the top configuration of figure 1-13, two KILOMUX-2000 units communicate through a leased line using two high-speed modems, or other transmission equipment (e.g., higher-speed digital multiplexers) capable of supporting the required main link data rate. The "modems" provide the transmit and receive clock signals to the KILOMUX-2000 units. In this configuration, the "modem" connected to one of the KILOMUX-2000 units is selected to provide the timing reference for the whole link, by selecting its INTERNAL timing mode. The other "modem" is set to operate in the LOOPBACK timing mode, thereby ensuring that both KILOMUX-2000 units derive their timing reference from the same source.
- In the bottom configuration of figure 1-13, two KILOMUX-2000 units communicate through a digital transmission network, e.g., a national or private carrier network, or an ISDN network (in the latter case, the connection is usually made by means of KML.10 main link modules).

  Data and ISDN networks usually incorporate very accurate timing sources, which are always preferable. Moreover, in many cases these networks will not accept data at a rate that differs from their own rate. Therefore, in this configuration, the "modems" that connect the KILOMUX-2000 units to the digital data network are set to operate in the LOOPBACK timing mode, thereby ensuring that the two KILOMUX-2000 units derive their timing reference from the accurate master clock provided by the network.

When operating in the DTE timing mode, buffers are used in the receive and transmit data paths to allow retiming and to absorb short-term timing instabilities. Buffers size is ±8 bits; when operating over satellite links, the receive buffer size can be increased to ±256 bits.

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External DCE Timing (KML.1, KML.2, KML.3 and KML.4 Modules)

With external DCE timing, the KILOMUX-2000 provides the main link transmit clock signal to the modem, and accepts a receive clock signal from the modem. In this timing mode, it is necessary to specify the transmit timing reference source. Two reference sources can be used:

- **External**: the KILOMUX-2000 main link transmit timing is synchronized to the transmit clock of a channel of one of the data modules installed in the unit. The desired channel is selected by the operator, and must operate in the DTE2 clock mode.

  The external mode is very useful when one or more of the KILOMUX-2000 channels are connected to a AT&T DDS link, or to a similar data network (a typical configuration with the KILOMUX-2000 units connected as a tail-end link for channels using the DDS network is shown in figure 1-14).

  The DDS network can provide highly accurate timing and will accept only data with similar accuracy, therefore it is necessary to lock the timing of the KILOMUX-2000 link to the channel timing. This is obtained by operating the modem connected to the West KILOMUX-2000 in the EXTERNAL timing mode. The other modem is set to operate in the LOOPBACK timing mode, thereby ensuring that the East KILOMUX-2000 unit derive its timing reference from the same source.

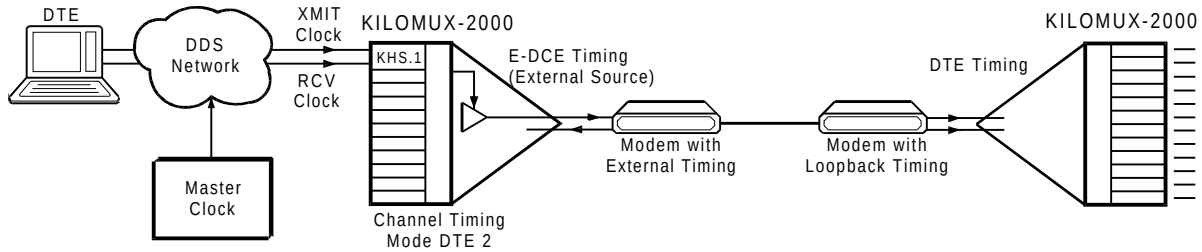

Figure 1-14. Typical External DCE Timing Application

- **Internal timing**: The source for the internal timing signals is a crystal oscillator located in the KML module. The timing accuracy of this oscillator is ±50 parts per million (ppm).

  The internal timing mode can be used in point-to-point links and in independent networks. In any system, only one unit may operate with internal timing: all the other units must use DTE timing to ensure synchronization. In this way, the unit that operates with internal timing is the source of the master clock and determines the timing of the entire network.

In the external DCE mode, buffers are used in the main link receive path, but not in the transmit path. Buffer size is selectable, ±8 or ±256 bits.

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DCE Timing (KML.1, KML.2, KML.3 and KML.4 Modules)

With DCE timing, the KILOMUX-2000 provides both the transmit and receive clock signals to the equipment to which it is connected, e.g., a MEGAPLEX-2000. The timing reference source of the transmit timing signals can be selected as for the external DCE mode. The connected equipment must then use the DTE timing mode.

The DCE timing mode is useful when the KILOMUX-2000 main link is connected a channel of a corporate data transmission system, e.g., the main link of one of the KILOMUX-2000 units is connected to a data channel of a MEGAPLEX-2000, and one or more of the KILOMUX-2000 channels are connected to a data network which provides accurate timing, e.g., to a DDS link, an ISDN line, or another data network. In this case, the network timing can be distributed through the KILOMUX-2000 to the other parts of the system. Figure 1-15 shows a typical connection to a DDS network through a KHS.1 module; for connection to an ISDN line, replace the KHS.1 module with a KHS.U module.

In the DCE mode, no buffers are used in the main link data paths, because the KILOMUX-2000 determines the receive and transmit rates.

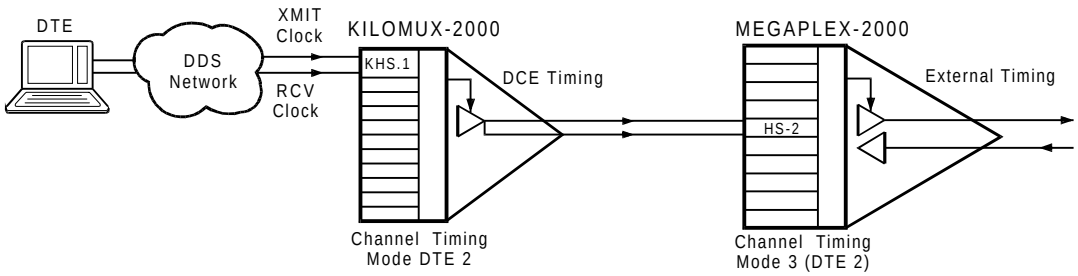

Figure 1-15. Typical DCE Timing Application

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Internal Timing (KML.5, KML.6, KML.7, KML.8, and KML.F Modules)

When the internal timing mode is used with a KML.5, KML.6, KML.7, KML.8, or KML.F module, the source for the internal timing signals is a crystal oscillator located in the main link module.

The internal timing mode can be used in point-to-point links and in independent networks. In any link or network, only one KILOMUX-2000 unit may operate with internal timing: all the other units must use loopback timing to ensure synchronization. In this way, the unit that operates with internal timing is the source of the master clock and determines the timing of the entire network.

Figure 1-16 shows a basic network configuration that uses a KML.5 or KML.6 module in the internal timing mode in conjunction with loopback timing.

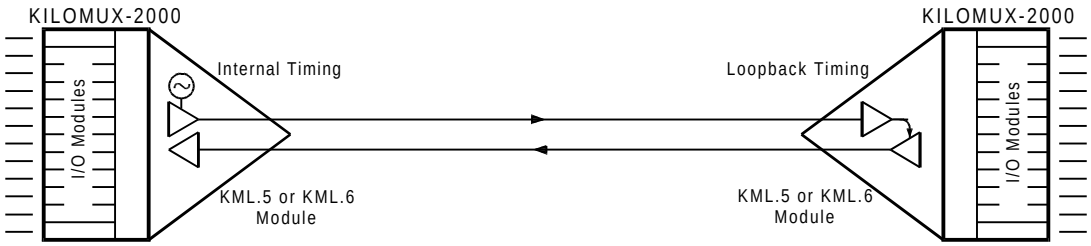

Figure 1-16. Typical Internal Timing Mode Application

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Loopback Timing (KML.5, KML.6, KML.7, KML.8, and KML.F Modules)

With loopback timing, the main link transmit clock is locked to the receive clock, recovered from the receive data signal. In effect, with loopback timing the KILOMUX-2000 is sending back data at the rate data is being received.

The loopback mode can be used as shown in figure 1-16, however there is an additional important application for the loopback mode, as shown in figure 1-17.

In the configuration of figure 1-17, two KILOMUX-2000 units communicate through a G.703 link provided by a digital transmission network, e.g., the national network or a private carrier network, or by the DDS network. Such networks usually incorporate very accurate timing source, which are always preferable. Loopback timing then allows the locking of the transmit timing of both KILOMUX-2000 units to the accurate master clock provided by the network.

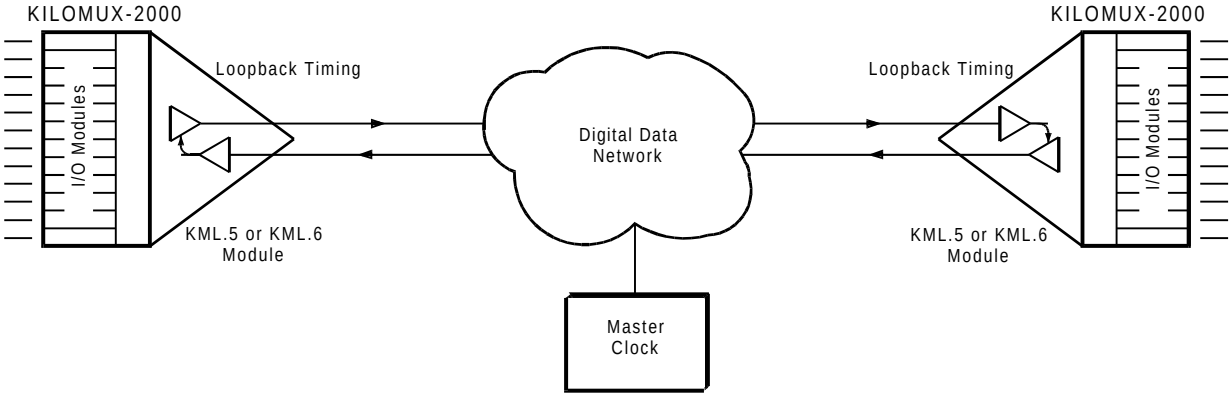

Figure 1-17. Typical Loopback Timing Application

Main Link Timing Considerations in Bypassing and Multidrop Configurations

In bypassing and multidrop configurations, data is directly transferred between the two links of a KILOMUX-2000 unit. To maintain bit integrity, the two links must have a common timing reference. By extension, all the KILOMUX-2000/KILOMUX-2004 units connected in a system that uses bypassing and multidropping must use a common timing reference.

The KDI module can be used to determine the reference source for both main links of a KILOMUX-2000, by internally locking their timing. The available selections are as follows:

- **Link A**: the clock of main link A serves as the local reference, therefore the timing of link B is locked internally to link A timing.
- **Link B**: the clock of main link B serves as the local reference, therefore the timing of link A is locked internally to link B timing.

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- **None**: there are system configurations in which neither link can be selected as a timing reference for the other link, because each link interface must receive external timing signals. These external signals must have a common reference source. The user can specify as usual master and fallback clock sources, just as in a KILOMUX-2000 without a KDI module (the selection of master and fallback sources is not possible when internal clock locking is used).

  The situation described above usually occurs when the two links are connected to different channels of a data network which has its own timing reference (the connections are usually made by modems or other data communication equipment that provides receive and transmit timing signals, and the two links use DTE timing). Nevertheless, in this common situation, the common timing reference requirement is inherently fulfilled (the timing reference is provided by the data transmission network).

Data Channel Clock Modes

The KILOMUX-2000 provides several clock modes for data channels. The various system I/O modules support all, or some of these modes.

- **Clock Mode 1** - DCE. In the DCE clock mode, the KILOMUX-2000 channel provides transmit and receive clocks for the equipment connected to the data sub channel, as shown in figure 1-18.

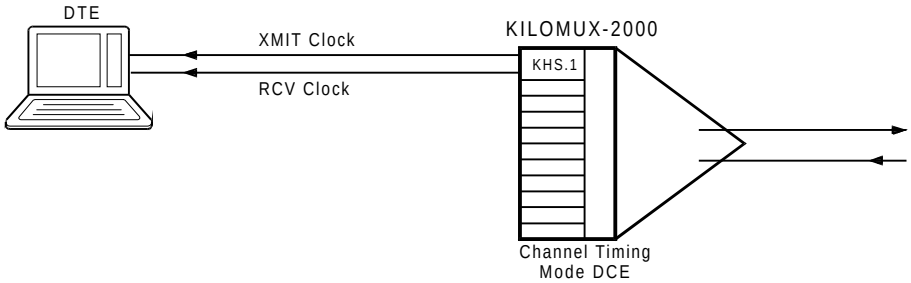

Figure 1-18. Clock Mode 1 (DCE)

  This clock mode is usually required for connection to DTE equipment.

- **Clock Mode 2** - DTE1. In the DTE1 clock mode, the KILOMUX-2000 data channel sends data accompanied by clock to the connected equipment and accepts data from the equipment according to the equipment clock, as shown in figure 1-19. In this mode, an elastic buffer (FIFO) is used in the receive path of the channel to absorb timing jitter. For KLS.1 data modules, the elastic buffer size is ±2 bits; for KHS.1 data modules, the buffer size is ±4 bits.

  This clock mode is usually required for "tail end" connections, when a DCE is connected to a data sub channel, and its timing is locked to the KILOMUX-2000 timing.

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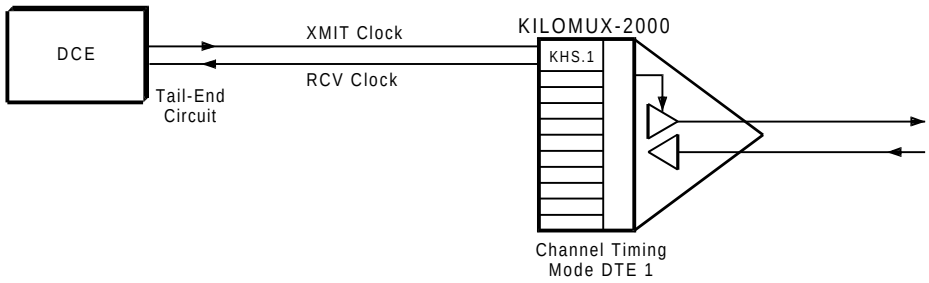

Figure 1-19. Clock Mode 2 (DTE1)

- **Clock Mode 3** - DTE2. In the DTE2 clock mode, the KILOMUX-2000 data channel transmits and receives data according to the clock received from the modems that connect it to the transmission equipment.

  To compensate for jitter and short-term instabilities, elastic buffers are used at the input and output of each channel (±2 bits for KLS.1 data modules, and ±4 bits for KHS.1 modules)

  The DTE2 clock mode is required in various applications, such as data channels connected to a digital data switch: since the data switch provides the timing reference for the whole network, is must be able to provide clock signals for both the KILOMUX-2000 and the equipment connected to it (figure 1-20). The clock signals are received from the modems serving the data channel.

  When operating channels in the DTE2 clock mode, one of the data channels can be selected as the external timing reference source for the entire system timing. In general, the external timing option must always be used, because it ensures the main link transmit and receive data rates are locked to the corresponding channel rates (if the main link data rates are not locked to the corresponding channel rates, bit integrity will be lost). The only situation that ensures locked timing without using to the use of external timing is when KILOMUX-2000 units are integrated in a large network that includes a master timing reference, and the master timing source is used by all the equipment in the network (including data equipment connected to the KILOMUX-2000 channels and the transmission equipment serving the main link). Therefore, do not use the DTE2 clock mode when the main link timing is derived from the internal oscillator of the KILOMUX-2000.

  The external timing option is not supported by the KML.5, KML.6, KML.7, KML.8, KML.10, and KML.F modules, therefore do not use the DTE2 clock mode in a KILOMUX-2000 equipped with these types of module if the conditions for master timing as described above cannot be attained.

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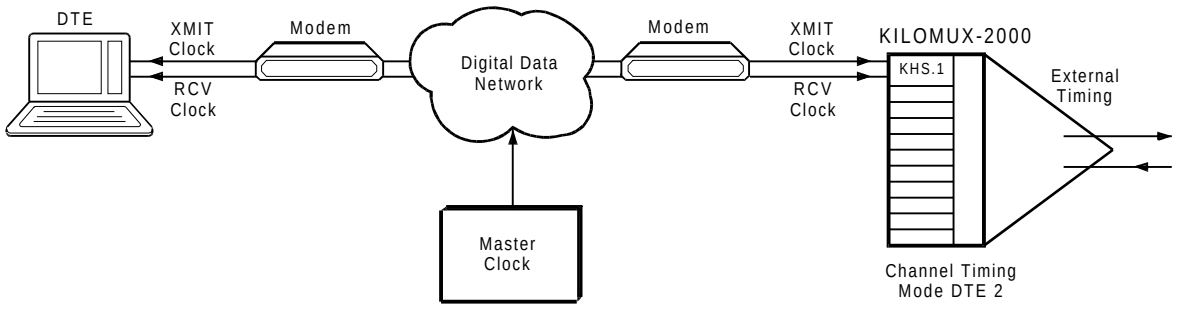

Figure 1-20. Clock Mode 3 (DTE2)

Timing Modes of ISDN Channels

ISDN basic rate access channels are available on the KHS.U and KVF.4/S0 modules. These channels provide the interface between the KILOMUX-2000 system and the ISDN network.

Timing of Channels with "U" Interface

The transmit timing of a channel with "U" interface, such as a KHS.U module, is locked to the nodal timing of the KILOMUX-2000. The system nodal timing depends on the selected operating mode of the channel:

- **NT Mode**: In the NT mode, the ISDN "U" interfaces are usually connected to an ISDN switch, whose timing is generally provided by an accurate and stable source.

  To use this timing, one of the KHS.U interfaces must be selected as an external clock source for the KILOMUX-2000. This locks the nodal timing of the KILOMUX-2000 to the timing of the ISDN switch.
- **LT Mode**: In the LT mode, the system nodal timing, which can be selected in accordance with other system considerations, determines the timing of the data transmitted to the user's network termination equipment (ASM-31, etc.), connected to the KHS.U interfaces. The receive timing is recovered from the line signal received from the user's equipment. The user's equipment must be an NT unit.

Timing of Channels with "S" Interface

The transmit timing of a channel with "S" interface, such as a KVF.4/S0 module, depends on the selected operating mode:

- **NT Mode**: The KILOMUX-2000 provides the transmit clock for the "S" interface. The receive timing is recovered from the signal received from the user's terminal equipment.
- **TE Mode**: One of the "S" interface ports connected to the network termination (NT) unit must be selected as an external clock source for the KILOMUX-2000. Thus the KILOMUX-2000 nodal clock, and therefore the transmit timing of the "S" interface, are locked to the timing of the NT unit.

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Sub Link Timing

The KVF.5 modules include a standard T1 or E1 sub link interface. The following timing options are available

- The receive clock of the sub link is always derived from the incoming T1 or E1 line signal, and the transmit clock is derived from the nodal timing source of the KILOMUX-2000.
- The recovered receive clock of the sub link can be selected as the reference for the KILOMUX-2000 nodal timing. If this option is not used, the equipment connected to the sub link must operate with loopback timing, or its timing must be locked to the same source that serves as the reference for the KILOMUX-2000 nodal timing.

Main Link Interface Characteristics

V.35 Interface (Module KML.1)

The V.35 interface supports all the interface signals specified by ITU-T Rec. V.35. Note the following:

- The DTR signal is constantly ON as long as the KILOMUX-2000 is powered.
- The RTS signal is normally ON, except when a local main link loop is connected.
- The DSR and CTS signals are handled in accordance with user's selection:
  - When the DSR&CTS parameter is set to external, and the DSR and/or CTS signals are OFF, the transmit data line is continuously held at MARK.
  - When the DSR&CTS parameter is set to internal, the DSR and CTS signals are ignored (internally interpreted as being continuously ON).

RS-232 Interface (Module KML.2)

The RS-232 interface supports all the interface signals specified by EIA RS-232. See the notes regarding the DTR, RTS, DSR and CTS signals presented for the V.35 interface.

V.36/RS-422/RS-530 Interface (Module KML.3)

The RS-530 interface supports all the interface signals specified by EIA RS-530, with the following exceptions:

- See the notes regarding the RTS, CTS and DSR signals presented for the V.35 interface.
- The DTR signal is not supported. The line is used as ERC (external receive clock) output line.

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X.21 Interface (Module KML.4)

The X.21 interface provides partial support for interface signals. The signals not fully supported are as follows:

- The C (control) signal is constantly ON.
- The I (indication) signal is used as follows.
- When the I signal is ON, the interface operates normally. When the signal is OFF, the KILOMUX-2000 sends a continuous MARK (binary "1") on the main link.

G.703 Codirectional Interface (Module KML.5)

The G.703 codirectional interface complies with all the requirements of ITU-T Rec. G.703 applicable to codirectional interfaces. This interface supports only data rates of 64 and 128 kbps.

Standard DDS CSU/DSU (Module KML.6)

The KML.6 main link interface complies with AT&T Pub. 62310: Standard Digital Data Service (DDS), Channel Interface Specifications. The interface supports data rates of 9.6, 19.2, and 56 kbps.

T1 Link Interface (Module KML.7)

The KML.7 module supports both the D4 (SF) and ESF framing formats, in accordance with user's selection. Zero suppression over the line is user-selectable (transparent (AMI) coding, B7ZS, or B8ZS).

The T1 line interface meets the requirements of AT&T TR-62411, ANSI T1.403, and ITU-T Rec. G.703, G.704. Jitter performance complies with the requirements of AT&T TR-62411.

E1 Link Interface (Module KML.8)

The E1 link interface meets the requirements of ITU-T Rec. G.703, G.704, and G.732, and supports both 256N and 256S multiframes (2 or 16 frames per multiframe, respectively), in accordance with user's selection. The KML.8 module also supports the CRC-4 option, including support for the E bit, as specified in ITU-T Rec. G.704, thereby allowing the carrier to monitor the link to the KILOMUX-2000. CRC-4 use is user-programmable.

The KML.8 module uses the HDB-3 line code. Jitter performance complies with the requirements of ITU-T Rec. G.823. The module has two line interfaces: a 120-ohm balanced interface, and a 75-ohm unbalanced interface.

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ISDN "S" Interface (Module KML.10/S)

The ISDN basic rate access "S" interface complies with ITU-T Rec. I.430. The interface operates at a nominal rate of 192 kbps, and carries two B data channels (nominal rate - 64 kbps), one D signaling channel (nominal rate - 16 kbps), and additional framing and maintenance overhead data. The line coding is 2B1Q. The line impedance is 100 ohm. The user can select whether to connect or not the internal line termination of the module.

ISDN "U" Interface (Module KML.10/U)

The ISDN basic rate access "U" interface complies with the ANSI T1.601 and ETSI DTR/TM3002 standards. The line data rate is 160 kbps, and the line coding is 2B1Q. The utilization of the B and D channels is similar to that described above for the KML.10/S module. The line impedance is 135 ohm.

Fiber-Optic Link Interface (Module KML.F)

The fiber-optic link interface of the KML.F module uses a proprietary signaling format which ensures optimum performance. To optimally meet a wide range of system requirements, the fiber-optic interface can be ordered for operation over 62.5/125 micron multi-mode fibers (typical attenuation - 3.5 dB/km), as well as over low-loss 9/125 micron single-mode fibers (typical attenuation - 0.4 dB/km).

Each option can be ordered with ST or FC-PC connectors; SMA connectors are also available at 850 nm.

Table 1-3 provides information on the characteristics of the optical interface. Typical range is up to 4.5 km at 850 nm over multimode fiber, up to 45 km at 1300 nm over single-mode fiber with LED transmitters, up to 60 km with 1300 laser transmitters, and up to 100 km with 1550 nm laser transmitters.

Table 1-3 KML.F Fiber-Optic Interface Characteristics

Wavelength	Fiber Type	Transmitter Type	Power Coupled into Fiber	Receiver Sensitivity	Optical Budget	Maximum Receiver Input Power	Receiver Dynamic Range
850 nm	62.5/125 µm multi-mode	LED	-18 dBm	-38 dBm	20 dB	-10 dBm	28 dB
	62.5/125 µm multi-mode	LED	-18 dBm	-40 dBm	22 dB	-12 dBm	28 dB
1300 nm	9/125 µm	LED	-18 dBm	-40 dBm	22 dB	-12 dBm	28 dB
	single-mode	Laser	-12 dBm	-40 dBm	28 dB	-12 dBm	28 dB
1550 nm	9/125 µm single-mode	Laser	-12 dBm	-40 dBm	28 dB	-12 dBm	28 dB

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1.4 I/O Module Applications

This section describes typical applications for the KILOMUX-2000 I/O modules. For additional details, refer to the corresponding section of Part II of this manual.

KVC.1 PCM/ADPCM Voice Module

The KVC.1 module provides two high quality voice channels over the KILOMUX-2000 link.

The KVC.1 utilizes either PCM or ADPCM digitizing techniques. When utilizing the PCM A-Law technique, voice is digitized at 64 kbps. When utilizing ADPCM, voice is digitized at selectable rates of 16, 24 or 32 kbps, according to the quality desired and the available main link bandwidth.

Note *The KVC.1 module is not supported for main link rates of 768 kbps.*

Toll quality voice transmission is guaranteed when using PCM complying with ITU-T Rec. G.711, or 32 kbps ADPCM complying with ITU-T Rec. G.721 and ANSI T1.301. High quality voice reproduction is attained at 16 and 24 kbps ADPCM.

The KVC.1 may be ordered with one of the following analog interfaces: KVC.1/E&M with 2-wire or 4-wire E&M interface for connection to PABX tie lines, KVC.1/FXS with 2-wire FXS interface for direct connection to a telephone handset, or KVC.1/FXO with 2-wire FXO interface for direct connection to a PABX extension line. The KVC.1/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages, which can be provided by the stand-alone RINGER-2000 unit (intended for shelf and rack mounting), or by the KM-RINGER plug-in module offered by RAD.

The 2-wire or 4-wire E&M module supports five E&M signaling types: EIA RS-464 Types I, II and III and V and British Telecom SSDC5.

The KVC.1 also permits transmission of fax signals. When operating at 64 kbps PCM or 32 kbps ADPCM, 9600 bps fax may be transmitted. At 24 kbps ADPCM, 4800 bps fax may be transmitted, and at 16 kbps ADPCM, 2400 bps fax may be transmitted. Figure 1-21 shows a typical application for KVC.1 modules.

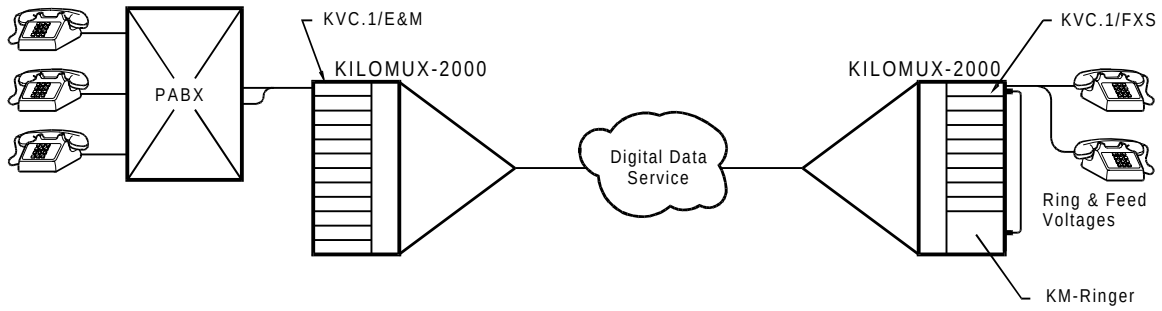

Figure 1-21. Typical KVC.1 Applications

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KVC.1M PCM/ADPCM Voice Module

The KVC.1M is a voice module that provides one or two high-quality voice channels, and supports error-free fax transmission.

The KVC.1M utilizes either PCM or ADPCM digitizing techniques. When utilizing the PCM A-Law technique, voice is digitized at 64 kbps. When utilizing ADPCM, voice is digitized at selectable rates of 16, 24 or 32 kbps, according to the quality desired and the available main link bandwidth.

Toll quality voice transmission is guaranteed when using PCM complying with ITU-T Rec. G.711, or 32 kbps ADPCM complying with ITU-T Rec. G.721 and ANSI T1.301. High quality voice reproduction is attained at 16 and 24 kbps ADPCM in compliance with ANSI T1.303.

When operating at a data rate of 64 kbps the KVC.1M support error-free fax transmission a rates up to 9600 bps. Operation at 24 kbps supports fax transmission at rates up to 4800 bps, and at 16 kbps fax transmission is available up to 2400 bps.

To improve the perceived link quality, the KVC.1M module can be ordered with an optional adaptive echo canceler to handle near-end reflections (echo delay less than 32 milliseconds), such as reflections caused by a nearby hybrid used for 2W/4W conversion. The echo canceler convergence time exceeds ITU-T Rec. G.165 requirements. If the link is a pure 4W link (no hybrid along the path between the two subscribers), the adaptive echo canceler can be turned off by the user.

The KVC.1M module replaces the KVC.1, but offers additional interfaces:

- **KVC.1M/E&M and KVC.1M/E&M48** - provide two channels with 2-wire or 4-wire E1 interface for connection to PABX tie lines. Each channel has a separate eight-pin RJ-45 connector.

  The E&M interface supports five E&M signaling types: E1A RS-464 Types I, II and III and V and British Telecom SSDC5. The KVC.1M/E&M generates a -12 VDC signaling voltage, which is sufficient for connection to PABX lines, as well as for many short line length applications.

  The KVC.1M/E&M48 module requires an external -48 VDC source to supply the signaling voltage for increase the maximum allowed line length.

- **KVC.1M/FXS and KVC.1M/FXSP** - provide two voice channels with two-wire analog interfaces and FXS loop start or ground start signaling, for direct connection of a subscriber telephone set, or other equipment (answering machines, fax, etc.). Each channel has a separate six-pin RJ-11 connector.

  The KVC.1M/FXP has an internal ringer and line feed supply. The internal ringer provides a nominal ring voltage of 23 VRMS, and the nominal line feed voltage is -42 VDC at a line current of 25 mA. These voltages are sufficient for connection to PABX lines, as well as for many short line length applications.

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The KVC.1M/FXS module requires an external source for the feed (nominally -48 VDC) and ring (nominally +72 VDC) voltages, therefore it has an additional three-pin connector for the external feed and ring source. The required voltages can be supplied by a RINGER-2000 unit offered by RAD, or by a special-purpose power supply unit, KM-RINGER, also offered by RAD.

- **KVC.1M/FXSW** - provides one voice channel, intended for the connection to the local subscriber's equipment. This channel is similar to the voice channels of the KVC.1M/FXS module. In addition, the module includes a second two-wire interface operating with FXO signaling, intended for connection to the PSTN, or to a PABX extension line.

  The local subscriber connected to the FXS interface can access the multiplexed voice channel, as well as the PSTN/PABX line:

  - When the local subscriber goes off-hook, the module connects the local subscriber in accordance to a default selection, either to the multiplexed voice channel, or to the PSTN/PABX port. To make a call over the alternative port, the subscriber dials a user-selectable single-digit access code.
    For example, when the default routing is to the multiplexed voice channel, the subscriber can get the PSTN/PABX line by first dialing the access digit, followed by the desired directory number.
  - Incoming calls (received either via the multiplexed voice channel, or via the PSTN/PABX line) are automatically routed to the local subscriber. If a call is received through the other port while the subscriber is engaged in a call, a busy indication is provided.

  The PSTN/PABX port cannot access the multiplexed link.

- **KVC.1M/FXO** - provides two voice channels with two-wire analog interfaces and FXO loop start signaling, for direct connection to PABX extension lines. Each channel has a separate six-pin RJ-11 connector.

  The KVC.1M /FXS, /FXSP, and /FXSW modules, and KVC.1M/FXO module are intended for operation in a link, with the KVC.1M /FXS, /FXSP, or /FXSW module, respectively, on the subscriber side and the KVC.1M/FXO module on the PABX side.

- KVC.1M/FXS16K and KVC.1M/FXO16K are similar to the KVC.1M/FXS and KVC.1M/FXO modules, respectively, except that they are intended for support of pay phones, and therefore it includes dedicated circuits for the generation of polarity reversal and 0f 16 kHz metering pulses.
- KVC.1M/FXS12K and KVC.1M/FXO12K are similar to the KVC.1M/FXS and KVC.1M/FXO modules, respectively, except that they are intended for support of pay phones, and therefore it includes dedicated circuits for the generation of polarity reversal and 0f 12 kHz metering pulses.

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Figure 1-22 shows a typical application for KVC.1M/FXSW modules. This application is similar to the application shown in Figure 1-21, except that the user connected to the KVC.1M/FXSW module can use the same telephone set to call subscribers of the PABX to which the remote KILOMUX-2000 is connected, as well as to dial directly over the PSTN networks.

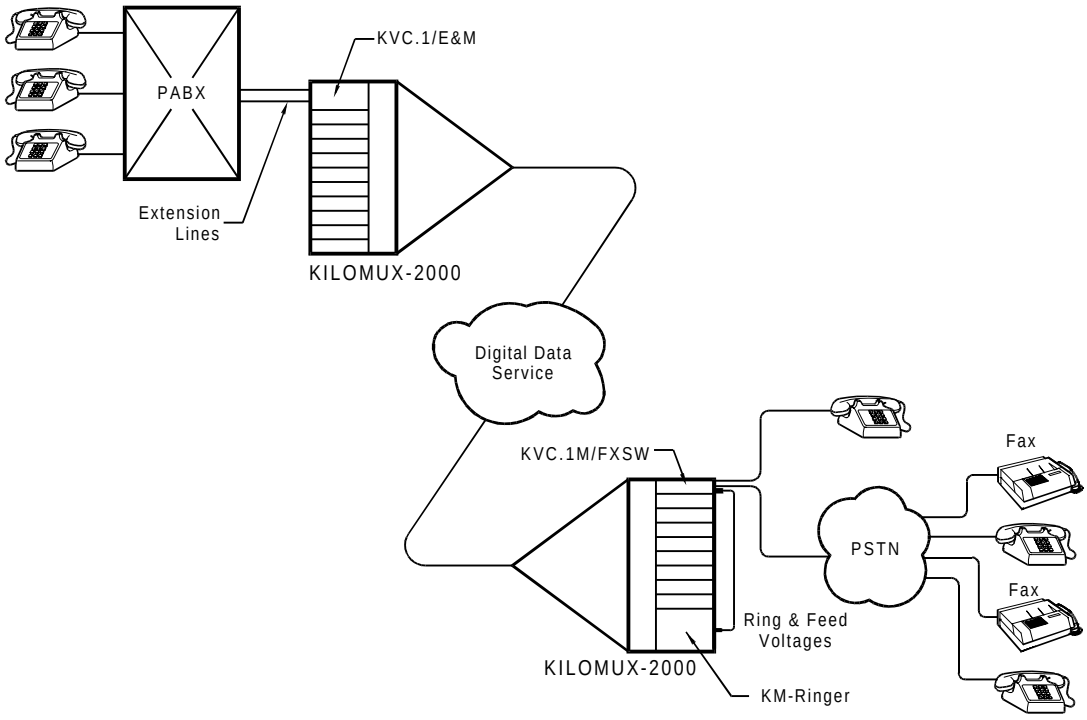

Figure 1-22. Typical Application for KVC.1M/FXSW Modules

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KVC.2 Low Bit Rate Voice Module

The KVC.2 is a voice module that allows the transmission of one or two high quality compressed voice channels over the KILOMUX-2000 link. The KVC.2 is not intended for the transmission of fax signals: for this purpose, RAD offers the KVF.1 voice/fax relay module.

The KVC.2 utilizes a proprietary voice digitizing technique which allows the selection of the digitized voice data rate according to the desired quality and the available main link bandwidth. Voice is digitized at selectable rates of 6.4, 7.2, 8 or 9.6 kbps. The 7.2 kbps rate is not available when the main link rate is 256, 384 and 768 kbps. Near toll quality voice reproduction is guaranteed when using the 9.6 or 8 kbps rates.

The KVC.2 may be equipped with one of the following analog interfaces: KVC.2/E&M with 4-wire E&M interface for connection to PABX tie lines, KVC.2/FXS with 2-wire FXS interface for direct connection to a telephone handset, or KVC.2/FXO with 2-wire FXO interface for direct connection to a PABX extension line. The KVC.2/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages, which can be provided by the stand-alone RINGER-2000 unit (intended for shelf and rack mounting), or by the KM-RINGER plug-in module offered by RAD.

The 4-wire E&M module supports five E&M signaling types: EIA RS-464 Types I, II and III and V and British Telecom SSDC5.

The KVC.2 is equipped with an integral echo canceler for canceling the near-end hybrid echo. The echo canceler may be enabled or disabled by the user. The module is also equipped with forward error correction for checking the most vital speech information bits. The maximum channel bit error rate is 1×10^{-3}.

Figure 1-23 shows a typical application for KVC.2 modules.

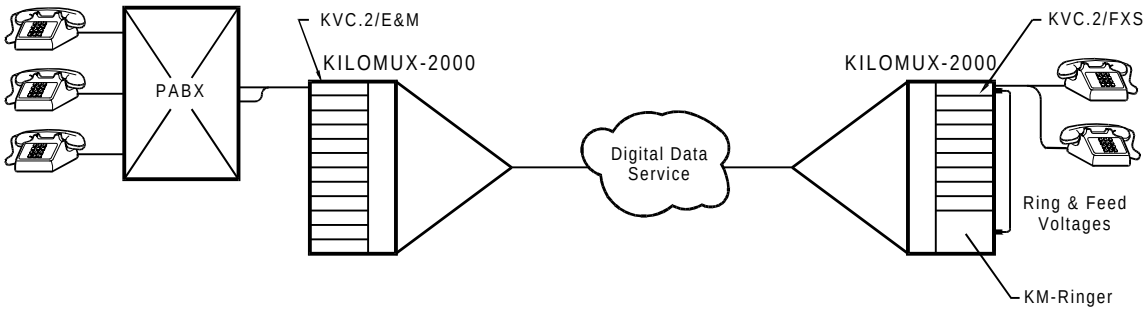

Figure 1-23. Typical KVC.2 Applications

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KVC.3 Low Bit Rate and ISDN Voice Module

The KVC.3 module is a voice compression interface module, that uses advanced digital signal processing (DSP) techniques (MPMLQ - Multipulse Maximum Likelihood Quantization per ITU-T Rec. G.723) to provide one or two channels for transmission of Group III facsimile and high-quality compressed voice signals while requiring a main link bandwidth of only 4.8, 6.4, 7.2, or 9.6 kbps.

When operating at rates of 6.4, 7.2, or 9.6 kbps, the voice quality provided by the KVC.3 module is equivalent to that achieved by 32 kbps ADPCM encoding; high-quality voice is maintained even at a transmission rate of 4.8 kbps. Moreover, unlike most low bit rate compression techniques that are currently available, the advanced low bit rate voice compression technique used by the KVC.3 enables tandem connection of two independent transmission segments with relatively low degradation.

The KVC.3 module can be ordered with a variety of interfaces:

- **KVC.3/E&M**: This module offers two channels with user-selectable two-wire and four-wire analog interfaces and E&M signaling. The module is intended mainly for connection to PABX trunk lines, and supports five types of E&M signaling: RS-464 types I, II, III, and V, and British Telecom SSDC5. Channel audio line connection is made to an eight-point RJ-45 connector.

  The KVC.3/E&M module generates a -12 VDC signaling battery voltage, which is sufficient for connection to PABX lines, as well as for many short line length applications.

- **KVC.3/FXS and KVC.3/FXSP**: These modules offer two channels with two-wire analog interfaces and FXS loop start or ground start signaling, for direct connection to a subscriber telephone set, or other equipment with similar interface (answering machines, fax, etc.). Each channel has a separate six-pin RJ-11 connector. The KVC.3/FXS module requires an external source for the feed (nominally -48 VDC) and ring (nominally +72 VDC) voltages, therefore it has an additional three-pin connector. The required voltages can be supplied by a RINGER-2000 stand-alone unit, or by a KM-RINGER module.

  The KVC.3/FXSP module, includes an internal ringer and line feed supply. The internal ringer provides a nominal ring voltage of 23 VRMS, and the nominal line feed voltage is -42 VDC at a line current of 25 mA. These voltages are sufficient for connection to PABX lines, as well as for many short line length applications.

- **KVC.3/FXSW**: The KVC.3/FXSW module has one FXS channel, intended for the connection to the local subscriber's equipment. This channel is similar to the voice channels of the KVC.3/FXS module. In addition, the module includes a second channel with FXO signaling, intended for connection to the PSTN, or to a PABX extension line.

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The local subscriber connected to the FXS interface can access the multiplexed voice channel, as well as the PSTN/PABX line:

- When the local subscriber goes off-hook, the module connects the local subscriber in accordance to a default selection, either to the multiplexed voice channel, or to the PSTN/PABX port. To make a call over the alternative port, the subscriber dials a user-selectable single-digit access code.
  For example, when the default routing is to the multiplexed voice channel, the subscriber can get the PSTN/PABX line by first dialing the access digit, followed by the desired directory number.
- Incoming calls (received either via the multiplexed voice channel, or via the PSTN/PABX line) are automatically routed to the local subscriber. If a call is received through the other port while the subscriber is engaged in a call, a busy indication is provided.

The PSTN/PABX port cannot access the multiplexed link.

- **KVC.3/FXO**: The KVC.3/FXO offers two channels with two-wire analog interface and FXO loop start signaling, for direct connection to PABX extension lines. Each channel has a separate six-pin RJ-11 connector.

  The KVC.3/FXS, /FXSP, and /FXSW modules, and the KVC.3/FXO module are intended for operation in a link, with the KVC.3/FXS, /FXSP, or /FXSW module on the subscriber side, and the KVC.3/FXO module on the PABX side.
- **KVC.3/S0 Module**: The KVC.3/S0 module has one ISDN basic rate access type "S" interface, which enables direct connection to an ISDN PABX, for extending voice access to locations at which direct access to the ISDN facilities is not available, or is not cost-effective. The extension is provided over the KILOMUX-2000 data link, by converting the PCM-coded voice channels carried by the two B channels of the "S" interface to low bit rate voice channels that can be effectively transmitted over the data link.

  To establish a basic rate connection through the KVC.3/S0 link, it is necessary to transmit, in addition to the B-channels, the D-channel. The user can then enable end-to-end transmission of the D-channel through the KILOMUX-2000 link (the required bandwidth is 16 kbps).

  The "S" interface conforms to ITU-T Rec. I.430 and supports full duplex transmission of 2B+D channels over unconditioned four-wire telephone loop (two twisted pairs). The line data rate is 192 kbps, and the line coding is pseudoternary. The nominal line impedance is 100 ohm. The ISDN channel terminates in an RJ-45 eight-pin connector.

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The KVC.3/S0 module has two selectable operating modes:

- **TE Mode**: The TE (terminal equipment) mode enables the connection of the KVC.3/S0 channel to a network termination (NT) unit. This mode should be used when the KVC.3/S0 is connected to an ISDN switch, because in this case the timing reference is derived from the clock recovered from the ISDN line signal. In this mode, it is necessary to select the KVC.3/S0 module as the timing reference for the KILOMUX-2000.
- **NT Mode**: The network termination (NT) mode enables direct connection of terminal equipment to the KVC.3/S0 channel.

Figure 1-24 shows a typical application for KVC.3/FXSW modules. The user connected to the KVC.3/FXSW module can use the same telephone set to call subscribers of the PABX to which the remote KILOMUX-2000 is connected, as well as to dial directly over the PSTN networks.

Figure 1-25 shows a typical application for a KVC.3/S0 module. A KVC.3/S0 module is used to connect to a basic rate access line of the ISDN switch located at the main offices. As a result, the subscribers connected to the KVC.3/FXSP module at the other end of the multiplexed KILOMUX-2000 link effectively become subscribers of the main office switch.

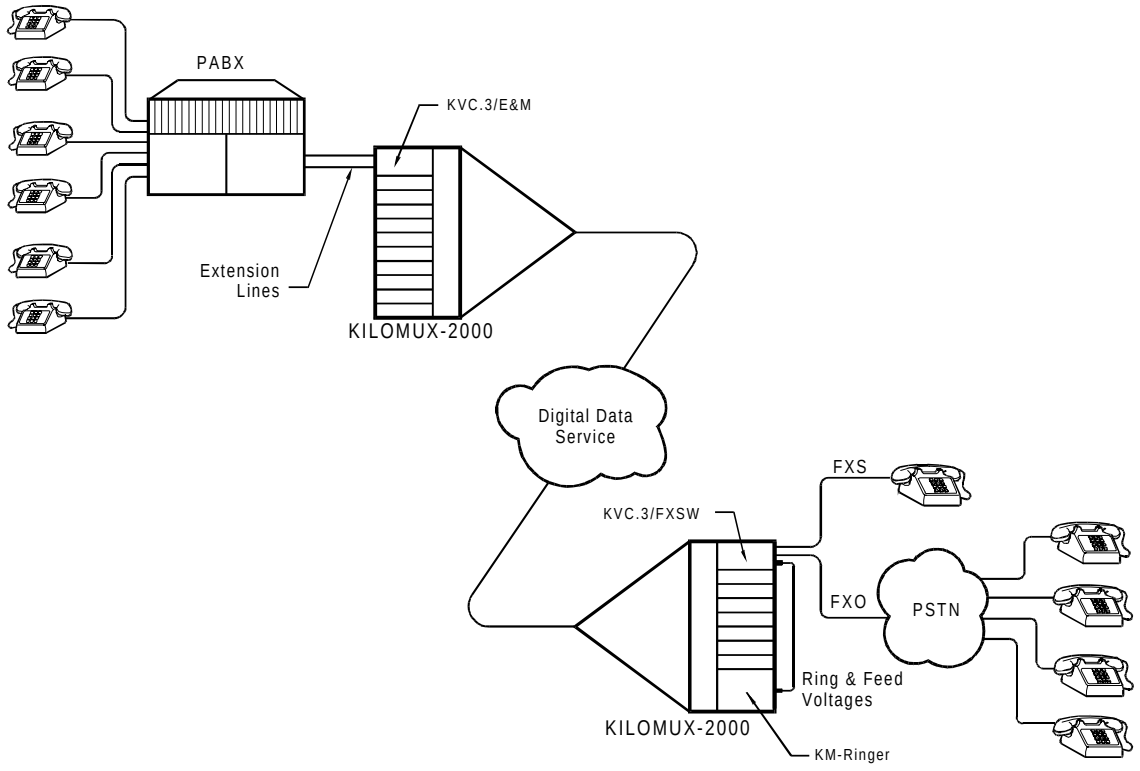

Figure 1-24. Typical Application for KVC.3/FXSW Modules

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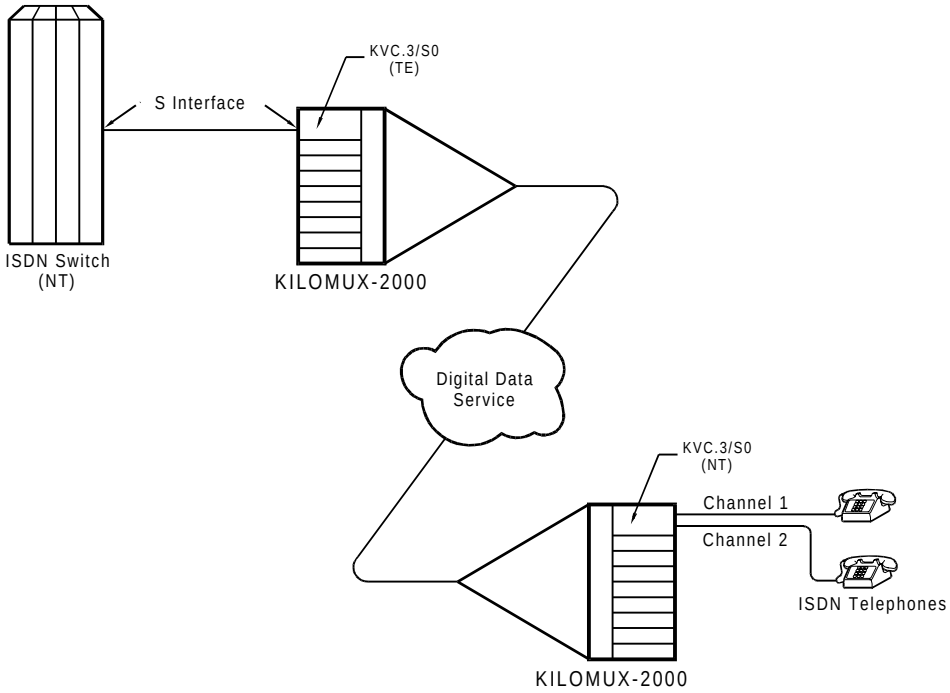

Figure 1-25. Typical Applications for KVC.3/S0 Module

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KLS.1 Low-Speed 2-Channel V.24/RS-232 Data Sub-Multiplexer Module

The KLS.1 is a low-speed data module that provides two EIA RS-232/ITU-T Rec. V.24 low-speed synchronous or asynchronous data channels with DCE interfaces. Each channel supports three groups of data rates:

- **Group 1**: 300 to 38,400 bps in either synchronous or asynchronous mode.
- **Group 2**: 7.2, 14.4, 28.8, and 57.6 kbps in either synchronous or asynchronous mode.
- **Group 3**: 8, 16, 24, 32, 48, 56, and 64 kbps in the synchronous mode only.

Rates can be freely selected, as long as both channels operate at rates taken from the same group.

Programmable timing modes and channel buffers permit connection to all types of digital lines, including digital data services, and ensure data integrity:

- In the asynchronous mode, the number of data bits in the word is user-programmable: 6, 7, 8, or 9 (this number includes the parity bit, if parity is enabled, because the parity bit is transparently transferred). In addition to the selected number of data bits, the word format includes one start bit and one stop bit.
- In the synchronous mode, each channel has three user-programmable timing modes:
  - DCE: the KLS.1 channel provides the timing signals to the DTE connected to it.
  - DTE1: the KLS.1 channel provides the receive timing signal, and accepts the transmit timing from the equipment connected to the channel.
  - DTE2: the KLS.1 channel accepts the receive and transmit timing signals from the equipment connected to the channel, and buffers and retimes the incoming data. When connected to the national network or to private carrier data lines, e.g., DDS or Kilostream lines, a KLS.1 channel operating in the DTE2 mode can be used as an external timing reference source for the KILOMUX-2000/KILOMUX-2004 unit the module is installed in.

The KLS.1 module provides two user-selectable modes of support for the V.24/RS-232 interface control signals:

- Local control signal support. This mode can be independently selected for each channel. When local support is enabled, the channel locally supports four interface control signals, that is, the state of the control signals is not transmitted to the remote channel. The locally-supported control signals are as follows:
  - RTS.
  - CTS: can be programmed to follow RTS with a programmable delay, or to be constantly ON. If a channel is disconnected, its CTS line is always OFF, irrespective of the selected mode.

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- DSR: either constantly ON (except when the channel is in remote loopback, or under PRBS or BER testing), or ON only when the KILOMUX-2000/KILOMUX-2004 is synchronized. The selection is made by the user.
- DCD: constantly ON, except when communication is not possible because of loss of frame synchronization.

- End-to-end transmission of control signals. To minimize bandwidth requirements, two selections are available:
  - End-to-end transmission of local RTS line state to the remote DCD line, and vice versa.
  - End-to-end transmission of local RTS line state to the remote DCD line, and local DSR line to remote DTR line, and vice versa.

The end-to-end transmission mode can be independently selected for each channel, with the restriction that when both channels are configured for end-to-end transmission, both channels must be configured to transmit the same number of control signals, i.e., both channels can transmit either one pair, or two pairs. Typical end-to-end delay is 2.5 msec.

The module automatically performs self-test upon power-up and during normal operation.

Comprehensive diagnostic capabilities reduce downtime to a minimum. Diagnostics include local and remote channel loops, and in addition the channels support loops per ITU-T Rec. V.54. When downloading is enabled, the channels also allow transparent transmission of local and remote V.54 loop commands to modems connected as a tail-end circuit. The loops can be activated either by the corresponding interface connector pins, or by commands from a supervision terminal. During maintenance, the activity of the channel transmit and receive lines, and the state of the RTS and DCD control lines can be monitored on the dedicated KILOMUX-2000 front-panel indicators.

Each channel terminates on a separate 25-pin D-type, female connector. Pin-out assignment is in accordance with ITU-T Rec. V.24/EIA RS-232 specifications.

Figure 1-26 shows a typical KLS.1 application.

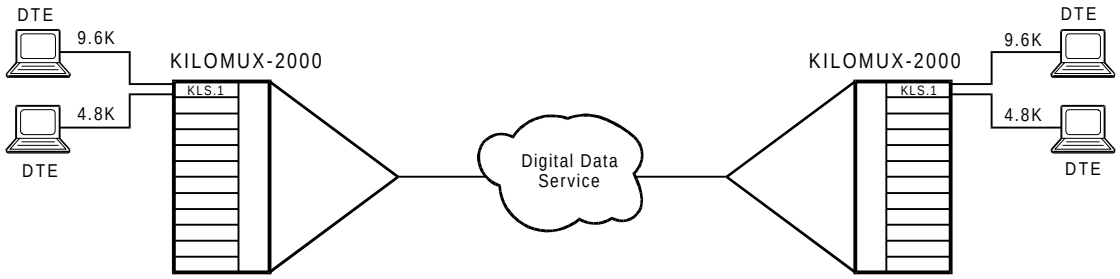

Figure 1-26. Typical KLS.1 Applications

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KLS.2 Four-Channel Statistical Sub-Multiplexer Data Module

The KLS.2 module provides four asynchronous data channel interfaces. The sub-channel interfaces comply with ITU-T Rec. V.24/RS-232, and operate as DCE interfaces. Sub-channel data rates are in the range of 300 bps to 19.2 kbps. Word format and parity are programmable.

Four control signals are supported for each sub-channel (CTS, RTS, DCD, DTR), including end-to-end transmission of local RTS state to the remote DCD. The KLS.2 support both hardware and software flow control, independently selectable for each sub-channel, for both end-to-end and user DTE-to-sub-channel data transfer. The X-ON and X-OFF characters used for software flow control are selectable, for compatibility with most applications.

The composite bandwidth is selectable up to 19.2 kbps.

The multiplexing method used by the KLS.2 module is compatible with the RAD STM-4 four-channel statistical multiplexer. Therefore it is possible to save on the number of modems and links by multiplexing data channels at a remote location with an STM-4 unit, transfer the multiplexed signal by a single line to an KLS.1 module installed in the KILOMUX-2000 at one end of the link, and demultiplex the channels by means of a KLS.2 module installed in the KILOMUX-2000 at the other end of the link.

A typical KLS.2 application is shown in figure 1-27.

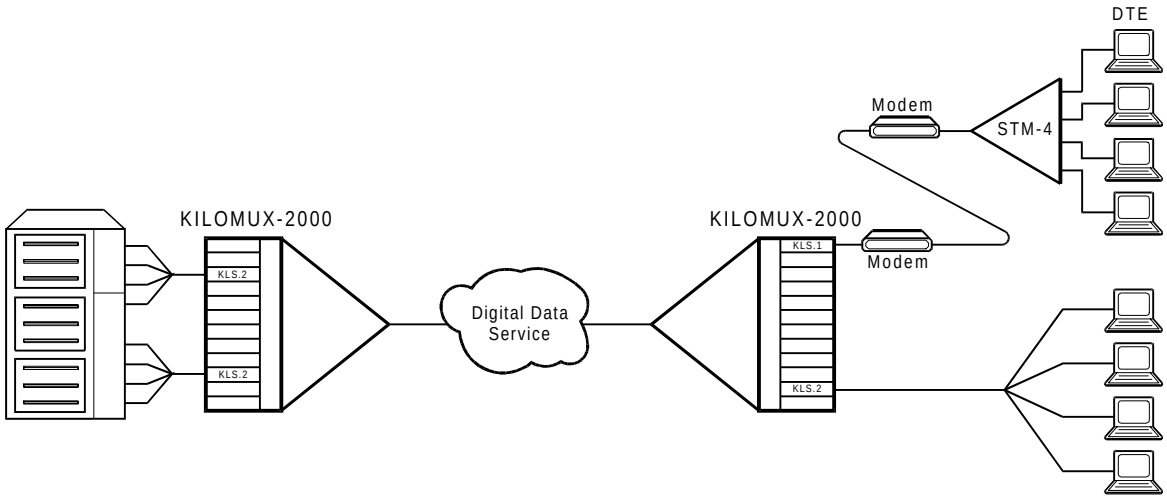

Figure 1-27. Typical KLS.2 Applications

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KHS.1 Two-Channel High-Speed Data Channel Interface Module

The KHS.1 is a high-speed data module providing two high-speed synchronous data channels for the KILOMUX-2000. Channel parameters can be programmed independently for each channel. Each channel can be configured for either V.35, RS-530, V.36/RS-422/RS-499 or X.21 operation. Channel interface is DCE. The bit rate on each channel can be selected for 32, 48, 56, 64, 128 or 192 kbps, depending on the main link rate.

Programmable timing modes and channel buffers permit connection to all types of digital lines, including digital data services, ensuring data integrity.

One control signal per channel may be transmitted end-to-end for handshaking purposes, or alternately, local support for the control signals may be provided. Typical end-to-end delay is 2.5 msec.

Comprehensive diagnostic capabilities reduce downtime to a minimum. Diagnostics include loopbacks, EIA pin and V.54 compatible commands and built-in 511-bit pseudo-random sequence transmission and BERT tests, which are initiated via any of the control systems. Automatic self-test is performed during power-up and normal operation.

Each channel terminates on a 25-pin D-type, female connector. Pin-out assignment is in accordance with RS-530 specifications. Local support of four control signals is provided. For connection to V.35, X.21 or RS-422/RS-449 equipment, special cables are available.

Figure 1-28 shows typical KHS.1 applications.

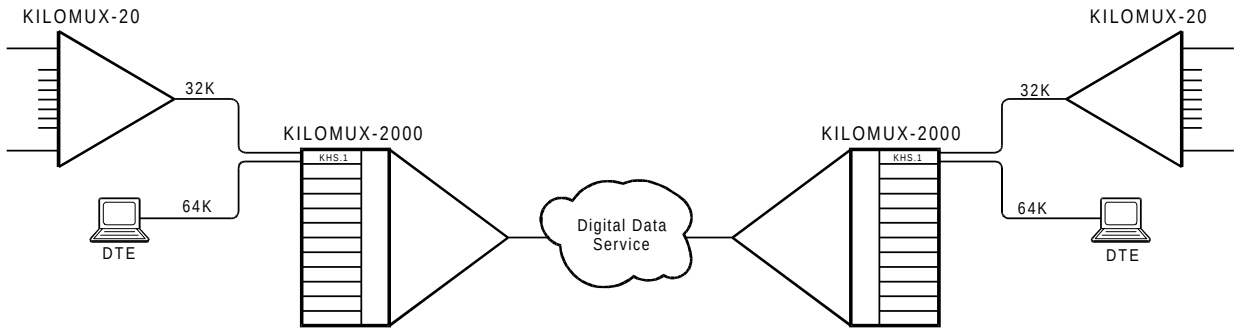

Figure 1-28. Typical KHS.1 Application

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KHS.2 Two-Channel Synchronous Data Channel Interface Module

The KHS.2 module is a two-channel synchronous data module that provides two synchronous data channels with independently selectable data rates. The supported data rates, as well as the total data rates, depend on the data rate of the KILOMUX-2000 main link:

- For main link data rates up to 128 kbps, the supported data rates are *n*×2.4 kbps. The allowed range of values for *n* is 1 to 53, resulting in data rates of 2.4 to 127.2 kbps.
- For main link data rates of 256 kbps and 384 kbps, the supported data rates are *n*×4.8 kbps. The allowed range of values for *n* is 1 to 64, resulting in data rates of 4.8 to 307.2 kbps.
- For a main link data rate of 768 kbps, the supported data rates are *n*×9.6 kbps. The allowed range of values for *n* is 1 to 64, resulting in data rates of 9.6 to 614.4 kbps.

Both channel interfaces are configured as DCE, and can be independently configured for either V.35/RS-530, V.36/RS-530, V.24/RS-232, or X.21 operation. Each channel terminates on a separate 25-pin D-type female connector. Pin-out assignments for all interfaces, except RS-232, are made in accordance with the RS-530 specifications; for the RS-232 interface, pin-out assignments are made in accordance with ITU-T Rec. V.24. For connection to equipment using different interfaces, special adapter cables are available.

Programmable timing modes and channel buffers permit connection to all types of digital lines, including digital data services, and ensure data integrity. Each channel has three user-programmable timing modes:

- DCE: the KHS.2 channel provides the timing signals to the DTE connected to it.
- DTE1: the KHS.2 channel provides the receive timing signal, and accepts the transmit timing from the equipment connected to the channel.
- DTE2: the KHS.2 channel accepts the receive and transmit timing signals from the equipment connected to the channel, and buffers and retimes the incoming data.

  When connected to the national network or to private carrier data lines, e.g., DDS or Kilostream lines, a KHS.2 channel operating in the DTE2 mode can be used as an external timing reference source for the KILOMUX-2000 unit the module is installed in. This is however possible only when the channel data rate is 2.4, 4.8, 9.6, 19.2, 38.4 or 48 kbps.

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The KHS.2 module provides two user-selectable modes of support for interface control signals. The support mode can be independently selected for each channel.

- **Local Control Signal Support**: When local support is enabled, the channel locally supports four interface control signals, that is, the state of the control signals is not transmitted to the remote channel. The locally-supported control signals are as follows:
  - RTS.
  - CTS: can be programmed to follow RTS with a programmable delay, or to be constantly ON. If a channel is disconnected, its CTS line is always OFF, irrespective of the selected mode.
  - DSR: constantly ON, except when the channel is in remote loopback, or under PRBS or BER testing.
  - DCD: constantly ON, except during loss of frame synchronization.
- **End-to-End Control Signal Transfer**: When this mode is selected, the following functions are available:
  - Transmission of local RTS line state to the remote DCD line, and vice versa.
  - Transmission of local DTR line state to the remote DSR line, and vice versa. This capability is available only for V.24/RS-232 interfaces.

Typical end-to-end delay for control signal transfer is 2.5 msec.

The module automatically performs self-test upon power-up and during normal operation. Comprehensive diagnostic capabilities reduce downtime to a minimum. Diagnostics include local and remote channel loops. During maintenance, the activity of the channel transmit and receive lines, and the state of the RTS and DCD control lines can be monitored on the dedicated KILOMUX-2000 front-panel indicators.

Figure 1-29 shows typical KHS.2 applications.

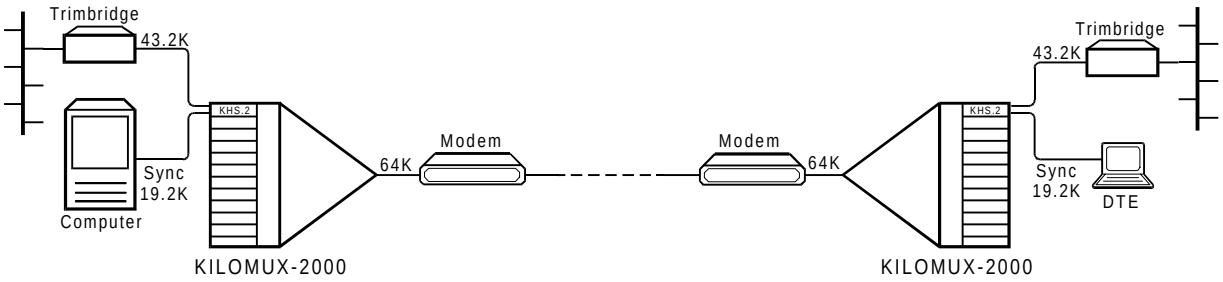

Figure 1-29. Typical KHS.2 Application

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KHS.U "U" ISDN Basic Rate Access Interface Module

The KHS.U module is a data interface module that enables the extension of ISDN lines over non-ISDN facilities. The KHS.U module provides "U" ISDN basic rate access interfaces. The module is available in two versions: KHS.U/S with one "U" interface, and KHS.U/D with two "U" interfaces.

The KHS.U module has two operating modes (for the KHS.U/D module, the selection applies to both module interfaces):

- **NT Mode**.:The NT mode enables the connection of the KHS.U interfaces to ISDN switch lines with LT interface.
- **LT Mode**: The LT mode enables the connection of the KHS.U interfaces to network termination (NT) units , e.g., regular NT1 units, ASM-31, or other equipment.

Each "U" interface carries two B (64 kbps) channels and one D (16 kbps) channel. The user can individually configure each B channel, to support payload data rates of 16, 32, and 64 kbps. Each channel can be independently connected to the KILOMUX-2000 main link. Therefore, the user needs allocate main link bandwidth only in accordance with the actual payload carried by the module channels. The KHS.U modules can operate over main link data rates up to 384 kbps; the minimum main link data rate depends on the actual payload carried by the modules installed in the KILOMUX-2000.

Each U interface of a KHS.U module supports full duplex transmission of 2B+D channels over one unconditioned two-wire telephone loop (one twisted pair). The line data rate is 160 kbps, and the line coding is 2B1Q. Using advanced adaptive echo cancellation techniques, the KHS.U interfaces support data transmission up to a maximum line attenuation of 42 dB at 40 kHz, and a maximum resistance of 1300 ohm. This corresponds to a typical range of 5.5 km (3.4 miles) over 26 AWG (0.4 mm) pairs. The nominal line impedance is 135 ohm.

Each KHS.U interface terminates in an RJ-45 eight-pin connector.

The KHS.U module can be used to connect ISDN equipment to an ISDN switch, as shown in the typical application shown in figure 1-30. In this application, the KHS.U module connected directly to the ISDN switch is configured to operate in the NT mode, and the other module is configured to operate in the LT mode. The module transparently transfers the data in the 2B + D channels, and is therefore independent of the ISDN switch in use.

The KHS.U channel interfaces can also serve as dedicated line termination units for the ASM-31 short-range modems, also offered by RAD. Figure 1-31 shows a typical application for a KHS.U module in conjunction with ASM-31.

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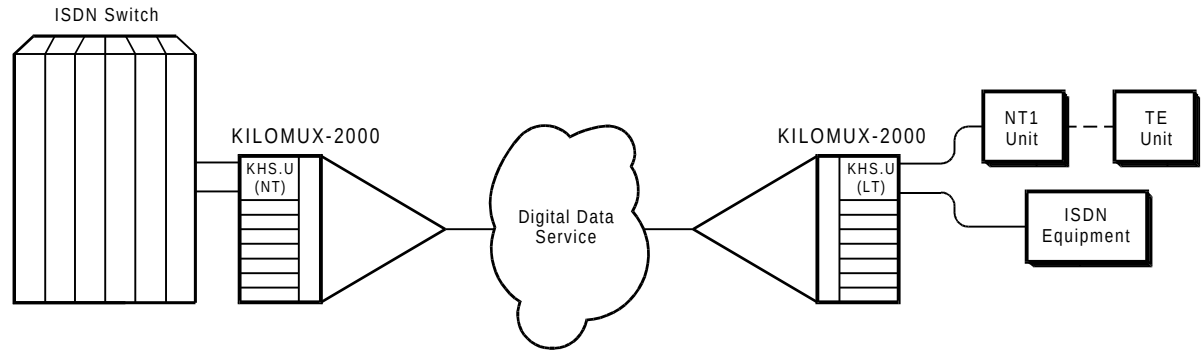

Figure 1-30. Typical KHS.U Application

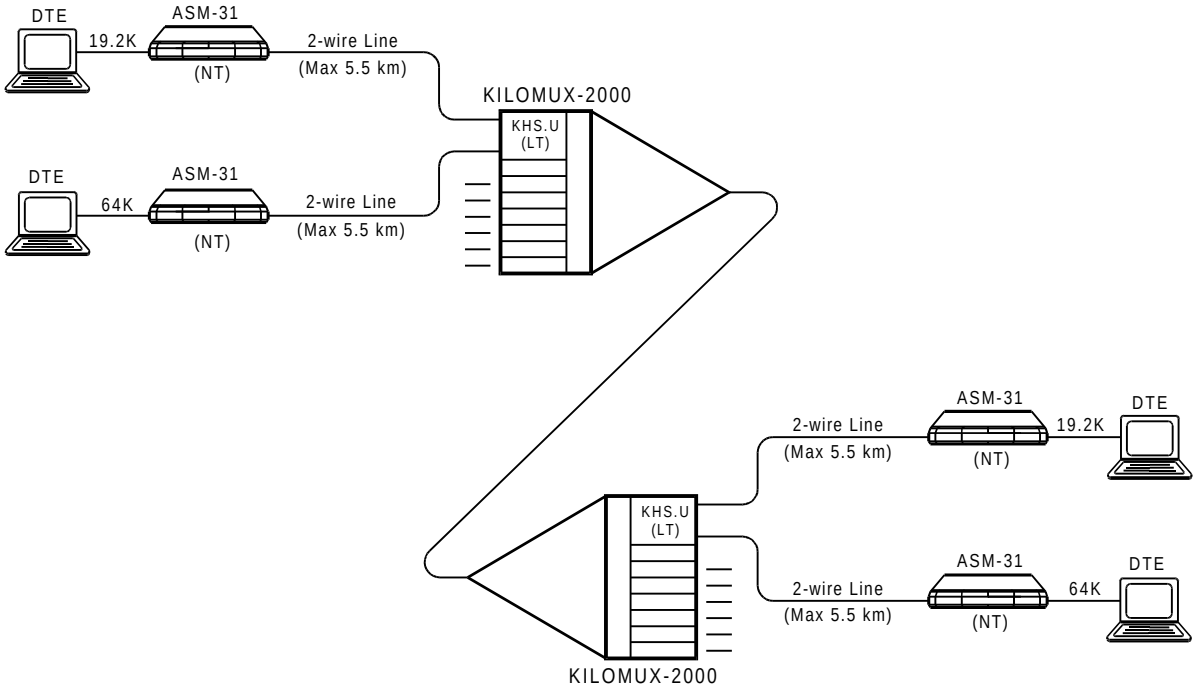

Figure 1-31. Typical KHS.U Application in Conjunction with ASM-31

In the application shown in figure 1-31, each channel interface of the KHS.U module serves as a line termination unit (LT) for one ASM-31. Each ASM-31 unit operates as a network termination unit (NT). This configuration enables the connection of various types of remotely located data equipment such as computer terminals, statistical multiplexers, etc., via the KILOMUX-2000 data link.

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KVF.1 Voice/Fax Relay Module

The KVF.1 is a voice/fax relay module that uses advanced digital signal processing (DSP) techniques to allow the transmission of Group III facsimile and high-quality compressed voice signals while requiring a main link bandwidth of only 9.6 kbps (lower bandwidths of 8.0, 7.2 kbps, or 6.4 kbps can also be used, as explained below). When operating at 9.6 or 7.2 kbps rates, the KVF.1 module is fully compatible with the FRL-1 stand-alone voice/fax relay unit offered by RAD.

The KVF.1 module may be ordered with one of the following analog interfaces: KVF.1/E&M with 4-wire E&M interface for connection to PABX tie lines, KVF.1/FXS with 2-wire FXS interface for direct connection to a telephone handset, or KVF.1/FXO with 2-wire FXO interface for direct connection to a PABX extension line. The KVF.1/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages, which can be provided by the stand-alone RINGER-2000 unit (intended for shelf and rack mounting), or by the KM-RINGER plug-in module offered by RAD.

The KVF.1/E&M module supports five E&M signaling types: EIA RS-464 Types I, II and III and V and British Telecom SSDC5. The internally-generated signaling battery voltage is -12 V: when maximum range is desired, -48 VDC can be provided by an external source, e.g., the RINGER-2000 or the KM-RINGER.

The KVF.1 module has two operating modes, voice and fax:

- **Voice mode**: in this mode, the KVF.1 module enables the transmission of a high-quality compressed voice channel, including the associated call set-up signaling information (either DTMF or pulse dialing), over the main link. Voice is digitized at the selected main link rate, i.e., 6.4, 7.2, 8.0, or 9.6 kbps. When operating at a digitized voice data rate of 8 or 9.6 kbps, the end-to-end voice performance is nearly toll quality.

  The end-to-end processing delay introduced by the KVF.1 module is relatively low (less than 65 msec for 6.4 kbps; for 9.6 kbps, the delay is less than 40 msec). To improve the perceived link quality, the KVF.1 module includes an adaptive echo canceler that handles near-end reflections (echo delay less than 6 milliseconds) such as reflections caused by a nearby hybrid used for 2W/4W conversion. The echo canceler convergence time exceeds ITU-T Rec. G.165 requirements. If the link is a pure 4W link (no hybrid along the path between the two subscribers), the adaptive echo canceler can be turned off by the user.

  To maintain voice quality on bad communication links, the KVF.1 module includes Hamming forward error correction (FEC) coding that protects the critical information bits in the digitized voice data stream. The FEC code can maintain voice quality for main link error rates down to 1×10-3.

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- **Fax relay mode**: in this mode, the KVF.1 module permits any standard Group III facsimile machine to transmit over the data link, thus eliminating the need for expensive digital fax or store-and-forward systems. Facsimile transmission over the digital network improves transmission quality, while greatly reducing long distance telephone costs and the time needed for freeing the facsimile machine.

  In the fax relay mode, the KVF.1 module will automatically recognize and transmit fax transmissions at fax standard rates that do not exceed the selected digital link bandwidth. To improve fax transmission characteristics, the KVF.1 module includes an equalizer that allows compensation for long cable runs (up to 7.2 km on typical subscriber loop cable). The supported fax rates are as follows:

  - For operation over 8.0 kbps and 9.6 kbps links, fax rates of 7.2, 4.8, and 2.4 kbps are supported.
  - For operation over 6.4 kbps and 7.2 kbps links, fax rates of 4.8 and 2.4 kbps are supported.

  Although the KVF.1 module cannot transfer 9.6 kbps fax, it is designed to be inter-operable with 9.6 kbps machines without operator's intervention. Inter-operability is achieved by taking advantage of the automatic fallback capability of fax machines ("fallback" means that two fax machines connected in a link will automatically switch to the next lower data rate supported by both machines, if it is not possible to operate at the initially selected data rate).

When the KVF.1 receives a call setup request from a 9.6 kbps machine, it simulates the conditions required for switching to the fallback rate, and thus the fax connection is automatically setup for operation at the next lower rate, which is usually 7.2 kbps (for machines not supporting 7.2 kbps, the connection will be made at 4.8 kbps).

The KVF.1 module assumes by default the voice mode; it automatically switches to the fax relay mode when a facsimile transmission is detected, and then returns to the voice mode when the transmission is over. Therefore, this highly flexible voice/fax relay module can be directly connected to a PABX tie line, as shown in figure 1-32, or to a combined phone/fax machine, as shown in figure 1-33.

These capabilities allow the user connected to the KVF.1 module to place phone and facsimile calls over the PSTN, and to receive phone and fax calls from the PSTN via a private network. In 4-wire E&M applications, facsimile calls may be placed over data lines between the PABX using normal DTMF or pulse dialing, and operator actions are identical to those using the fax over the PSTN.

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Figure 1-32 shows a typical KVF.1/E&M voice/fax relay application in conjunction with the FRL-1. In this application, the digital output of the FRL-1 is connected to a 9.6 or 7.2 kbps channel of a KLS.1 low-speed data multiplexer module installed in the local KILOMUX-2000. In the remote KILOMUX-2000, the corresponding channel is routed to a KVF.1/E&M module that connects to a trunk line of the remote PABX.

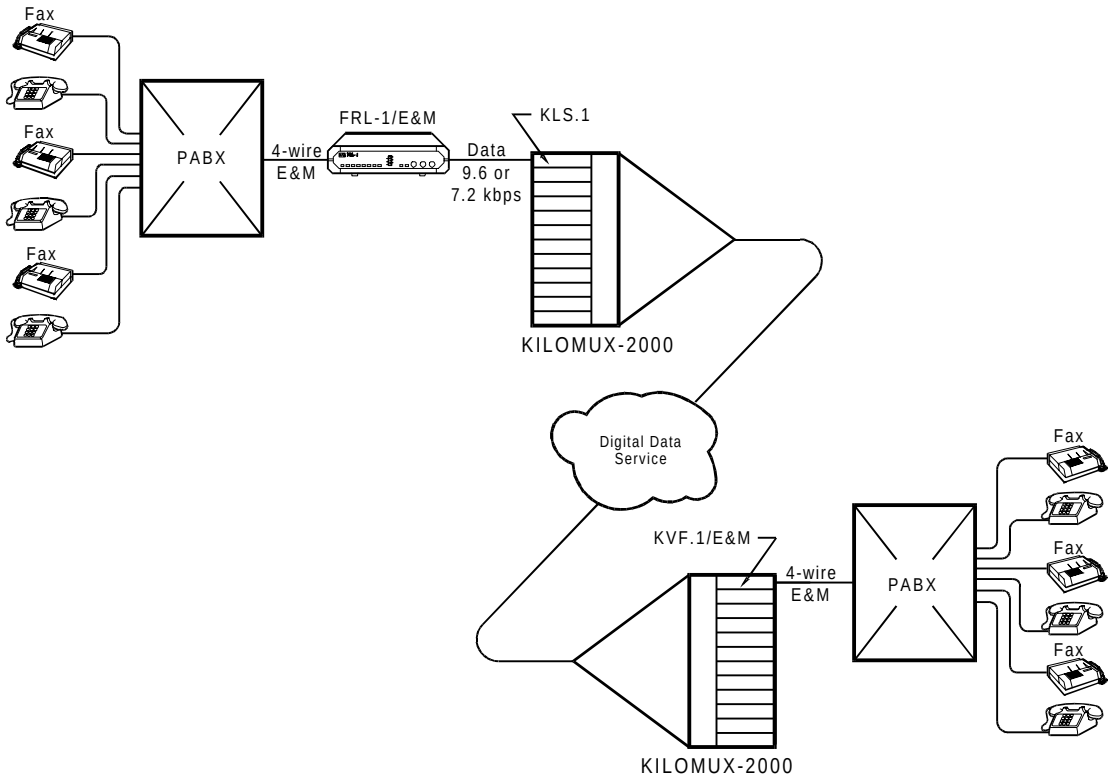

Figure 1-32. Typical Application of KVF.1/E&M

Figure 1-33 shows a typical application for KVF.1/FXO and KVF.1/FXS modules, which allows fax users to access a high-volume fax machine at the main corporate offices via the public switched telephone network (PSTN) by making calls to the local offices: to place a call to the fax machine located at the main corporate offices, the fax users dial the number of the local office fax line, which is connected to the KVF.1/FXO module. The calls are transferred via the corporate digital network to the KVF.1/FXS module, which connects to the main office fax machine.

If desired, the remote fax users can also converse with the local operator using the KVF.1 voice mode, before starting the actual fax transmission.

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The KVF.1 module automatically performs self-test upon power-up and during normal operation. Comprehensive diagnostic capabilities reduce downtime to a minimum. Diagnostics include local and remote channel loops, and tone injection. The current operating mode (voice or fax) of the module, and the state of the E and M control lines can be monitored on the rear panel module indicators. In addition, during maintenance, the state of the E and M control lines can be monitored on the dedicated KILOMUX-2000 front-panel indicators.

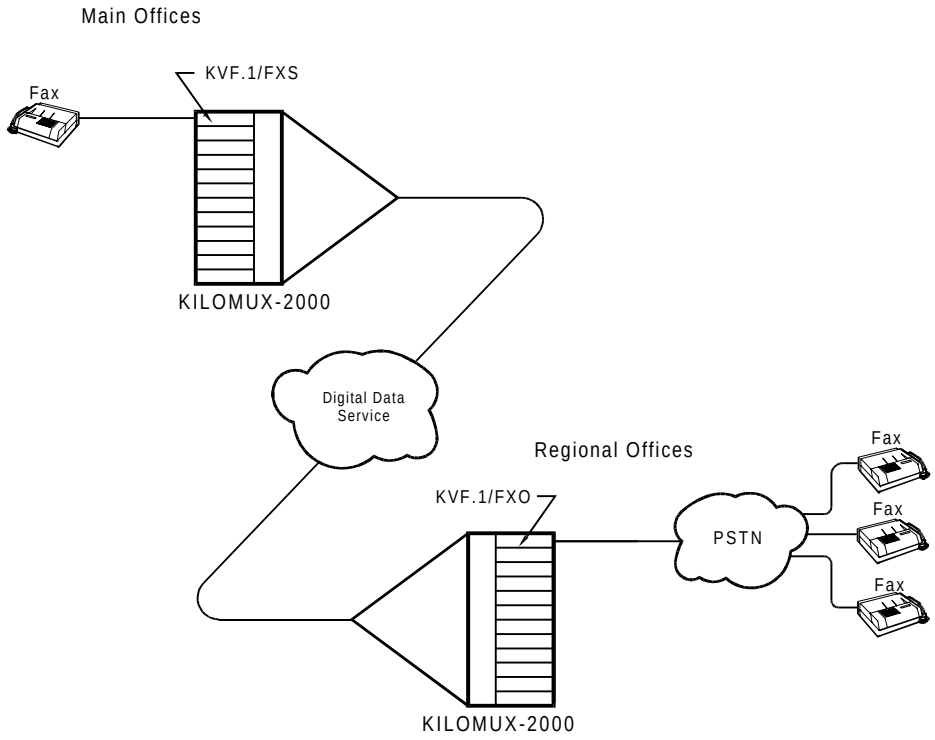

Figure 1-33. Typical KVF.1/FXS and KVF.1/FXO Application

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KVF.3 Voice/Fax Relay Module

The KVF.3 is a voice/fax compression interface module for that uses advanced proprietary digital signal processing (DSP) techniques to allow the transmission of Group III facsimile and high-quality compressed voice signals while requiring a main link bandwidth of only 4.8, 6.4, 7.2, or 9.6 kbps. The KVF.3 replaces the KVF.1 module, bit provides improved voice quality.

When operating at rates of 6.4, 7.2, or 9.6 kbps, the voice quality provided by the KVF.3 module is equivalent to that achieved by 32 kbps ADPCM encoding; high-quality voice is maintained even at a transmission rate of 4.8 kbps.

The KVF.3 module may be ordered with one of the following analog interfaces: KVF.1/E&M with 4-wire E&M interface for connection to PABX tie lines, KVF.1/FXS with 2-wire FXS interface for direct connection to a telephone handset, or KVF.1/FXO with 2-wire FXO interface for direct connection to a PABX extension line. The KVF.3/FXS module requires the connection of external line feed (-48 VDC) and ring (+72 VDC) voltages, which can be provided by the stand-alone RINGER-2000 unit (intended for shelf and rack mounting), or by the KM-RINGER plug-in module offered by RAD.

The KVF.3/E&M module supports five E&M signaling types: EIA RS-464 Types I, II and III and V and British Telecom SSDC5. The internally-generated signaling battery voltage is -12 V: when maximum range is desired, -48 VDC can be provided by an external source, e.g., the RINGER-2000 or the KM-RINGER.

The KVF.3 module has two operating modes, voice and fax:

- **Voice mode**: in this mode, the KVF.3 module enables the transmission of a high-quality compressed voice channel, including the associated call set-up signaling information (either DTMF or pulse dialing), over the main link. The KVF.3 module utilizes a proprietary digitizing algorithm, MPMLQ (Multipulse Maximum Likelihood Quantization). Voice is digitized at the selected main link rate, i.e., 4.8, 6.4, 7.2, or 9.6 kbps.

  Due to the use of the MPMLQ speech compression technique, the end-to-end voice performance at all the rates, except 4.8 kbps, as measured using the mean opinion score (MOS), is equivalent to the performance of 32 kbps ADPCM.

  The end-to-end processing delay introduced by the KVF.3 module is 108 msec. To improve the perceived link quality, the KVF.3 module includes an adaptive echo canceler that handles near-end reflections (echo delay less than 8 milliseconds) such as reflections caused by a nearby hybrid used for 2W/4W conversion. The echo canceler convergence time exceeds ITU-T (formerly CCITT) Rec. G.165 requirements. If the link is a pure 4W link (no hybrid along the path between the two subscribers), the adaptive echo canceler can be turned off by the user.

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To maintain voice quality on bad communication links, when operating at rates of 7.2 and 9.6 kbps the KVF.3 module uses Hamming forward error correction (FEC) coding to protect the critical information bits in the compressed voice data stream. The FEC code can maintain voice quality for main link error rates down to 1×10^{-3}.

- **Fax Relay Mode**: The operation of the KVF.3 module in the fax relay mode is similar to the operation of the KVF.1. The supported fax rates are as follows:
  - For operation over 9.6 kbps links, fax rates of 7.2, 4.8, and 2.4 kbps are supported.
  - For operation over 6.4 kbps and 7.2 kbps links, fax rates of 4.8 and 2.4 kbps are supported.
  - For operation over 4.8 kbps links, the supported fax rate is 2.4 kbps.

The KVF.3 module assumes by default the voice mode; it automatically switches to the fax relay mode when a facsimile transmission is detected, and then returns to the voice mode when the transmission is over. Therefore, this highly flexible voice/fax relay module can be directly connected to a PABX tie line, or to a combined phone/fax machine.

These capabilities allow the user connected to the KVF.3 module to place phone and facsimile calls over the PSTN, and to receive phone and fax calls from the PSTN via a private network. In 4-wire E&M applications, facsimile calls may be placed over data lines between the PABX using normal DTMF or pulse dialing, and operator actions are identical to those using the fax over the PSTN.

The applications of the KVF.3 module include the applications of the KVF.1. In addition, due to the use of the MPMLQ speech compression technique, the KVF.3 module provides high quality voice transmission, equivalent to the performance of 32 kbps ADPCM (this applies to all the rates, except the lowest rate, 4.8 kbps). The performance is good enough to enable the use of tandem compressed speech link segments, as shown in figure 1-34.

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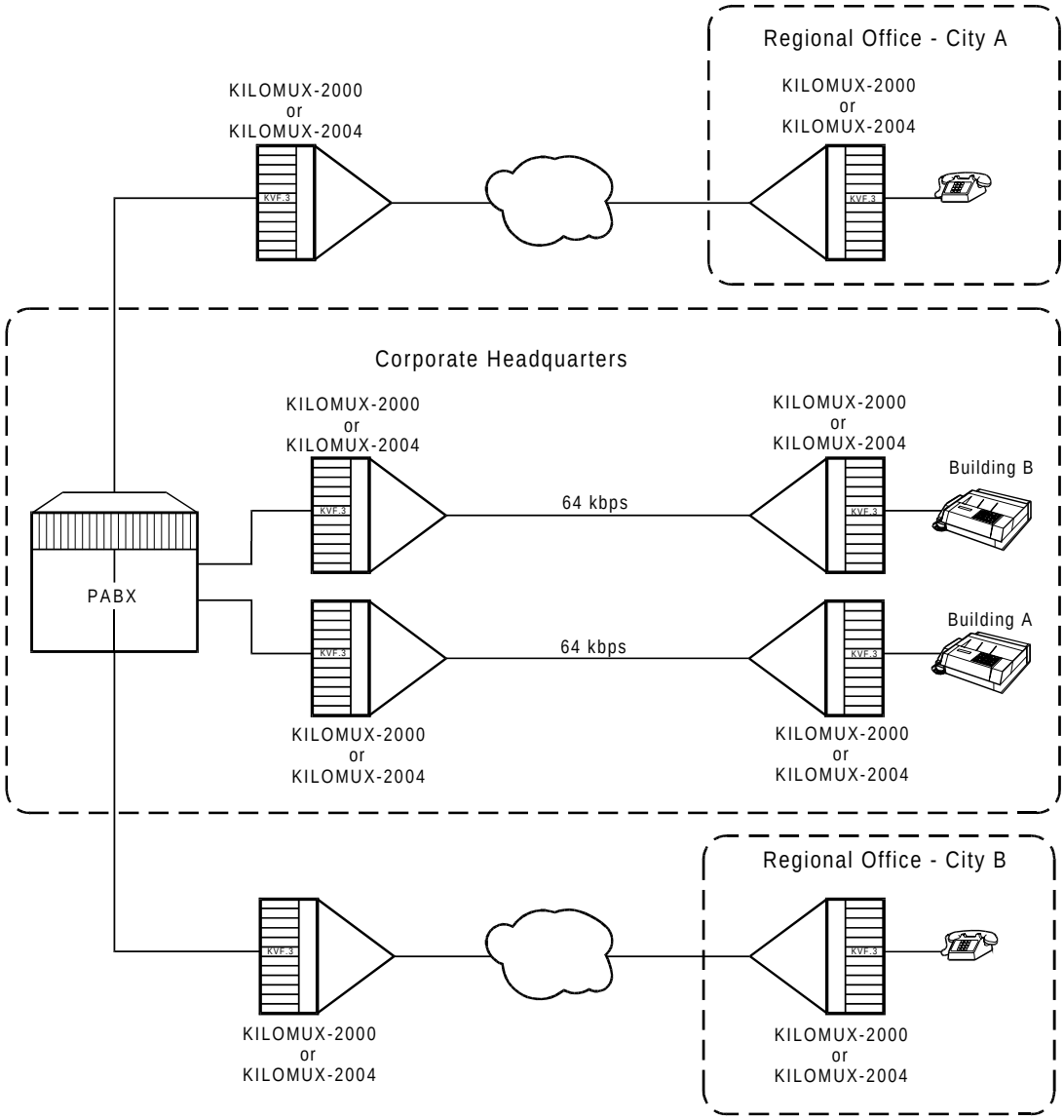

Figure 1-34. Typical Tandem Application for the KVF.3 Modules

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KVF.4 Two-Channel Low Bit Rate Voice/Fax Interface Module

The KVF.4 module is a voice/fax compression interface module, that uses advanced digital signal processing (DSP) techniques (MPMLQ - Multipulse Maximum Likelihood Quantization per ITU-T Rec. G.723) to provide one or two channels for transmission of Group III facsimile and high-quality compressed voice signals while requiring a main link bandwidth of only 4.8, 6.4, 7.2, 9.6, or 12.8 kbps.

When operating at rates of 6.4, 7.2, 9.6, or 12.8 kbps, the voice quality provided by the KVF.4 module is equivalent to that achieved by 32 kbps ADPCM encoding; high-quality voice is maintained even at a transmission rate of 4.8 kbps. Moreover, unlike most low bit rate compression techniques that are currently available, the advanced low bit rate voice compression technique used by the KVF.4 enables tandem connection of two independent transmission segments with relatively low degradation.

The KVF.4 module can be ordered with a variety of interfaces:

- **KVF.4/E&M and KVF.4/E&M/E**: These modules offer two channels with user-selectable two-wire and four-wire analog interfaces and E&M signaling. These modules are intended mainly for connection to PABX trunk lines. These module support five types of E&M signaling: RS-464 types I, II, III, and V, and British Telecom SSDC5. Channel audio line connection is made to an eight-point RJ-45 connector.

  The KVF.4/E&M module generates a -12 VDC signaling battery voltage, which is sufficient for connection to PABX lines, as well as for many short line length applications.

  The KVF.4/E&M/E module requires an external -48 VDC source for the signaling battery voltage, for increasing the maximum allowed line length. For this purpose, the module includes an additional connector. The required voltages can be supplied by a RINGER-2000 unit offered by RAD, or by a special-purpose power supply unit, KM-RINGER, also offered by RAD.
- **KVF.4/FXS and KVF.4/FXSP**: These modules offer two channels with two-wire analog interfaces and FXS loop start or ground start signaling, for direct connection to a subscriber telephone set, or other equipment with similar interface (answering machines, fax, etc.). Each channel has a separate six-pin RJ-11 connector. The KVF.4/FXS module requires an external source for the feed (nominally -48 VDC) and ring (nominally +72 VDC) voltages, therefore it has an additional three-pin connector. The required voltages can be supplied by a RINGER-2000 stand-alone unit, or by a KM-RINGER module.

  The KVF.4/FXSP module, includes an internal ringer and line feed supply. The internal ringer provides a nominal ring voltage of 23 VRMS, and the nominal line feed voltage is -42 VDC at a line current of 25 mA. These voltages are sufficient for connection to PABX lines, as well as for many short line length applications.

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- **KVF.4/FXS3**: similar to KVF.4/FXS, except it supports metering.
- **KVF.4/FXSW**: The KVF.4/FXSW module has one FXS channel, intended for the connection to the local subscriber's equipment. This channel is similar to the voice/fax channels of the KVF.4/ FXS module. In addition, the module includes a second channel with FXO signaling, intended for connection to the PSTN, or to a PABX extension line.

  The local subscriber connected to the FXS interface can access the multiplexed voice/fax channel, as well as the PSTN/PABX line:

  - When the local subscriber goes off-hook, the module connects the local subscriber in accordance to a default selection, either to the multiplexed voice/fax channel, or to the PSTN/PABX port. To make a call over the alternative port, the subscriber dials a user-selectable single-digit access code.
  - For example, when the default routing is to the multiplexed voice/fax channel, the subscriber can get the PSTN/PABX line by first dialing the access digit, followed by the desired directory number.
  - Incoming calls (received either via the multiplexed voice/fax channel, or via the PSTN/PABX line) are automatically routed to the local subscriber. If a call is received through the other port while the subscriber is engaged in a call, a busy indication is provided.

  The PSTN/PABX port cannot access the multiplexed link.
- **KVF.4/FXO**: The KVF.4/FXO offers two channels with two-wire analog interface and FXO loop start signaling, for direct connection to PABX extension lines. Each channel has a separate six-pin RJ-11 connector.

  The KVF.4/FXS, /FXS3, /FXSP, and /FXSW modules, and the KVF.4/FXO and /FXO3 modules are intended for operation in a link, with the KVF.4/FXS, /FXS3, /FXSP, and /FXSW modules, respectively, on the subscriber side and the KVF.4/FXO and /FXO3 modules on the PABX side.
- **KVF.4/FXO3**: similar to KVF.4/FXO, execpt it supports metering.
- **KVF.4/S0 Module**: The KVF.4/S0 module has one ISDN basic rate access type "S" interface which enables direct connection to an ISDN PABX, for extending voice and fax access to locations at which direct access to the ISDN facilities is not available, or is not cost-effective. The extension is provided over the KILOMUX-2000 data link, by converting the PCM-coded voice channels carried by the two B channels of the "S" interface to low bit rate voice channels that can be effectively transmitted over the data link. The user can select one of the B channels for transparent transmission through the KILOMUX-2000 link (this enables data transmission through the ISDN connection). In this case, the main link bandwidth needed by the module is 64 kbps, plus the rate selected for the compressed voice channel.

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To establish a basic rate connection through the KVF.4/S0 link, it is necessary to transmit, in addition to the B-channels, the D-channel. The user can then enable end-to-end transmission of the D-channel through the KILOMUX-2000 link (the required bandwidth is 16 kbps).

The "S" interface conforms to ITU-T Rec. I.430 and supports full duplex transmission of 2B+D channels over unconditioned four-wire telephone loop (two twisted pairs). The line data rate is 192 kbps, and the line coding is pseudoternary. The nominal line impedance is 100 ohm. The ISDN channel terminates in an RJ-45 eight-pin connector.

The KVF.4/S0 module has two selectable operating modes:

- **TE Mode**: The TE (terminal equipment) mode enables the connection of the KVF.4/S0 channel to a network termination (NT) unit. This mode should be used when the KVF.4/S0 is connected to an ISDN switch, because in this case the timing reference is derived from the clock recovered from the ISDN line signal. In this mode, it is necessary to select the KVF.4/S0 module as the timing reference for the KILOMUX-2000.
- **NT Mode**: The network termination (NT) mode enables direct connection of terminal equipment to the KVF.4/S0 channel.

- **KVF.4/NS0**: similar to KVF.4/S0, execept it supports D channel compression.

The KVF.4 module can replace two KVF.3 or KVF.1 modules for all applications that require two voice and fax channels connected to the same KILOMUX-2000. Due to the variety of available KVF.4 models, the KVF.4 module offers additional applications.

Figure 1-35 shows a typical application for KVF.4/FXSW modules. The user connected to the KVF.4/FXSW module can use the same telephone set to call subscribers of the PABX to which the remote KILOMUX-2000 is connected, as well as to dial directly over the PSTN networks.

Figure 1-36 shows a typical application for a KVF.4/S0 module. A KVF.4/S0 module is used to connect to a basic rate access line of the ISDN switch located at the main offices. As a result, the subscribers connected to the KVF.4/FXSP module at the other end of the multiplexed KILOMUX-2000 link effectively become subscribers of the main office switch.

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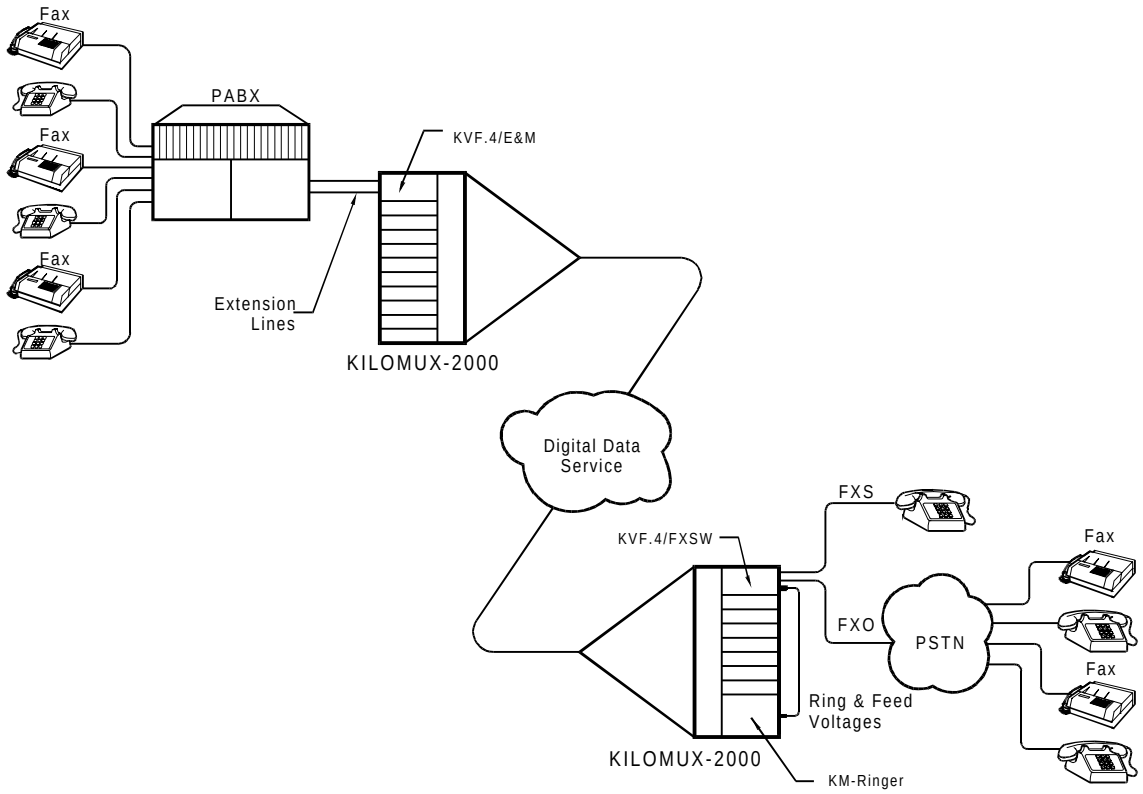

Figure 1-35. Typical Application for KVF.4/FXSW Modules

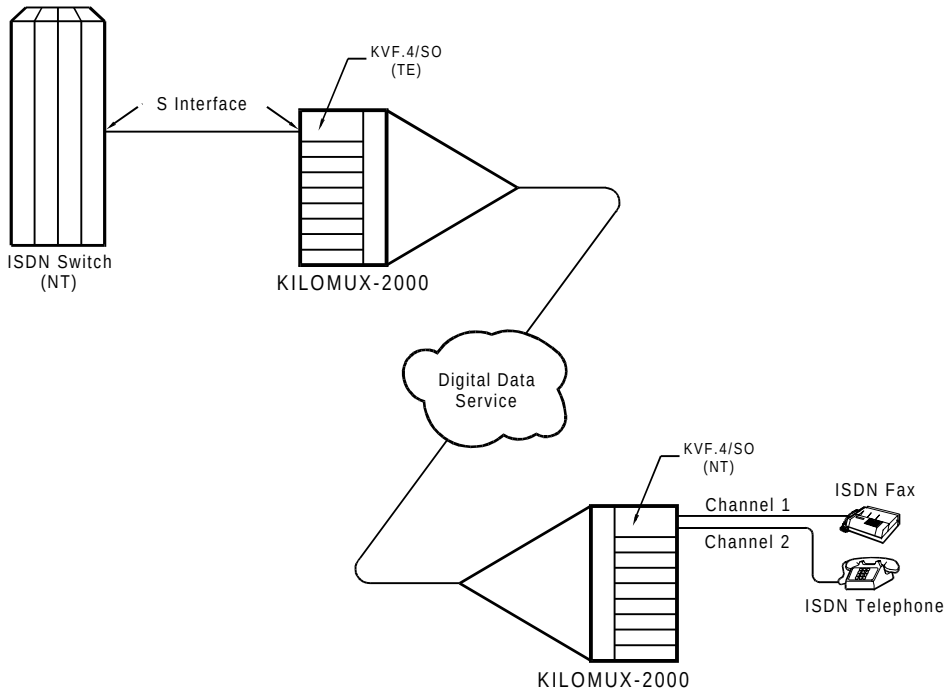

Figure 1-36. Typical Application for KVF.4/S0 Module

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KVF.5 Four Channel Voice/Fax Module

The KVF.5 is a module intended to connect voice and fax channels, using T1 or E1 trunks, from two digital PABX's over the KILOMUX-2000 link (a basic application of this type is shown in figure 1-37). For this purpose, the KVF.5 module has a standard T1 or E1 sub link interface, for direct connection to a digital PABX. The KVF.5 module converts up to four consecutive time slots of the E1 or T1 sub link data stream to compressed voice/fax channels.

The KVF.5 module uses advanced digital signal processing (DSP) techniques (MPMLQ - Multipulse Maximum Likelihood Quantization in accordance with ITU-T Rec. G.723.1) to allow the transmission of Group III facsimile and high-quality compressed voice signals while requiring, for each channel, a bandwidth of only 4.8, 6.4, 7.2, 9.6, or 12.8 kbps on the KILOMUX-2000 main link.

When operating at rates of 6.4, 7.2, 9.6, or 12.8 kbps, the voice quality provided by the KVF.5 module is equivalent to that achieved by 32 kbps ADPCM encoding; high-quality voice is maintained even at a transmission rate of 4.8 kbps. Moreover, unlike most low bit rate compression techniques that are currently available, the advanced low bit rate voice compression technique used by the KVF.5 enables tandem connection of two independent transmission segments with relatively low degradation.

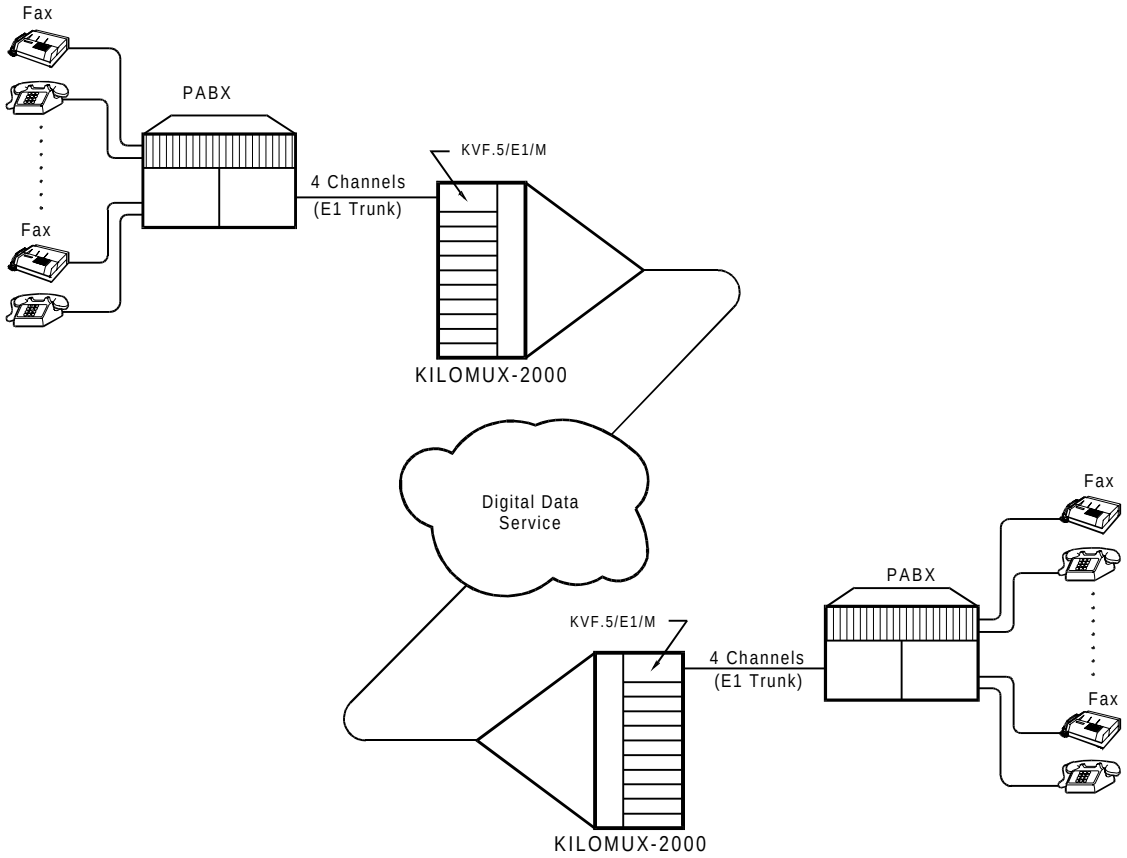

Figure 1-37. Basic KVF.5 Application

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When the number of voice channels that can be compressed is more than four, several KVF.5 modules can operate as a group. A group is formed by interconnecting the dedicated expansion ports of the KVF.5 modules. The number of KVF.5 modules that can be interconnected as a group is up to eight (a basic application of this type is shown in figure 1-38).

- A group of six KVF.5 modules can serve a full T1 trunk (24 voice channels), while using a bandwidth that is as little as 115.2 kbps (at 4.8 kbps digitizing rate), including in-band signaling and synchronization overhead. At the highest rate (12.8 kbps), the required bandwidth is still only 307.2 kbps.
- A group of eight KVF.5 modules can serve a full E1 trunk (30 voice channels), while using only a bandwidth of 144 kbps (at 4.8 kbps) up to a maximum of 384 kbps (at 12.8 kbps), including in-band signaling and synchronization overhead.

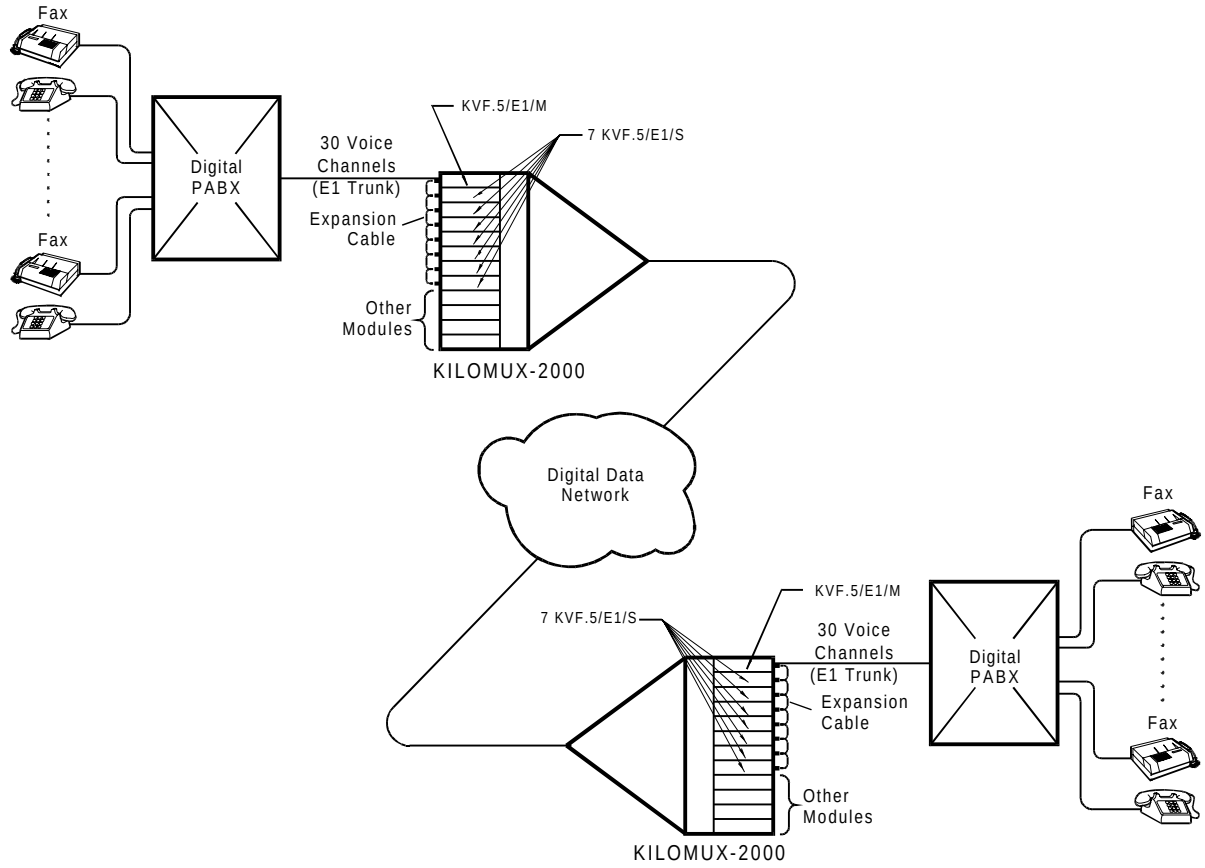

Figure 1-38. Typical KVF.5 Application - Compression of Full E1 Trunk

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The KVF.5 module can be ordered in several versions, that differ in the type of sub link interface. The available versions are as follows:

- **KVF.5/T1/M** - KVF.5 "master" module with balanced T1 sub link interface, for connection to PABX's with T1 interface. As an option, the T1 interface of the KVF.5/T1 module can be equipped with a CSU.
- **KVF.5/E1/M** - KVF.5 "master" module with balanced and unbalanced E1 sub link interfaces, for connection to PABX's with E1 interface. As an option, the E1 interface of the KVF.5/E1 module can be equipped with an LTU.
- **KVF.5/T1/S** - Basic KVF.5 "slave" module without sub link interface. This version is intended for use together with a KVF.5/T1/M module to increase the number of compressed voice channels beyond the four channels that can be handled by a single module.
- **KVF.5/E1/S** - Basic KVF.5 "slave" module without sub link interface. This version is intended for use together with a KVF.5/E1/M module to increase the number of compressed voice channels beyond the four channels that can be handled by a single module.

The T1 sub link interface of the KVF.5/T1/M and KVF.5/T1/S modules is compatible with virtually all carrier-provided T1 services. The T1 sub line interface meets the requirements of AT&T TR-62411, ANSI T1.403, and ITU-T Rec. G.703, G.704. It supports both the D4 (SF) and ESF framing formats, in accordance with user's selection. Zero suppression over the line is user-selectable (transparent (AMI) coding, B7ZS, or B8ZS).

The interface has a 100-ohm balanced line interface, terminated in a RJ-45 eight-pin connector. The nominal transmit level is ±3V, and the line signal is software-adjustable for line lengths of 0 to 655 feet in accordance with AT&T CB-119. The maximum line attenuation, without CSU, is up to 10 dB; when the integral CSU option is used, the maximum line attenuation is up to 36 dB. For shorter lines, the CSU transmit level can be set to -7.5, -15 dB, or -22.5 dB.

The E1 sub link interface of the KVF.5/E1/M and KVF.5/E1/S meets the requirements of ITU-T Rec. G.703, G.704 and G.732, and supports both G732N and G732S multiframes (2 or 16 frames per multiframe, respectively), in accordance with user's selection. The KVF.5 also supports the CRC-4 option specified in ITU-T Rec. G.704. CRC-4 use is user-selectable.

The E1 sub link has two line interfaces: a 120-ohm balanced line interface terminated in a RJ-45 eight-pin connector, and a 75-ohm unbalanced interface terminated in two BNC female coaxial connectors. Line coding is HDB-3.

When the balanced interface is used, the maximum line attenuation, without LTU, is up to 10 dB; when the integral LTU option is used, the maximum line attenuation is up to 36 dB.

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Each processing channel of the KVF.5 module can operate in two modes, voice and fax:

- **Voice mode**: in this mode, the KVF.5 channel enables the transmission of a high-quality compressed voice channel, including the associated call set-up signaling information (either DTMF or pulse dialing), over the main link. Voice is digitized at the selected channel rate, i.e., 4.8, 6.4, 7.2, 9.6, or 12.8 kbps. Due to the use of the MPMLQ speech compression technique, the end-to-end voice performance at all the rates, except 4.8 kbps, as measured using the mean opinion score (MOS), is equivalent to the performance of 32 kbps ADPCM.

  The end-to-end processing delay introduced by the KVF.5 module is 120 msec. To improve the perceived link quality, the KVF.5 module includes an adaptive echo canceler that handles near-end reflections (echo delay less than 15 milliseconds) such as reflections caused by a nearby hybrid used for 2W/4W conversion. The echo canceler convergence time exceeds ITU-T Rec. G.165 requirements. If the link is a pure 4W link (no hybrid along the path between the two subscribers), the adaptive echo canceler can be turned off by the user.

  To maintain voice quality on bad communication links, when operating at rates of 7.2, 9.6, and 12.8 kbps, the KVF.5 module uses Hamming forward error correction (FEC) coding to protect the critical information bits in the compressed voice data stream. The FEC code can maintain voice quality for main link error rates down to $1\times 10\text{-}3$.

- **Fax relay mode**: in this mode, each KVF.5 channel permits any standard Group III facsimile machine to transmit over the data link. The KVF.5 channel automatically recognizes and transmits fax transmissions at standard fax rates that do not exceed the selected digitizing rate.

  The supported fax rates are as follows:

  - For operation at 12.8 kbps, fax rates of 9.6, 7.2, 4.8, and 2.4 kbps are supported.
  - For operation at 9.6 kbps, fax rates of 7.2, 4.8, and 2.4 kbps are supported.
  - For operation at 6.4 and 7.2 kbps, fax rates of 4.8 and 2.4 kbps are supported.
  - For operation at 4.8 kbps, the supported fax rate is 2.4 kbps.

  The KVF.5 module has automatic fallback capability ("fallback" means that two fax machines connected in a link will automatically switch to the next lower data rate supported by both machines, if it is not possible to operate at the initially selected data rate).

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Each KVF.5 channel assumes by default the voice mode; it automatically switches to the fax relay mode when a fax transmission is detected, and then returns to the voice mode when the transmission is over. These capabilities allow the user served by a KVF.5 channel to place phone and fax calls over the PSTN, and to receive phone and fax calls from the PSTN via a private network; operator actions are identical to those using the fax over the PSTN.

The KVF.5 channel data stream is compatible with the compressed data stream generated by the KVF.4 modules, therefore the KVF.5 module can be operated in a link with two KVF.4 modules. A typical application of this type is shown in figure 1-39.

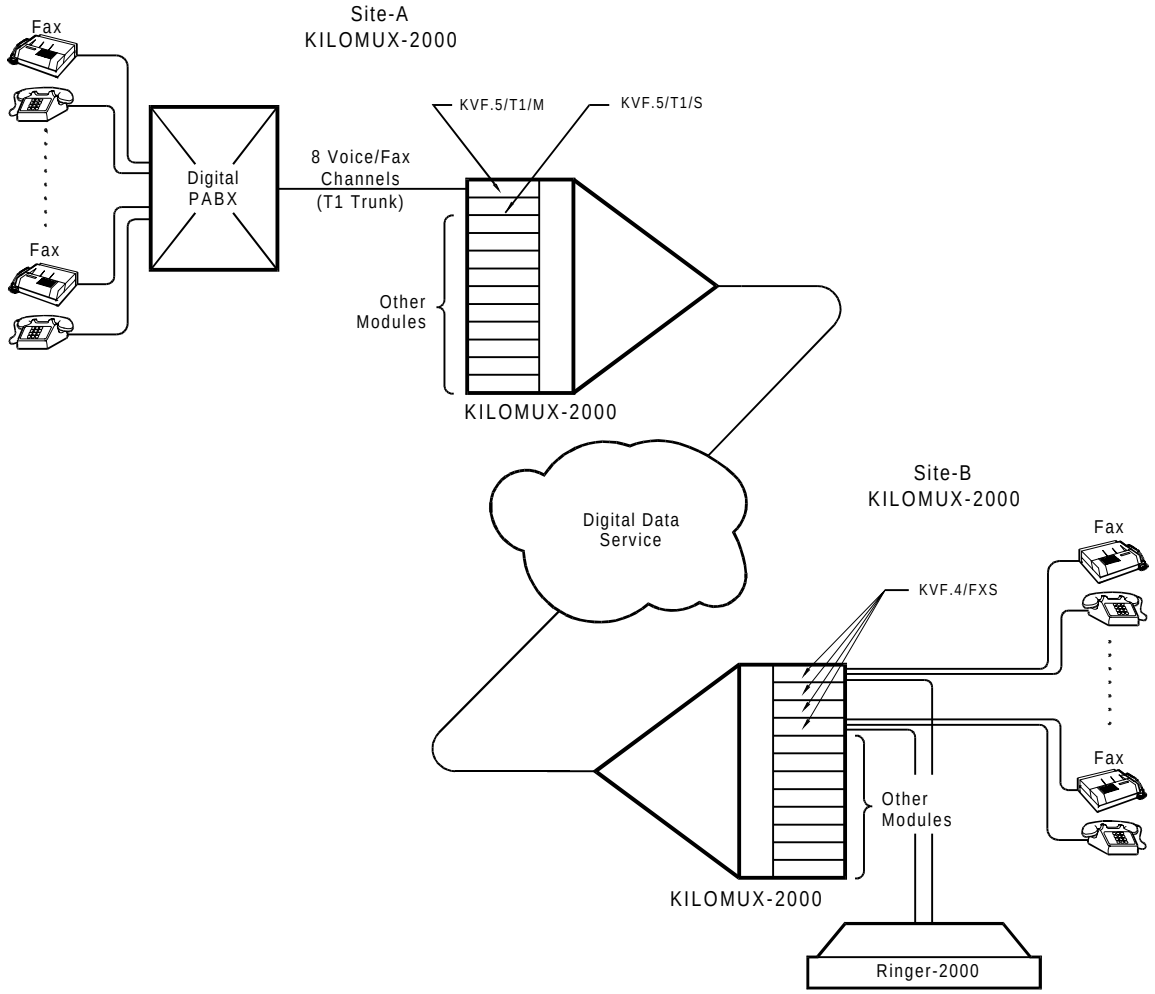

Figure 1-39. Typical KVF.5 Application in Conjunction with KVF.4 Modules

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In the application of figure 1-39, remote users are connected as PABX subscribers. For this purpose, the PABX is connected to the KVF.5 module installed at the local KILOMUX-2000 unit. The module processes the four channels selected by the user, and the resulting data stream is routed through the KILOMUX-2000 link to the remote unit. The remote users are directly connected to two KVF.4/FXS modules installed in the remote KILOMUX-2000 unit.

The number of remote users can be increased by increasing the number of modules installed in the two KILOMUX-2000 units.

Since each KVF.4 module serves two channels, two KVF.4/FXS modules are necessary to handle the four channels processed by the local KVF.5 module.

Due to the method of bandwidth allocation used by KILOMUX-2000 systems when operating in the master- mode (refer to Part I of the manual), it is necessary to install the KVF.4 modules operating in a link with KVF.5 modules in the proper enclosure slots, relative to the position of the KVF.5 modules in the other KILOMUX-2000. For example:

- If the KVF.5 module is the first module (counted from slot 1) and is physically installed in I/O slot 3 in one KILOMUX-2000 (that is, I/O slots 1 and 2 are empty), the first of the two KVF.4 modules at the other end of the link must be installed as the first module in that chassis, e.g., it can be installed in I/O slot 1, and the other KVF.4 - in slot 2. In this case, the first two voice channels configured to be processed by the KVF.5 module are connected to the KVF.4 module in slot 1, and the other two channels - by the KVF.4 module in slot 2.
- Alternately, the KVF.4 modules could be installed in I/O slots 8 and 12, provided slots 1 through 7 and 9, 10, 11 are left empty. In this case, the first two voice channels configured to be processed by the KVF.5 module are connected to the KVF.4 module in slot 8, and the other two channels - by the KVF.4 module in slot 12.

The same approach can be extended to a group of KVF.5 modules: For example, assuming that in the previous example one slave KVF.5 module is added (then it must be located in slot 4 of the first KILOMUX-2000 unit), and the KVF.4 modules are currently installed in slots 8 and 12 of the other KILOMUX-2000 unit, the two additional KVF.4 modules must be installed in slots 9 and 11 (leaving slot 10 empty). In this case, the channels are handled as follows:

- The master KVF.5 module would handle channels 1 through 4, and the slave - channels 5, 6 and 7, 8.
- The KVF.4 module in slot 8 would handle channels 1, 2; the KVF.4 in slot 9 - channels 3, 4.
- The KVF.4 module in slot 11 would handle channels 5, 6; the KVF.4 in slot 12 - channels 7, 8.

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KTRE Token Ring Extender Module

The KTRE module is a token ring extender module. Two KTRE modules, installed in two KILOMUX-2000 units interconnected by a link, allow the connection of up to 80 workstations attached to a remote token ring LAN to the main token ring LAN via the KILOMUX-2000 link.

The KTRE modules support both 4 and 16 Mbps token ring LAN rates; moreover, the remote and main LAN rates can operate at different rates, e.g., a pair of KTRE modules allow the connection of 4 Mbps token ring workstations to a 16 Mbps token ring, and vice versa. The LAN interface is a STP (shielded twisted pair) LAN interface, terminated in a 9-pin female D-type connector, that complies with IEEE 802.5.

The KTRE module can be assigned main link bandwidths in the range of 9.6 to 368 kbps, therefore it is possible to select the link rate best suited to the expected traffic load between the two LAN's, without wasting main link bandwidth.

The KTRE module operates at the physical and data link layers of the OSI model, and is completely transparent to higher level protocols, such as TCP/IP, DECnet, XNS, ISO, and to operating systems, such as Netware, VINES, and 3COM+. Module operation is similar to that of a media access (MAC) layer remote bridge with self-learning capabilities: the KTRE module connected to the remote LAN automatically recognizes the addresses of the nodes attached to the remote LAN (up to 80), and transmits this information to the other KTRE module, which is attached to the main LAN. Using this information, the TRE's filter the LAN traffic, block the packets addressed to local nodes, and forward through the main link only multicasts, broadcasts, and packets addressed to nodes attached to the other LAN segment.

The KTRE module is fully compatible with the other token ring extenders offered by RAD: the stand-alone TRE-8 unit and the RADring TRE module. Thus, the link port of a stand-alone TRE-8 unit or of a RADring TRE module can be connected to a channel of a high-speed data module installed in one of the KILOMUX-2000 units connected in a link, e.g., a KHS.2 module, that operates at the data rate required by the TRE-8. The link data stream is then transferred through the link between the two KILOMUX-2000 units, and therefore can benefit from all the available reliability-enhancing features of the KILOMUX-2000 system. The data stream is then routed to a KTRE module installed in the other KILOMUX-2000, which is attached to the other LAN. A typical system configuration of this type is shown in figure 1-40.

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The KTRE module provides status indications by means of dedicated indicators located on the module rear panel. The available indications include the reception and transmission of packets on the LAN, ready-for-packet-forwarding indication, indication of selected KTRE operating mode (remote module, or module connected to the main LAN), indication of selected token ring rate (4 Mbps or 16 Mbps), and indicators for errors on the LAN and on the link. The KTRE module automatically performs self-test upon power-up. Faults detected during the power-up self-test are indicated by the rear panel indicators.

Additional diagnostics, configuration and monitoring can be performed using an optional "dumb" ASCII terminal (or a PC running a terminal emulation program), connected to the KTRE control port. The KTRE control port has an asynchronous RS-232 interface, and operates at rates between 1.2 and 19.2 kbps, with automatic recognition of data rate (Autobaud). Word format is one start bit, eight data bits with no parity, and one stop bit. The control port is terminated in an RJ-45 connector located on the rear panel of the KTRE module.

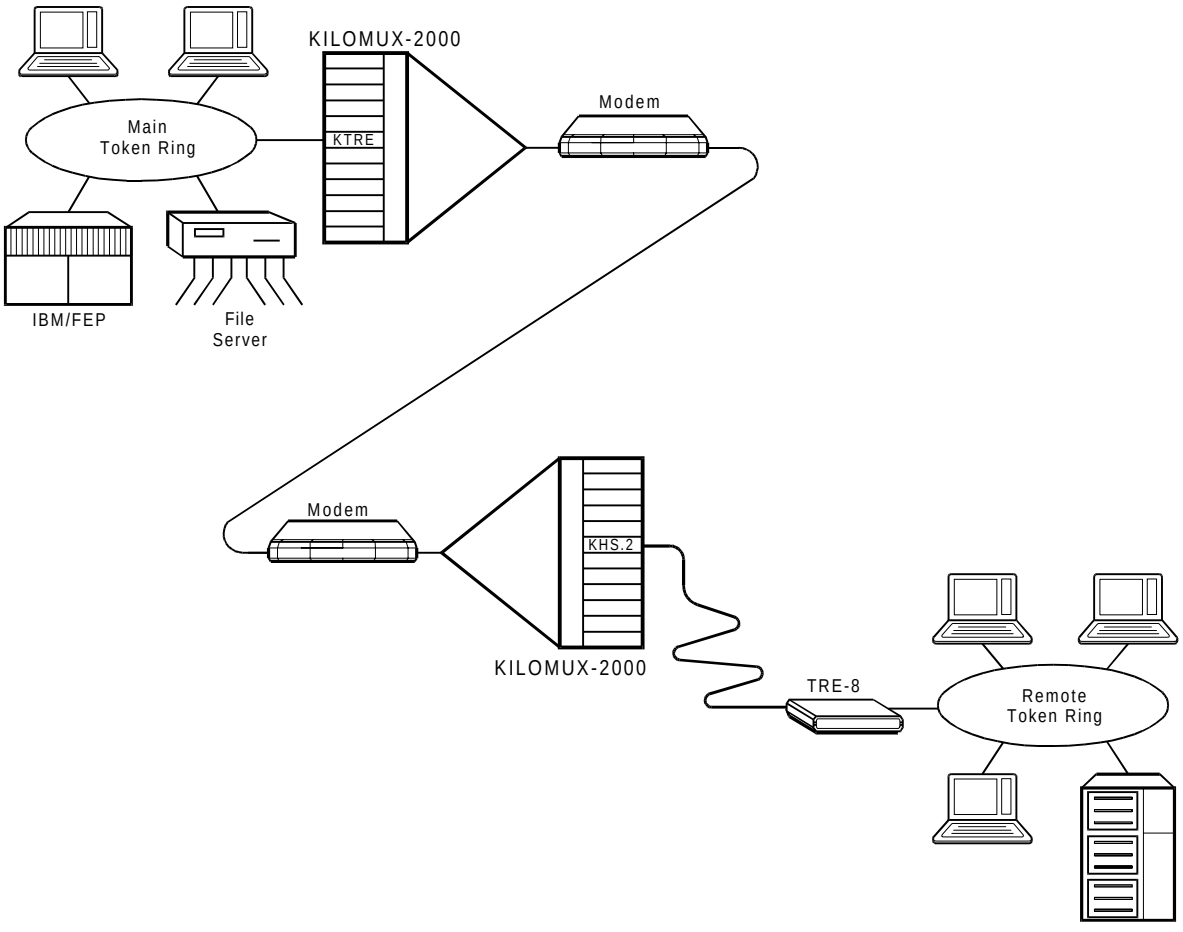

Figure 1-40. Typical KTRE System Configuration in Conjunction with Stand-Alone TRE-8 Unit

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KMBE Elementary Ethernet Bridge Module

The KMBE module is an elementary Ethernet bridge module for the KILOMUX-2000. Two KMBE modules, installed in two KILOMUX-2000 units, allow the connection of up to 80 Ethernet workstations attached to a remote Ethernet LAN to the main LAN via the KILOMUX-2000 link.

The KMBE modules are fully compatible with the MBE-8 Elementary Ethernet Bridge offered by RAD. Thus, a stand-alone MBE-8 unit, connected to a high-speed data module installed in one KILOMUX-2000, e.g., a KHS.2 module operating at the same rate as the KMBE module, can be connected to a KMBE module installed in the other KILOMUX-2000. A typical system configuration of this type is shown in figure 1-41.

The KMBE module operates at the physical and data link layers of the OSI model, and is completely transparent to higher level protocols, such as TCP/IP, DECnet, XNS, ISO, and to operating systems, such as NetWare, VINES, and 3COM+. Module operation is similar to the operation of a media access (MAC) layer remote bridge with self-learning capabilities. The KMBE module connected to the remote LAN automatically recognizes the addresses of the nodes attached to the remote LAN (up to 80), and transmits this information to the other KMBE module, which is attached to the main LAN. Using this information, the KMBE's filter the LAN traffic, block the packets addressed to local nodes, and forward through the main link only multicasts, broadcasts, and packets addressed to nodes attached to the other LAN segment.

The KMBE LAN interface complies with IEEE 802.3. Three KMBE versions, which differ in the LAN interface, are available:

- KMBE with AUI interface (10Base5), for use with an external transceiver. Uses 15-pin D type female connector.
- KMBE with thin coax interface (10Base2, Cheapernet). Uses BNC female connector.
- KMBE with UTP interface (10BaseT). Uses eight-pin RJ-45 connector.

The link bandwidth assigned to the KMBE modules can be selected by the user in the range of 9.6 to 368 kbps, therefore it is possible to select the link rate best suited to the expected traffic load between the two LAN's, without wasting main link bandwidth.

The KMBE module provides status indications by means of dedicated indicators located on the module rear panel. The available indications include the reception and transmission of packets on the LAN, ready-for-packet-forwarding indication, indication of selected KMBE operating mode (remote module, or module connected to the main LAN), and indicators for errors on the LAN and on the link. The KMBE module automatically performs self-test upon power-up. Faults detected during the power-up self-test are indicated by the rear panel indicators.

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Additional diagnostics, configuration and monitoring can be performed using an optional "dumb" ASCII terminal (or a PC running a terminal emulation program), connected to the KMBE control port. The KMBE control port has an asynchronous RS-232 interface, and operates at rates of 2.4 to 19.2 kbps, with automatic recognition of data rate (Autobaud). Word format is one start bit, eight data bits with no parity, and one stop bit. The control port is terminated in an RJ-45 connector located on the rear panel of the KMBE module.

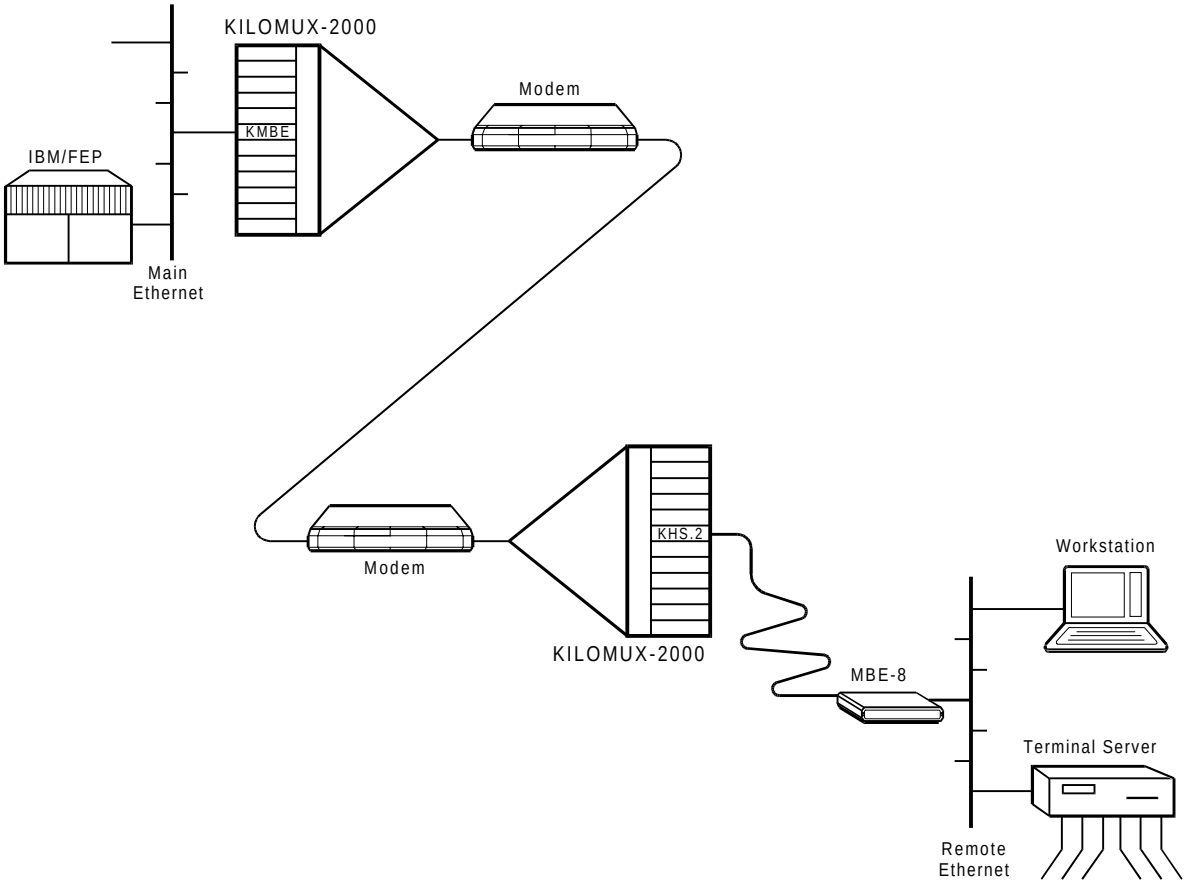

Figure 1-41. Typical KMBE System Configuration in Conjunction with Stand-Alone MBE-8 Unit

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KDI Bypass & Multidrop Module

The KDI is a bypass and multidrop module that supports all the KILOMUX-2000 main link data rates (9.6, 14.4, 19.2, 28.8, 32, 48, 56, 64, 128, 256, 384, 512, and 768 kbps). The KDI module enables direct bypassing of channels between the two main links of the KILOMUX-2000, and optionally offers a data channel interface for multidrop applications.

Figure 1-42 shows a typical bypassing application for the KDI module.

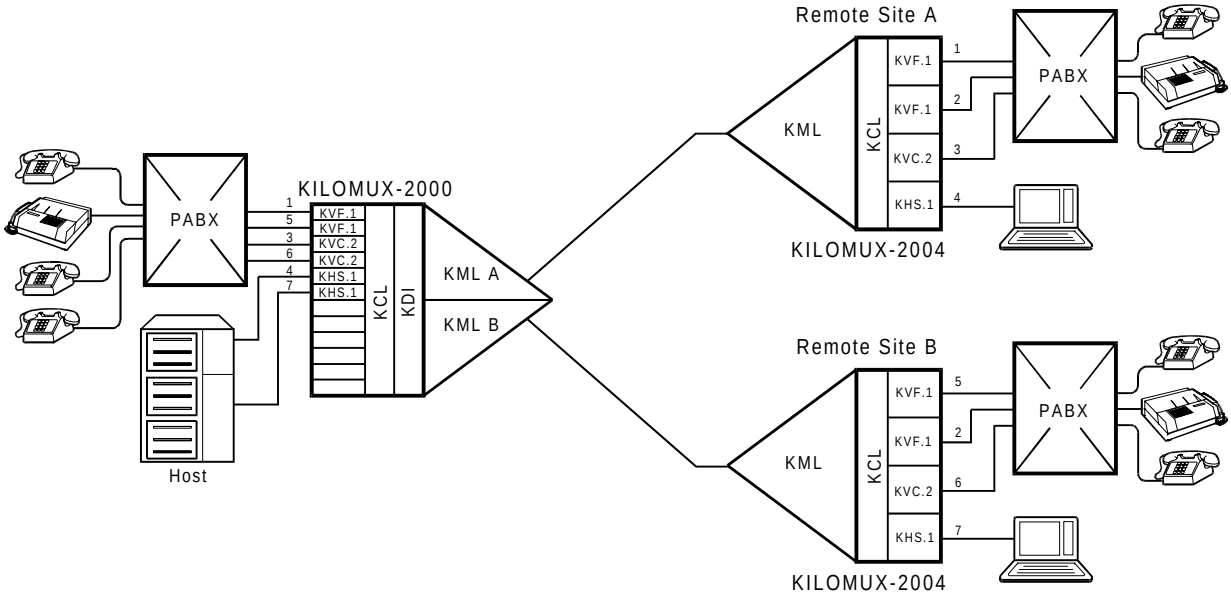

Figure 1-42. Typical KDI Bypassing Application

In the typical application shown in figure 1-42, two KILOMUX-2004 multiplexers, located at two branch offices, are connected to the KILOMUX-2000 located at the central site. The KDI module installed in the KILOMUX-2000 located at the central site provides a direct connection between the two KILOMUX-2004 units via the central site for selected channels.

The connection is performed by transferring (bypassing) the group of main link frame bits assigned to these KVF.1 modules in both directions between the two main link modules. For example, in figure 1-42 the bypassed time slots connect between the two KVF.1 modules identified by No. 2, which are installed in the two KILOMUX-2004 units.

Channels that are not bypassed are connected to users connected to the KILOMUX-2000 at the central site: for example, the two channels of the KVC.2 module at location A (identified by No. 3) are connected to the channels of the KVC.2 module also identified by No. 3 which is installed at the central site, and the KHS.1 module at location B (identified by No. 7) is connected to the KHS.1 module at the central site.

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Fully digital transmission for bypassing voice channels is an essential requirement to the preservation of high-quality voice reproduction when low bit rate voice compression is used, because it eliminates back-to-back analog interconnections at intermediate locations, and the ensuing analog-to-digital and digital-to-analog conversions. Full digital transmission has significant advantages for data channels as well, because it does away with the cables that would otherwise be required for the connection of data channels, and provides the equivalent of an electronic cross-connect function (programmable by the same means used to control the operation of the KILOMUX-2000).

Since the bypassing is bit-oriented, the two KILOMUX-2000 links can operate at different data rates, but they must use bandwidth allocation units of equal sizes. Therefore, the bypassing can be performed between links operating at rates within the same group of rates.

With respect to bypassing, the main link rate groups are as follows:

- 9.6, 14.4, 19.2, 28.8, or 32 kbps (0.4 kbps bandwidth allocation unit).
- 48, 56, 64, or 128 kbps (0.8 kbps bandwidth allocation unit).
- 256 or 384 kbps (1.6 kbps bandwidth allocation unit).
- 512 or 768 kbps (3.2 kbps bandwidth allocation unit).

In order for the user to be able to specify the allocation of main link bits to the individual channels, the structure of the main link frame must be specified by the user. Therefore, the automatic bit allocation algorithm used by the KILOMUX-2000 must be disabled, and the allocation must be manually performed. Manual allocation is required for all the KILOMUX-2000 connected along a link.

To further increase functionality, the KDI module is available in two versions:

- KDI version, which supports only the bypassing function.
- KDI/M version, which includes a data channel interface for one multidrop channel. The multidrop channel has an EIA RS-232/ITU-T Rec. V.24 interface, and is terminated in a 25-pin D-type female connector. The multidrop channel is compatible with the data channels of the KLS.1/NEW low-speed data module, and supports data rates in the range of 0.3 to 64 kbps. As is standard practice in a multidrop application, the receive path of the local multidrop channel continuously receives the allocated bandwidth on the desired main link, e.g., link A (the same data is also bypassed to the other link, to make it available downstream), but its transmit path is connected to main link A only when the RTS line in the local interface is asserted.

A typical bypassing and multidrop application for the KDI/M module is shown in figure 1-43. In this application, the multidrop channel of the KDI module is used to connect between the host computer (connected to a data channel of a KLS.1/NEW module installed in the KILOMUX-2000 situated at the central site), and several data terminals located at other locations.

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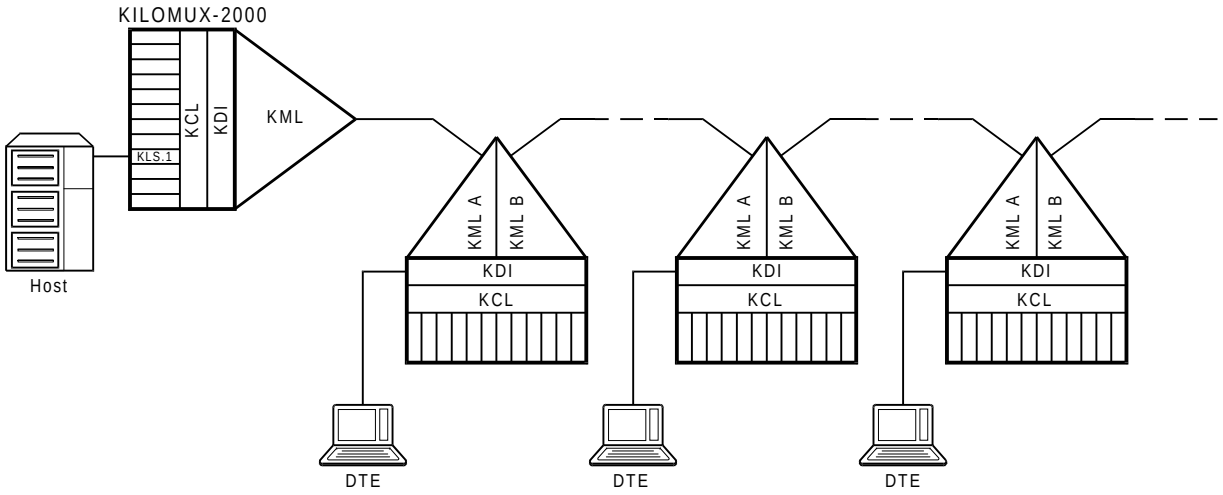

Figure 1-43. Typical KDI Bypassing and Multidrop Application

The communication is based on a polled protocol, whereby the host operates as the master and arbitrates the traffic on the multidrop link by addressing the DTE's one at a time. The multidrop feature operates as follows:

- All the DTE's connected along the link can receive the data sent by the host, because all the multidrop channels of all the KILOMUX-2000 are allocated bandwidth on link A. In addition, the bandwidth allocated to the multidrop channels is also designated for bypassing to link B, to enable all the downstream DTE's to receive the host.
- When a DTE connected to a KDI/M module has data to transmit toward the host, it must assert its RTS line. The assertion of the RTS line in the multidrop channel interface changes the routing of the main link data by the corresponding KDI/M module:
  - The KDI/M module disconnects the bypassing connection of the multidrop channel data to main link B, and the channel data is dropped locally. As long as the RTS line is asserted, the DTE remains connected to main link A, just as in a point-to-point connection.
  - When the RTS line is deserted (at the end of DTE transmission), the KDI/M module stops dropping the channel data, and the bypassing path is re-established.
  - The KDI module occupies one slot in the KILOMUX-2000 enclosure. The recommended location is in the options slot, slot 6, however the KDI module can also be installed in any I/O slot. The KDI module can be used in conjunction with main link interface modules type KML.1, KML.2, KML.3, KML.4 and KML.5, and is supported by KCL.1 modules Rev. 1.0 or higher.

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1.5 Technical System Characteristics

Main Link

Number of Main Links	1 or 2
Multiplexing Technique	Time Division, Bit Interleaved
Multiplexing Efficiency	Typically 98.5%
Bit Rates	9.6, 19.2, 32, 48, 56, 64, 128, 256, 384, 768 kbps
Interface and Connector Type	
KML.1 Module	V.35, 34-pin female connector
KML.2 Module	V.24/RS-232, 25-pin D-type female connector
KML.3 Module	V.36/RS-422/RS-530, 25-pin D-type female connector
KML.4 Module	X.2, 15-pin D-type female connector
KML.5 Module	G.703 codirectional, RJ-45 (8-pin) connector
KML.6 Module	Standard DDS, RJ-48 (8-pin) connector
KML.7 Module	T1 link, 100-ohm balanced, RJ-45 (8-pin) connector
KML.8 Module	– E1 link, 120-ohm balanced, RJ-48 (8-pin) connector – E1 link, 75-ohm balanced, RJ-48 (8-pin) connector
KML.10/S Module	S-type interface, 100 ohm balanced, RJ-45 (8-pin) connector
KML.10/U Module	U-type interface, 135 ohm balanced, RJ-45 (8-pin) connector
KML.F Module	– Fiber-optic (850 mm), ST, SMA or FC/PC connector, in accordance with order – Fiber-optic (1300 mm, 1550 mm), ST or FC/PC connector, in accordance with order

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Control Signals	
RS-232 & V.35	Full local support of all control signals
V.36	Full local support of all control signals, with the exception of RI
X.21	Local support of C and I
Clock Modes	
KML.1, KML.2, KML.3, KML.4	– DTE
	– External DCE
	– DCE
KML.5, KML.6, KML.7, KML.8, KML.F	– Internal
	– Loopback
KML.10	DTE

Equipment Enclosure

Physical Description	18-slot card cage
Slot Use	– 2 power supply slots
	– 2 main link slots
	– 1 common logic slot
	– 1 optional slot
	– 12 I/O slots
Dimensions	19" rack mount, front-mounting or stand-alone unit
Height	13.3 cm / 5.24 in (3U)
Width	43.7 cm / 17.3 in
Depth	25.3 cm / 10 in
Power Requirements	
Supply Voltages	115 or 230 VAC
	-24 VDC, -48 VDC
Power Consumption	30 VA, 50 VA

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	Environment	
	Operating Temperature	32 to 122°F (0 to +50°C)
	Storage Temperature	0 to 160°F (-20 to -70°C)
	Humidity	Up to 90%, non-condensing
Management		
	Front Panel Control	2×16 character LCD display and three push-buttons
	LED Indicators	– Main link and power supply on line – Main link TX and RX – Selectable I/O channel TX and RX – Selectable I/O channel control Data: RTS and DCD Voice: E-lead and M-lead – Local sync – Remote sync – Alarm indication – Test in progress
	Supervision Interface	Asynchronous RS-232 or Hayes™ compatible dial-up modem interface
	Data Rates	300, 1200, 2400, 4800, 9600 bps
	Word Format	7/8 bit, even/odd/no parity, 1 stop bit format
	Interface Type	DTE or DCE
	Connection Type	25-pin female D-type
	RADview Management System Interface	– Provides complete control, configuration and monitoring – Automatic recognition of all modules and their status – Three level security access administration – Alarm/event recording

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Diagnostics

	– Power-up self-test
	– Continuous self-test during normal operation
	– Link test when configuration downloading is invoked
Main Link Tests	– Local loopback
	– Remote loopback
	– Loop 2 and loop 3 on main link modem as defined in ITU-T Rec. V.54
I/O Channel Tests	– Local loopback
	– Remote loopback
	– Pseudo-random sequence transmission test (511-bit pattern)
	– BERT (bit error rate test using 511-bit pattern pseudo-random sequence)
	– ITU-T Rec. V.54 loop 2 and loop 3 by interface connector pins
	– Tone injection for voice modules
Alarms	– LCD alarm buffer: stores one alarm of each type
	– Supervision terminal alarm buffer: stores the last 100 alarms. Each alarm time and date stamped

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Chapter 2
System Installation

2.1 General

Scope

This chapter provides installation and operation instructions for the KILOMUX-2000 enclosure, and for the modules that are part of the basic system configuration. The chapter includes two main sections:

- **Section I - GENERAL** - presents general information related to the site requirements, power supply considerations, installation and operation procedures, and describes the front and rear panels of the KILOMUX-2000 enclosure.
- **Section II - INSTALLATION** - provides mechanical and electrical installation instructions for the enclosure and the power supply and common logic modules (KPS and KCL), respectively. The auxiliary ringer module, KM-RINGER, is also covered.

After installing the system, it is necessary to configure it in accordance with the specific user's requirements.

- Chapter 3 provides operating instructions and instructions for the preliminary system configuration, using the front-panel LCD and push-buttons.
- Chapter 4 provides system configuration instructions by means of a supervision terminal.

After the preliminary configuration, the system can also be managed by means of the RADview-PC network management station offered by RAD. Refer to the User's Reference Manual of the network management station for operating instructions.

In case a problem is encountered, refer to Chapter 5 for test and diagnostics instructions.

Warning

No internal settings, adjustment, maintenance, and repairs may be performed by either the operator or the user; such activities may be performed only by a skilled technician who is aware of the hazards involved. Always observe standard safety precautions during installation, operation, and maintenance of this product.

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2.2 Unpacking

Before unpacking, make a preliminary inspection of the container. Evidence of damage should be noted and reported immediately. Unpack the equipment as follows:

- Place the container on a flat surface, cut all straps and open the top of the container.
- Carefully take the KILOMUX-2000 out of the container and place it securely on a flat, clean surface.
- Inspect the unit for signs of damage. Immediately report any damage found.
- Check that all the modules are in their proper slots and are secure.
- Check the packing list against your order to ensure that the supplied modules match your order. Immediately report any deviations.
- Check that all the necessary cables have been included.

2.3 Site Requirements

Input Power Requirements

For AC operation, the KILOMUX-2000 unit should be installed within 1.5m (5 feet) of an easily-accessible grounded AC outlet capable of furnishing the mains voltage of the ordered KPS module:

- For power supply units rated for 115 VAC operation, e.g., KPS.1, the rated line frequency is 60 Hz, and the allowed range of input voltages is 100 to 120 V. The maximum current consumption is 1.1 A.
- For power supply units rated for 230 VAC operation, e.g., KPS.2, the rated line frequency is 50 Hz, and the allowed range of input voltages is 200 to 240 V. The maximum current consumption is 0.6 A.
- KPS.4 and KPS.6 modules can operate on AC supply voltages in the range of 100 to 240 VAC, at input frequencies of 47 through 440 Hz. The maximum input current varies with the input voltage.

For DC operation, the KILOMUX-2000 must be connected to a -48 VDC or -24 VDC source (in accordance with the nominal voltage of the ordered KPS module) through a circuit breaker. The DC source must comply with the requirements of EN60950. For KPS modules without ON-OFF switch, the external circuit breaker will also serve as an on/off switch.

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Grounding

For your protection and to prevent possible damage to equipment when a fault condition, e.g., lightning stroke or contact with high-voltage power lines, occurs on the lines connected to the equipment, the case of the KILOMUX-2000 unit must be properly grounded at any time. Any interruption of the protective (grounding) connection inside or outside the equipment, or the disconnection of the protective ground terminal can make this equipment dangerous. Intentional interruption is prohibited.

Before switching on this equipment and before connecting any other cable, the protective ground terminals of the equipment must be connected to a protective ground. The grounding arrangements depend on the equipment power supply source:

- DC-powered units: the grounding connection is made through one of the pins of the DC power connector. In addition, the KPS.7 module has a grounding terminal: connect it to the nearest grounding point using a short, wide copper braid (or a thick copper wire).
- AC-powered units: the grounding connection is made through the power cable, which must be inserted in a power socket (outlet) with protective ground contact. Therefore, the mains plug must always be inserted in a socket outlet provided with a protective ground contact, and the protective action must not be negated by use of an extension cord (power cable) without a protective conductor (grounding). In addition, the KPS.6 module has a grounding terminal: connect it to the nearest grounding point using a short, wide copper braid (or a thick copper wire).
- Whenever possible, the KILOMUX-2000 units should be installed in a properly-grounded rack, connected to a reliable, low-resistance grounding system.

Channel Connections

Special cables can be ordered to connect the KILOMUX-2000 main link and I/O modules either directly to the user equipment, or via a main distribution frame. T1 and E1 interfaces of KILOMUX-2000 modules must not be connected directly to the telecommunication network. The connections must be made through a network termination unit that provides separation between the interface conductors and the telecommunication network conductors in accordance with the applicable local regulations.

When a KILOMUX-2000 module with T1 interface connects to a system that requires compliance with DSX-1 requirements, the distance between the module and the DSX-1 unit (assuming 22 AWG pairs) should not exceed 200 m (655 ft).

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Front and Rear Panel Clearance

Allow at least 90 cm (36 inches) of frontal clearance for operator access. Allow the same clearance at the rear of the unit for interface cable connections and module replacement.

Ambient Requirements

The range of ambient operating temperatures of the KILOMUX-2000 is 32 to 104°F (0 to +40°C), at a relative humidity of up to 90%, non-condensing.

The KILOMUX-2000 is cooled by free air convection. Its cooling vents are located in the top and bottom covers: air is taken in through the holes in the bottom cover and exits through the holes in the top cover.

Caution

To prevent overheating, do not obstruct the KILOMUX-2000 cooling vents and make sure enough free space is available below, and above, the KILOMUX-2000, to permit free air flow. When the KILOMUX-2000 is installed in a 19" rack, allow at least 1U of space below and above the unit.

Electromagnetic Compatibility Considerations

The KILOMUX-2000 is designed to comply with the electromagnetic compatibility (EMC) requirements of Sub-Part J of FCC Rules, Part 15, for Class A electronic equipment, and additional applicable standards.

To meet these standards, it is necessary to perform the following actions:

- Connect the KILOMUX-2000 case to a low-resistance grounding system.
- Install blank panels to cover all empty slots. Appropriate blank panels can be ordered from RAD.

Note *Covering all empty slots is also required for reasons of personal safety, and to ensure proper flow of cooling air inside equipment case.*

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2.4 Power Supply Rating Considerations

RAD Technical Support Department publishes Technotes which provide up-to-date information on power supply considerations. The information given below is correct at the time this manual has been published. For latest data, request the last version of Technote 12.

Current and Power Requirements of KILOMUX-2000 Modules

The KILOMUX-2000 power supplies provide supply voltages of +5V, +12V, and -12V. Table 2-1 lists the power requirements of the KILOMUX-2000 modules.

Table 2-1. Power Requirements of KILOMUX-2000 Modules

Module	+5V Requirements	+12V Requirements	-12V Requirements	Total Power
	Current [A]	Current [A]	Current [A]	[W]
KAI	0.065	0.001	–	0.337
KCL.1	0.075	0.005	0.003	0.471
KCL.1/N	0.100	0.013	0.0035	0.698
KDI	0.220	–	–	1.10
KHS.1	0.160	0.065	0.007	1.664
KHS.2	0.211	0.076	0.007	2.051
KML.1, KML.2, KML.3, KML.4	0.225	0.035	0.001	1.557
KML.1/N, KML.2/N, KML.3/N, KML.4/N	0.270	0.0342	0.0048	1.818
KML.5	0.350	–	–	1.750
KML.5/N	0.400	–	–	2.0
KML.6/N	0.320	0.035	–	2.020
KML.7/N	0.400	0.035	–	2.420
KML.8/N	0.410	0.035	–	2.470
KML.10/N	0.380	0.035	–	2.320
KML.F	0.520	0.005	0.005	2.685
KLS.1	0.052	0.030	0.018	0.836
KLS.2	0.082	0.022	0.006	0.746
KVC.1/E&M	0.175	–	0.015	1.055
KVC.1/FXO	0.175	–	0.005	0.935
KVC.1/FXS	0.230	–	0.033	1.546
KVC.2D/E&M	0.350	–	0.023	2.026
KVC.2D/FXO	0.320	–	0.006	1.672
KVC.2D/FXS	0.430	–	0.048	2.726

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Table 2-1. Power Requirements of KILOMUX-2000 Modules (Cont'd)

Module	+5V Requirements	+12V Requirements	-12V Requirements	Total Power
	Current [A]	Current [A]	Current [A]	[W]
KVC.2D/FXSP	0.838	–	0.120	5.630
KVC.2S/E&M	0.270	–	0.016	1.542
KVC.2S/FXO	0.220	–	0.025	1.400
KVC.2S/FXS	0.280	–	0.050	2.000
KVC.2S/FXSP	0.650	–	0.085	4.270
KVC.3/E&M	0.510	–	0.0225	2.820
KVC.3/FXO	0.490	–	0.0315	2.828
KVC.3/FXS	0.610	–	0.056	3.722
KVC.3/FXSP	0.980	–	0.109	6.208
KVF.1/E&M	0.430	0.005	0.042	2.714
KVF.1/FXO	0.430	0.004	0.038	2.622
KVF.1/FXS	0.507	0.004	0.066	3.375
KVF.1/FXSP	0.780	0.004	0.100	4.068
KVF.3/E&M	0.500	0.010	0.060	3.270
KVF.3/FXO	0.500	–	0.050	3.100
KVF.3/FXS	0.550	0.015	0.100	4.025
KVF.3/FXSP	0.560	0.015	0.100	4.075
KVF.4/E&M	0.820	–	0.060	4.820
KVF.4/FXO	0.800	–	0.050	4.600
KVF.4/FXS	0.800	–	0.100	5.200
KVF.4/FXSP	1.500	–	0.100	8.700
KVF.4/S0	0.900	–	0.020	4.740
KVF.5/E1/M	1.550	–	0.050	7.750
KVF.5/E1/S	1.350	–	0.050	6.750
KVF.5/T1/M	1.550	–	0.050	7.750
KVF.5/T1/S	1.350	–	0.050	6.750
KHS.U/S	0.350	–	0.050	1.750
KHS.U/D	0.400	–	0.050	2.000
KTRE	0.850	0.020	0.020	4.380
KMBE	0.490	0.080	–	3.410

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Current and Power Capabilities of KILOMUX-2000 Power Supply Modules

Table 2-2 lists the current and power that can be provided by the individual KILOMUX-2000 power supply modules when cooled by free air connection.

Table 2-2. Ratings of KILOMUX-2000 Power Supply Modules

Module	+5V Output	+12V Output	-12V Output	Maximum Total Power [W]
	Current [A]	Current [A]	Current [A]	
KPS.1, KPS.2	2.6	1.2	0.3	30
KPS.3, KPS.5	3.1	0.4	0.4	25
KPS.4	6.0 (max. 8.0)	1.0 (max. 1.5)	0.8 (max. 1.0)	50
KPS.6	11 (max. 12)	0.85	0.85	56
KPS.7	11 (max. 12)	0.85	0.85	56

Note the following points:

- Power supply modules have load sharing capabilities, therefore by installing two KPS modules it is possible to double the allowed loading. Note however that in case the current and power requirements exceed the capabilities of a single power supply module, it is no longer possible to consider the two modules as providing redundancy: any failure must be immediately corrected.
- Any of the nominal output currents specified for the KPS.4 module can be safely exceeded, provided none of the specified maximum currents is exceeded, and the total power supplied by the module does not exceed the rated power, 50 W.
- For the KPS.6 module, the +5V output must always be loaded. The minimum current consumption from the +5V output is 3A. If less current is needed, use a power supply module with lower output currents.
- For the KPS.6 and KPS.7 modules, the maximum current that can be provided by the +5V output is 12A, provided the total output power does not exceed 56W.
  With forced air cooling, the total output power of the KPS.6 and KPS.7 modules can reach up to 80W. Contact RAD Technical Support Department for additional information.

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Verifying the Current and Power Requirements

Use the following procedure to determine whether a KILOMUX-2000 power supply module can provide the power and current requirements of the modules installed in the enclosure:

- **Step 1** - For each supply voltage, sum the currents drawn by the modules to be installed in the enclosure.
- **Step 2** - Sum the power required by the modules to be installed in the enclosure.
- **Step 3** - For each supply voltage, check that the total current drawn by the modules to be installed in the enclosure does not exceed the rated current of the power supply module that is to be installed in the enclosure.
- **Step 4** - Check the total power required by the installed modules.

If steps 3 and 4 show that the currents and power are within the allowed ratings, your design is OK.

If step 3 or 4 shows that one of the power supply current ratings is exceeded, use one of the following methods.

The list given below is arranged in decreasing order of preference:

- **Method 1** - Install the KPS.4 module. A single KPS.4 module can meet the supply requirements of most practical configurations.
- **Method 2** - Install an additional KPS module, to share the load.
- **Method 3** - Split the modules between two KILOMUX-2000 enclosures (you may also wish to consider using a KILOMUX-2004 if all you need is no more than four additional modules). You may also try to use an external ringer (KM-RINGER or RINGER-2000) instead of using FXSP voice modules.

Ratings of Ring and Feed Voltage Supplies

RAD offers two special-purpose power supply units that can provide DC battery feed and ringdown voltages for the voice modules used with the KILOMUX-2000 and KILOMUX-2004, e.g., KVC.1M, KVF.4, KVF.5, etc. These power supply units are independently powered and do not draw current from the KPS modules installed in the KILOMUX-2000/KILOMUX-2004.

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RINGER-2000

The RINGER-2000 is a stand-alone power supply unit that can provide power for up to 40 voice channels. The RINGER-2000 is intended for installation on shelves or in 19" racks. Unit height is only 1U.

The RINGER-2000 is available in three output versions:

- RINGER-2000-48: provides only -48 VDC. This version can be used when only /E&M modules must be powered.
- RINGER-2000-48/72: provides -48 VDC battery voltage and +72 VDC ring voltage. The +72 VDC is required by the /FXS modules to generate the subscriber ringdown voltage.
  The RINGER-2000-48/72 can be used for both /E&M and /FXS modules.
- RINGER-2000-24/72: similar to the RINGER-2000-48/72, except that it provides a battery voltage of -24 VDC (instead of -48 VDC), for reduced power consumption in installations with loop lengths that do not exceed 1 km.

The RINGER-2000 is available in three input voltage versions: 115 VAC, 230 VAC, or -48 VDC (for the -48 VDC version, the ring voltage is 60 VDC).

KM-RINGER

The KM-RINGER can provide power for up to 16 voice channels. The KM-RINGER is a small unit that can be located on shelves and desktops, or installed as a plug-in module in a KILOMUX-2000 enclosure (it occupies three I/O enclosure slots). The KM-RINGER is available in AC (115 VAC or 230 VAC) and DC (-24 VDC or -48 VDC) power supply versions.

Ratings

	RINGER-2000	KM-RINGER
Input Voltage	115 VAC ±10%, 50/60 Hz 230 VAC ±10%, 50/60 Hz -48 VDC (-36 to -72 VDC)	115 VAC ±10%, 50/60 Hz 230 VAC ±10%, 50/60 Hz -48 VDC (-36 to -72 VDC) -24 VDC (-18 to -32 VDC)
Number of Outputs	Ten	One
Battery Voltage	-48 VDC ±5%, max. 1.5A or -24 VDC ±5%, max. 1.5A, according to output version	-48 VDC ±5%, max. 600 mA, for the AC input versions -24 VDC ±5%, max. 600 mA, for the DC input versions
Ring Voltage	+72 VDC ±5%, max. 850 mA (not available on the RINGER-2000-48) +60 VDC voltage for -48 VDC input	+72 VDC ±5%, max. 500 mA, for the AC input version +60 VDC ±5%, max. 500 mA, for the DC input version

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2.5 KILOMUX-2000 Enclosure

General Description

The KILOMUX-2000 enclosure has 18 module slots. Five of the slots (slots 1 thru 5) are assigned to the system modules, and one slot (slot 6) is assigned for an options module (e.g., for the KDI or KAI modules). Two slots each are assigned for KML and KPS modules, respectively, to provide support for the redundancy option:

- Slots 1 and 2 - for KPS modules.
- Slots 3 and 4 - for KML modules.

The other 12 slots are intended for I/O modules. Each I/O slot can accept any type of I/O module. The modules are inserted from the rear side.

Rear View

Figure 2-1 shows a typical rear view of the KILOMUX-2000 enclosure and identifies the slots and their use.

Note the labels which designate the type of module that can be installed in each slot; in addition, each slot is keyed, therefore it is not possible to install the wrong module type.

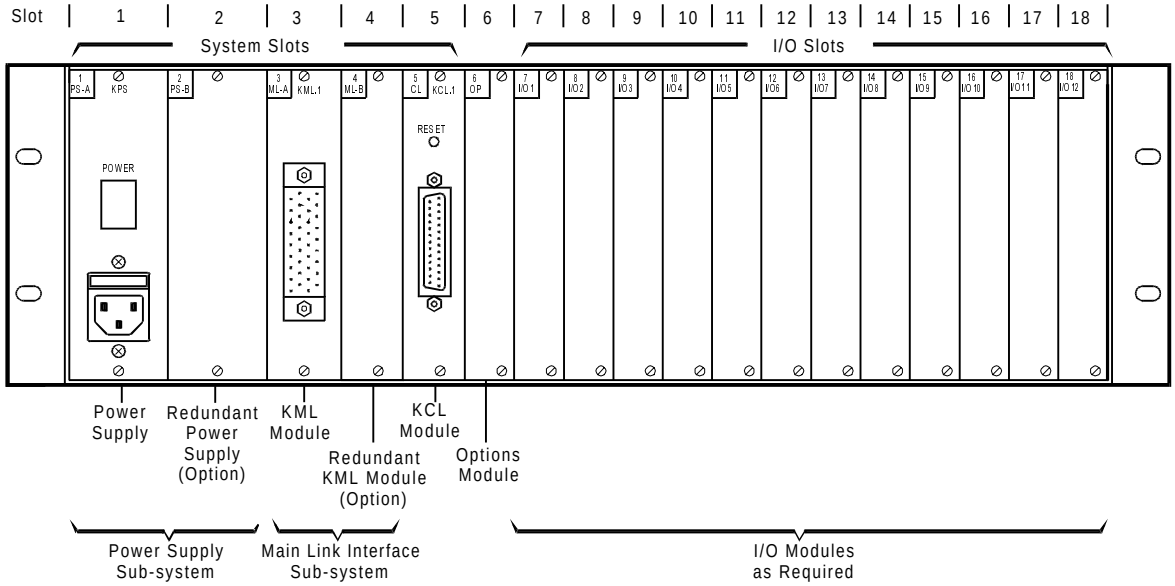

Figure 2-1. KILOMUX-2000 Enclosure, Rear View

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Front Panel

The front panel of the KILOMUX-2000 enclosure includes an LCD, three push-buttons, and labels for the show-through areas for the status indicators located on each system module. Note that the indicators are arranged in groups (one group for each system module), that are positioned before the corresponding module slot.

Figure 2-2 shows the front panel of the KILOMUX-2000 enclosure. Refer to Chapter 3 for a description of the front panel functions.

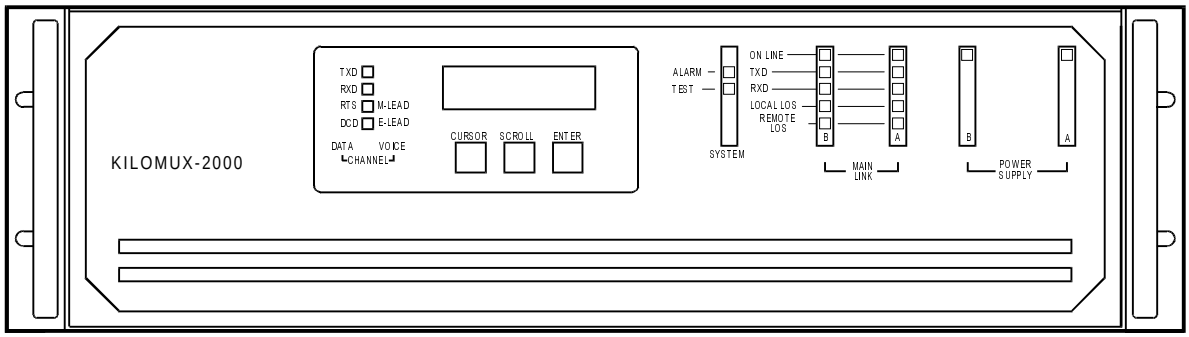

Figure 2-2. KILOMUX-2000 Enclosure Front Panel

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2.6 Installation of KPS Modules

Warning High Voltage

Dangerous voltages are present inside the KPS module when it is connected to power. Do not connect the KPS module to power before it is properly installed within the KILOMUX-2000 enclosure, and disconnect the input power from the module before removing it from the enclosure. The installation and preparation of the module shall be done by a qualified person who is aware of the hazards involved.

Rear Panels

The rear panels of the various types of KPS modules are shown in figure 2-3.

Table 2-3 lists the functions of the components located on these panels.

Table 2-3. KPS Modules, Rear Panels

Item	Description
ON/OFF Switch (on KPS.1, KPS.2 and KPS.4 only)	Turns the power on/off
Label	Indicates the nominal mains operating voltage of the module and the fuse rating
Power Connector (with integral fuse – for KPS.1, KPS.2, KPS.4, and KPS.6 only)	Connector for the module input power voltage: KPS.1: 115 VAC KPS.2: 230 VAC KPS.3 and KPS.7: -48 VDC KPS.4, KPS.6: 240 VAC KPS.5: -24 VDC
Power Indicator (on KPS.3, KPS.5, and KPS.7 only)	Lights when the -48 VDC (for KPS.3 and KPS.7), or -24 VDC (for KPS.5) input voltage is connected

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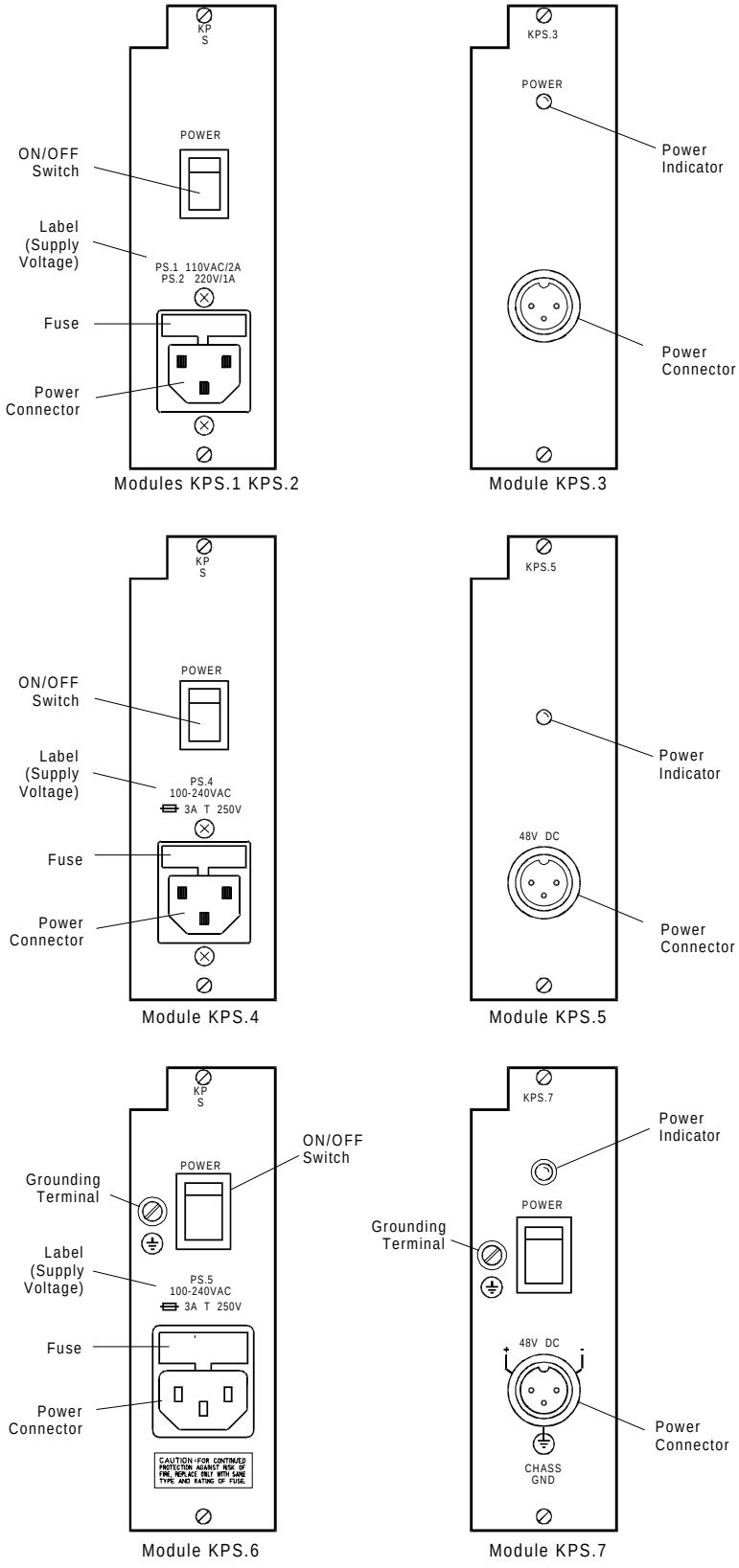

Figure 2-3. KPS Modules, Rear Panels

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Internal Jumpers

The KPS modules include one internal jumper, designed **FG=SG**. The location of the jumper is shown in figure 2-4. This jumper controls the connection between the internal signal ground and the frame (enclosure) ground. The module is delivered with the jumper set to **YES**. If necessary, you can set the jumper to **NO** to float the signal ground with respect to the frame ground. If redundant modules are installed, make sure that the jumper is set to the same position on both modules.

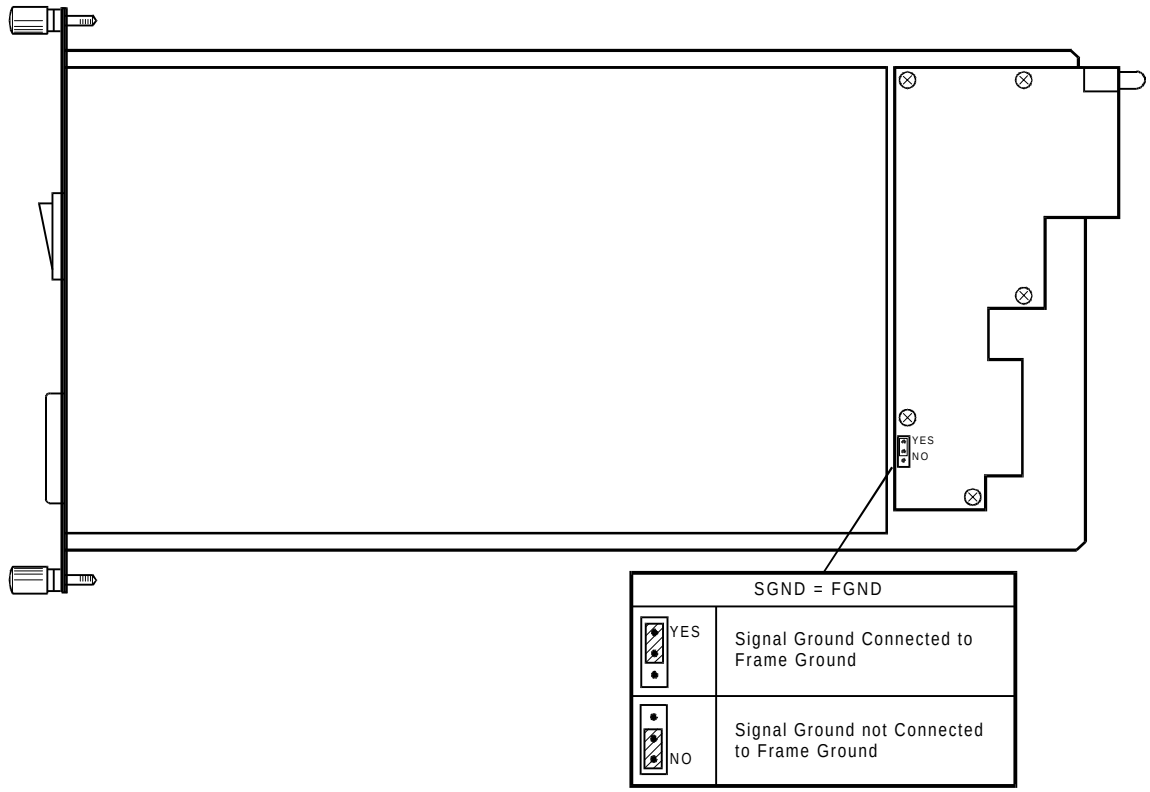

Figure 2-4. Typical KPS Module, Location of Internal Jumper

Module Installation

- Insert the KPS module in slot 1.
- If an additional redundant module is used, install it in slot 2. For example, a KPS.3 module can be used as a backup to an AC power supply module with similar rating, e.g., KPS.1 or KPS.2.

Note *You can install a redundant module in an operating enclosure without turning off the enclosure power. In this case, after the module is installed, connect its power cable and set its power switch to ON.*

Caution

The KPS.3 and KPS.5 modules do not have a power switch, and will start operating as soon as power is connected. Therefore, you must make external arrangements for controlling the supply of power to these modules.

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2.7 Installation of KM-RINGER Module

Warning High Voltage

Dangerous voltages are present inside the KM-RINGER module when it is connected to power. Do not connect the KM-RINGER module to power before it is properly installed within the KILOMUX-2000 enclosure, and disconnect the input power from the module before removing it from the enclosure. The installation and preparation of the module shall be done by a qualified person who is aware of the hazards involved.

Module Panel

Figure 2-5 shows the panel of an AC-powered KM-RINGER module. The panel of the DC-powered KM-RINGER is similar, except that a circular 3-pin male connector replaces the AC power connector. Table 2-4 lists the functions of the panel components.

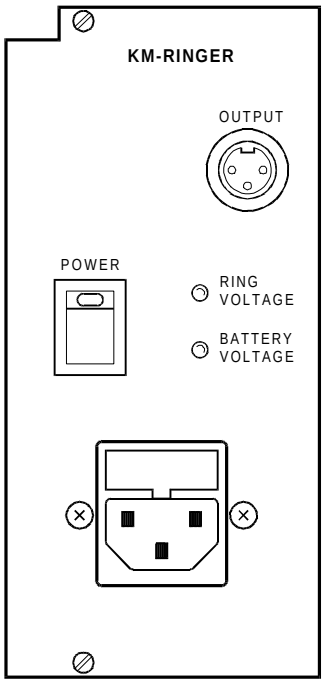

Figure 2-5. Typical KM-RINGER Module Panel

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Table 2-4. KM-RINGER Panel Components

Indicator	Description
RING VOLTAGE	Lights when the ring voltage (nominally 72 VDC) provided by the module is within the normal range. Off when the voltage is missing
BATTERY VOLTAGE	Lights when the feed voltage (nominally -48 VDC) provided by the module is within the normal range. Off when the voltage is missing
POWER Switch	On/off switch with a built-in indicator
Power Connector	Connection of power to the KM-RINGER. The AC power connector has an integral fuse (fuse rating for each nominal supply voltage is marked on the panel)
Output Connector	3-pin female connector for output voltages

Module Installation

- Set the POWER switch of the module being installed to off.
- Insert the module in the prescribed slots, and fasten it with the two screws. If necessary, move other modules to free three consecutive module slots for the KM-RINGER. It is recommended to install the module in I/O slots 10, 11, and 12.

Note *You can install the module in an operating enclosure without turning off the enclosure power. In this case, after the module is installed, connect its power cable and set its power switch to ON*

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2.8 Installation of KCL.1 Module

Rear Panel

Figure 2-6 shows the rear panels of the KCL.1 module. Two panels are shown: standard KCL.1 module with one 25-pin connector and KCL.1 module with dial-out port (terminated in a 9-pin connector), which is available upon special order. Table 2-5 describes the functions of the panel components.

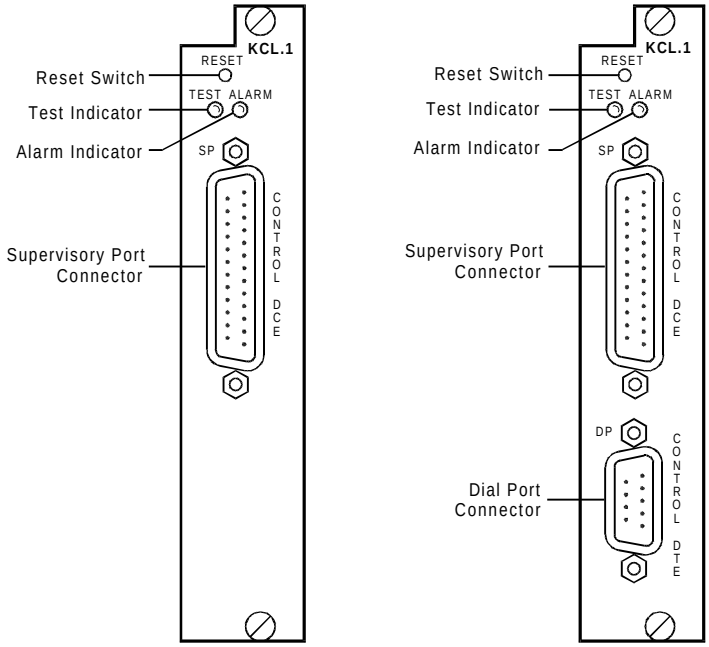

Figure 2-6. Module KCL.1,Rear Panel

Table 2-5. Module KCL.1, Rear Panel

Item	Function
RESET Push-button	Pressing the RESET push-button causes the reinitialization of all the modules in the KILOMUX-2000 enclosure
TEST Indicator	Indicates that a test (or test loop) is being performed on one of the local KILOMUX-2000 modules, or on the main link modem. When downloading is activated, also lights when a test is activated by the remote KILOMUX-2000 modules
ALARM Indicator	Indicates that a fault has been detected in one of the KILOMUX-2000 modules
SP (CONTROL DCE) Connector	25-pin D-type female connector, for connection to an optional ASCII supervision terminal or to a RADView network management station. Connector pin allocation is given in Appendix A
DP (CONTROL DTE) Connector	9-pin D-type male used as a dial-out port. This connector is installed only upon special order. Connector pin allocation is given in Appendix A

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Internal Switch and Jumpers

The KCL module has an eight-section DIP switch and two user-selectable jumpers. Their locations are shown in figure 2-7.

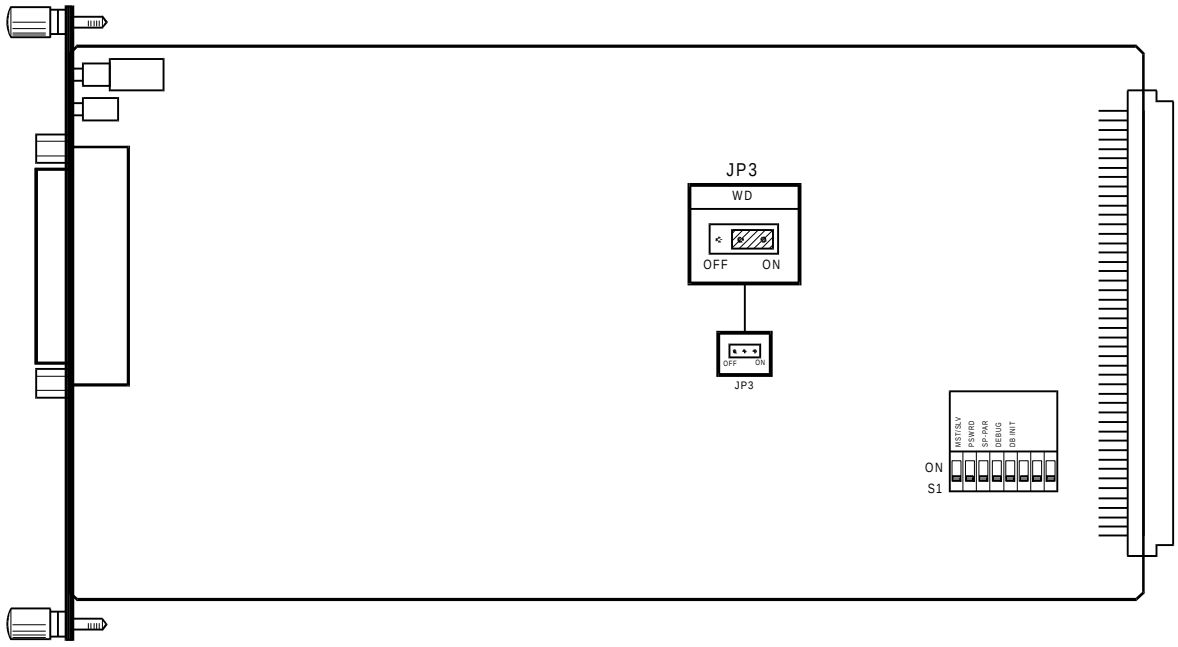

Figure 2-7. Module KCL.1, Internal Switch and Jumpers

Do not change the position of the other module jumpers. Table 2-6 describes switch and jumper functions.

Table 2-6. Module KCL.1, Internal Switch and Jumper Functions

Item	Function
JP3 WD	Used to disable the internal watchdog function during maintenance. The WD jumper has two positions:
	ON watchdog enabled (normal operation)
	OFF watchdog disabled
	Default: ON
Switch SW1 Section 1: MST/SLV	When downloading is enabled, selects the KILOMUX-2000 function: **OFF** Master unit, downloads the configuration to the slave unit **ON** Slave unit **Default setting: OFF** **Notes:** When downloading is enabled, the KILOMUX-2000 units connected in a link should be assigned different functions. The master/master selection is forbidden, however slave/slave is allowable: after the configuration procedure has been successfully completed, you can switch the master unit to slave status to prevent unauthorized changing of critical parameters. When the downloading is disabled, the setting of section 1has no effect.

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Table 2-6. Module KCL.1, Internal Switch and Jumper Functions (Cont'd)

Item	Function
Section 2: PSWRD	Selects the source of the password and management address (node number) for the supervisory port: **OFF** Password and node number selected by the user. **ON** Default password - RONNY and node number 0. **Default setting: OFF**
Section 3: SP PAR	Selects the source of the supervisory port parameters: **OFF** Parameters retrieved from the data base **ON** Default parameters (9600 bps, 8 data bits, no parity, one stop bit) **Default setting: OFF**
Section 4: DEBUG	For the use of technical support personnel only. **Default setting: OFF**
Section 5: DB INIT	Allows to load the default (factory-preset) configuration. Upon first-time operation, or in case errors are detected in the internal data base upon turn-on, set this section to ON, and then return to OFF to allow the use of user-configured parameters. **OFF** Configuration parameters determined by the user **ON** Default configuration parameters **Default setting: OFF**
Sections 6 thru 8	Not used

Note *You should load the default supervisory port password and communication parameters (by setting sections 2 and 3 of the DIP switch to ON) if the current parameters are not known, and the supervision terminal cannot communicate with the KILOMUX-2000 enclosure (in such a case, first make sure the supervision terminal is set for the correct parameters).*

Module Installation Install the module in slot 5.

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2.9 Installation of KILOMUX-2000 Enclosure

Mechanical Installation

The KILOMUX-2000 is intended for installation on shelves and racks. Do not connect power to the enclosure before it is installed in the designated position.

For rack installation, it is necessary to install two brackets to the sides of the unit (figure 2-8). As illustrated below, you may install the brackets in two ways, to orient the unit in accordance with your requirements (either with the KILOMUX-2000 front panel toward the front of the rack, or the module panels toward the front).

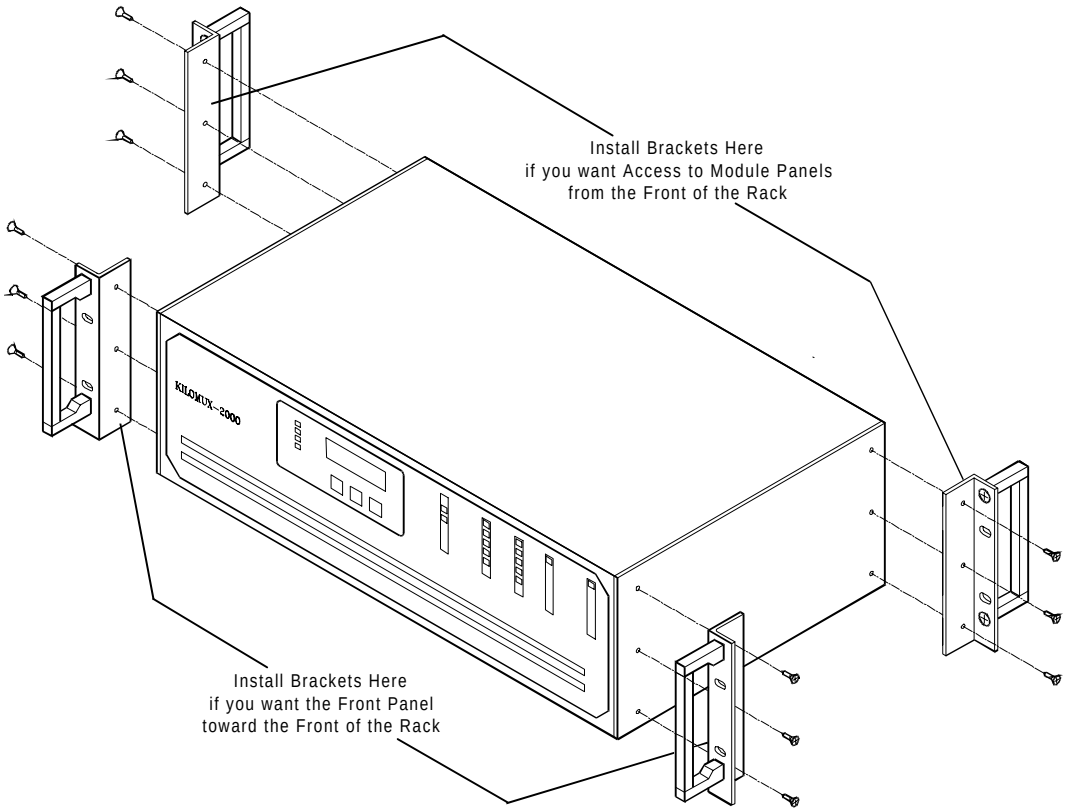

Figure 2-8. Attachment of Brackets

After attaching the brackets, fasten the enclosure to the rack by four screws (two on each side).

After attaching the enclosure, check and install the required modules, in accordance with the installation plan.

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Cable Connections

Warning

BEFORE SWITCHING ON THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective ground conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by use of an extension cord (power cable) without a protective conductor (grounding).
Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal can make this instrument dangerous. Intentional interruption is prohibited.
Make sure that only fuses of the required rating, are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders is forbidden.
Whenever it is likely that the protection offered by fuses has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

Power Connection

- Check that the ON/OFF switches on the KPS modules are set to OFF.
- Connect the power cable first to the connector on the KPS module, then to the mains outlet.

Notes

1. *When redundant power supplies are used, it is recommended to connect the power cables to outlets powered by different circuits.*
2. *The KPS.3 and KPS.5 modules do not have a power switch, and will start operating as soon as power is connected.*

Connections to KM-RINGER Module

- Check that the ON/OFF switch on the KM-RINGER module is set to OFF.
- Connect the power cable to the POWER connector.
- Connect cables between each OUTPUT connector and the corresponding DC POWER-IN connector of the prescribed voice I/O modules.

  Use CBL-RINGER1 for connection to one module, CBL-RINGER2 for connection to two modules, and CBL-RINGER4 for connection to three or four modules.

Caution

The KM-RINGER must always be turned on after the KILOMUX-2000 is already operating.
When you want to stop equipment operation, turn the KM-RINGER off before turning the KILOMUX-2000 off.

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Supervisory Port Connection - KCL Module

Refer to the installation plan to determine the supervision cable intended for connection to the enclosure, then connect the cable to the SP connector on the KCL module.

If the optional dial-out port is to be used, connect the corresponding cable to the DP connector on the KCL.1 module.

Connections to KML, Options, and I/O Modules

Refer to the corresponding section in Part II of this manual.

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Chapter 3

Front-Panel Operating Instructions

3.1 Scope

In this chapter you will find detailed instructions for operating the KILOMUX-2000 from its front panel. The information presented in this chapter includes:

- Description of KILOMUX-2000 front panel - section 3-2.
- General description of KILOMUX-2000 control, display and push-button functions, and menu organization - section 3-3.
- KILOMUX-2000 configuration parameters - section 3-4 thru 3-7.
- KILOMUX-2000 operating procedures (turn-on, front-panel indications, what to do in case of malfunction and turn-off) - section 3-8.
- KILOMUX-2000 local configuration procedures - section 3-9, 3-10.
- Use of KILOMUX-2000 diagnostic functions - section 3-11.

Refer to Chapter 4 for instructions on the use of a supervision terminal to configure KILOMUX-2000 equipment, and monitor its operation.

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3.2 Front Panel Controls and Indicators

Table 3-1 lists the functions of the KILOMUX-2000 controls, connectors and indicators, located on the KILOMUX-2000 front panel. The index numbers in Table 3-1 correspond to the item numbers in figure 3-1.

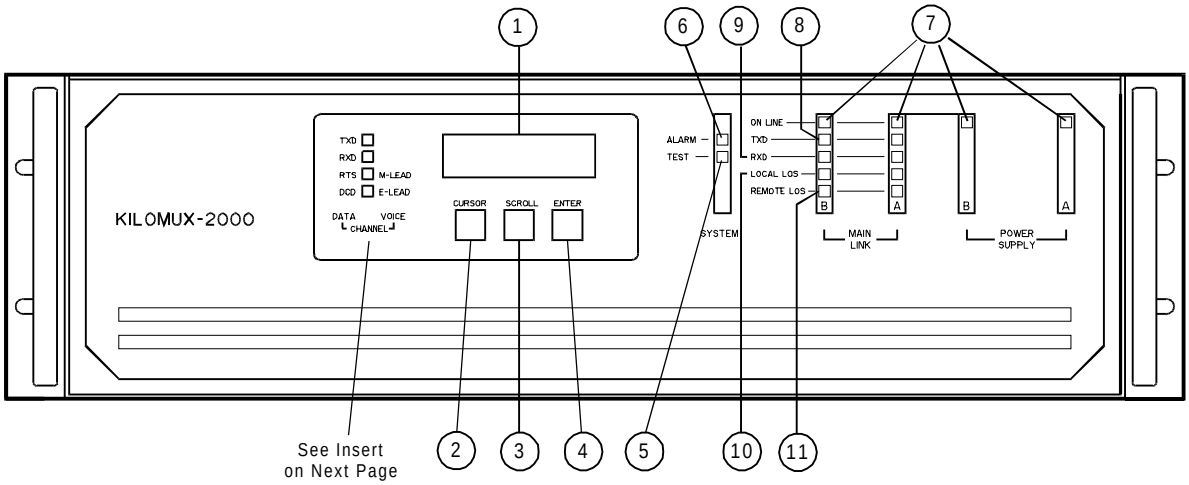

Figure 3-1. KILOMUX-2000 Front Panel

Table 3-1. KILOMUX-2000 Controls, Connectors, and Indicators

Nº	Control or Indicator	Function
1	Alphanumeric display	Liquid crystal display (LCD) used to display messages and status information. The display contains 2 rows of 16 characters each.
2	CURSOR push-button	Used to move among the information fields.
3	SCROLL push-button	Used to scroll among the available options of the selected field.
4	ENTER push-button	Used to enter the changes made in the KILOMUX-2000 configuration, and to initiate operation in the new set-up.
5	TEST indicator	Indicates that a test (or test loop) is being performed on one of the local KILOMUX-2000 modules (for main link modules KML.1 through KML.4, this indicator will also light when a V.54 loop is activated on the modem serving the main link). When downloading is activated, also lights when a test is activated by the remote KILOMUX-2000 on one of the local KILOMUX-2000 modules
6	ALARM indicator	Indicates that a fault has been detected in one of the KILOMUX-2000 modules
7	ON LINE indicator	Lights steadily when the module is operating properly and is active. For KML modules, flashes when the module is operating properly, but is in standby (the other module of the same type is active). Off when the corresponding module is defective, or is not installed. ON-LINE indicators are located on the KML and KPS modules.

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Table 3-1. KILOMUX-2000 Controls, Connectors, and Indicators (Cont'd)

Nº	Control or Indicator	Function
8	TXD indicator	Indicates activity on the transmit line of the active KML module. The indicator is located on the KML module.
9	RXD indicator	Indicates activity on the receive line of the active KML module. The indicator is located on the KML module.
10	LOCAL SYNC LOSS indicator	Lights when the local KILOMUX-2000 has lost frame synchronization. The indicator is located on the KML module.
11	REMOTE SYNC LOSS indicator	Lights when a loss-of-frame synchronization indication is received from the remote KILOMUX-2000. This indication is available only when downloading is activated. The indicator is located on the KML module.

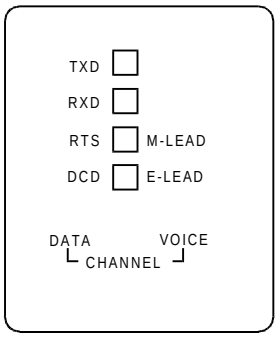
In addition, the front panel includes four indicators that can be connected by means of the TEST OPTIONS-MONITOR menu to any desired channel. The indicator functions are as follows:

TXD Indicates activity on the transmit path of the selected channel.

RXD Indicates activity on the receive path of the selected channel.

RTS/M LEAD If the selected channel is a data channel, shows the state of the RTS line. If the selected channel is a voice channel, shows the state of the M lead.

DCD/E LEAD If the selected channel is a data channel, shows the state of the DCD line. If the selected channel is a voice channel, shows the state of the E lead.



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3.3 Control of KILOMUX-2000 Operation, General

General

KILOMUX-2000 operating mode is determined by a set of parameters stored in the internal non-volatile memory of the KCL.1 module. These parameters are selected by the user, using the KILOMUX-2000 front panel push-buttons, a supervision terminal, or the RADview network management station. When main link bandwidth is allocated to the KILOMUX-2000 management channel, the parameters that must be used by both KILOMUX-2000 units connected by the main link can also be downloaded from one of the units (defined by the user as ***master***) to the other (***slave***) unit.

After the operating parameters have been selected, a process called configuration set-up, the KILOMUX-2000 no longer requires operator attendance.

The configuration stored in the KILOMUX-2000 memory is not affected when the power is turned off. Upon power-up, the stored configuration is retrieved and its validity is checked during the power-up self-test:

- If everything is OK, after power-up the KILOMUX-2000 assumes the last selected configuration and is immediately ready for operation (unless the user wants to change the system configuration).
- If errors are detected in the configuration data, the KILOMUX-2000 lets you load instead a default configuration. The default configuration, prepared by the manufacturer, is stored in the program EPROM. The user can later modify the default values as required.

General Front Panel Operating Instructions

All the operations that can be performed from the front panel are performed using an interactive, menu-driven user-friendly interface.

The user interface is controlled by means of the LCD display and three push-buttons. The KILOMUX-2000 guides you in the execution of the required task by means of simple and clear messages, presents the range of available functions and parameter values, and checks your inputs.

Moreover, the KILOMUX-2000 will present to you only those functions and parameter values available in the currently-configured operating mode for the modules installed in your KILOMUX-2000.

If you make a configuration error, e.g., you select a parameter value that conflicts with the current operating mode, the KILOMUX-2000 rejects the erroneous selection, displays for a few seconds an error message that identifies the error, and then the display returns to its previous state.

You will find detailed instructions for operating the KILOMUX-2000 in section 3-9 and 3-10. The configuration error messages, and instructions for correcting the problem that is indicated by the error message, are given in Appendix B.

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Front Panel Menu

Figure 3-2 shows the organization of the front-panel menu. As explained in section 3-8, the menu is automatically enabled after successfully completing the power-up self-test. For your convenience, the normal power-up message is also shown in figure 3-2.

The KILOMUX-2000 has several groups of configuration parameters. These groups are listed in Table 3-2, and explained in section 3-4 thru 3-7.

In addition to the configuration functions, the KILOMUX-2000 menu includes diagnostic functions, reached under the ALARM BUFFER, TEST OPTION, and REM TEST ST groups. These functions are described in Chapter 5.

Table 3-2. KILOMUX-2000 Front Panel Configuration Parameters

Display	Parameter Description	See ...
SYSTEM PARAMETER	Display and selection of system parameters:	Section 3-4
	– Main link master clock source	
	– Main link fallback clock source	
	– Downloading	
	– Main link operating mode	
	– Active main link	
LINK PARAMETER	Display and selection of main link parameters	Section 3-5
CH PARM	Display and selection of parameters for the various types of modules and module channels	Section 3-6
SP PARAMETERS	Display and selection of the supervisory port parameters:	Section 3-7
	– Data rate	
	– Number of data bits	
	– Parity	
	– Interface type	
	– Management by RADview network management stations	

In addition to the parameters that can be configured from the front panel, the KILOMUX-2000 has parameters that can be controlled only from a supervision terminal or a RADview network management station. These parameters are presented in Chapter 4.

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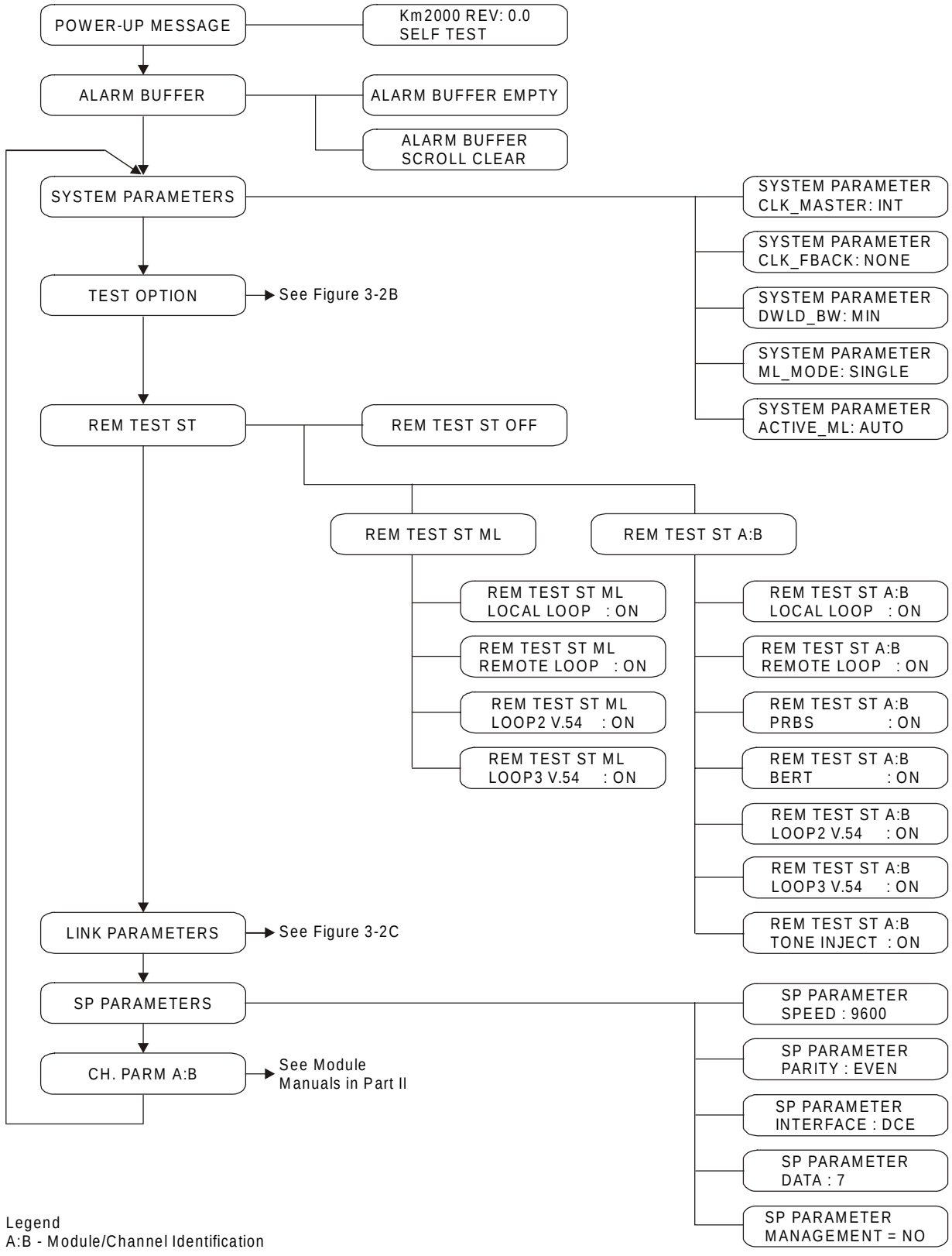

Figure 3-2A. Organization of Front Panel Menu (Part I)

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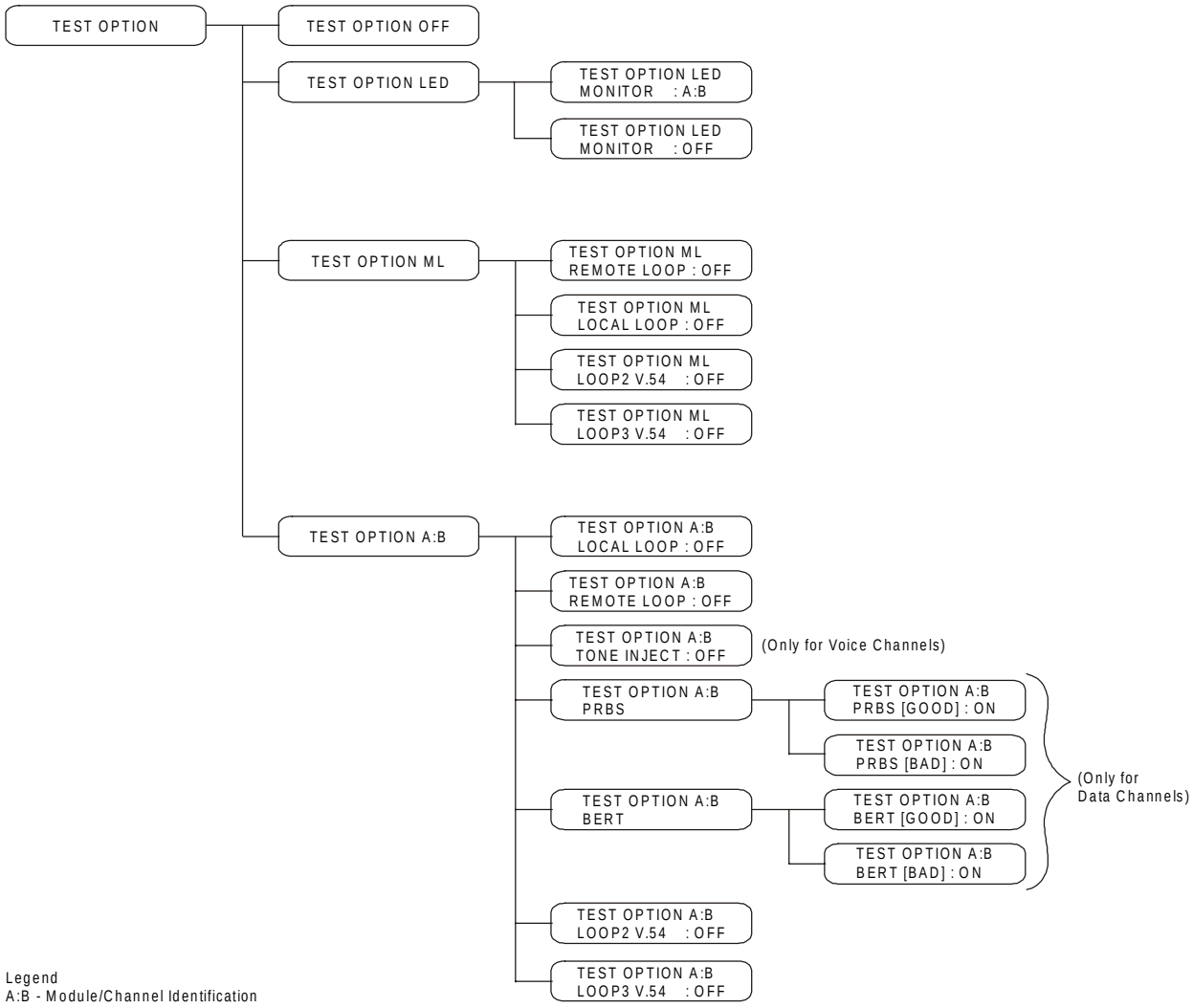

Figure 3-2B. Organization of Front Panel Menu (Part II)

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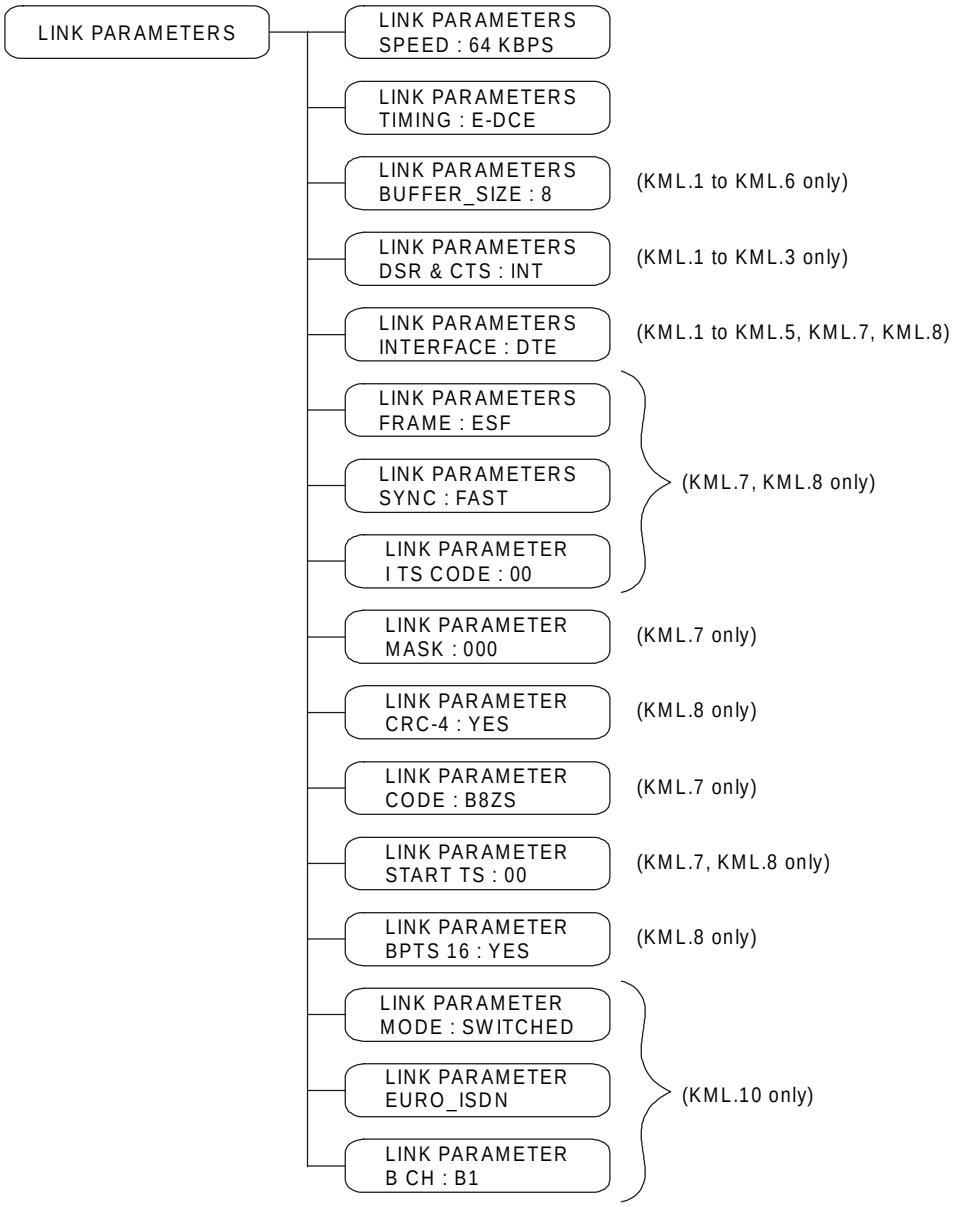

Figure 3-2C. Organization of Front Panel Menu (Part III)

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3.4 System Configuration Parameters

Table 3-3 lists the available system configuration parameters that can be configured from the front panel, and their functions. The table also lists the parameter values included in the KILOMUX-2000 default configuration. Refer to Chapter 4 for information on additional system parameters.

The DWLD column indicates whether a parameter can be downloaded from the master to the slave when downloading is enabled.

Table 3-3. System Parameters

Designation	Function	Values	DWLD
CLK_MASTER	Selects the master timing reference for the main link transmit path. This parameter is displayed only when the main link interface is DCE or external DCE (E-DCE), which are available only with the KML.1, KML.2, KML.3 and KML.4 modules using the TE mode. It is not displayed when a KML.5, KML.6, KML.7, KML.8, KML.10, or KML.F module is installed	INT Internal oscillator A:B Locked to the external clock received from the indicated data channel. This selection is available only when the KILOMUX-2000 enclosure includes I/O modules with synchronous data channels which support the DTE2 timing mode, e.g., KLS.1, KHS.1, modules with ISDN interface, e.g., KHS.U or KVF.4/S0, or modules with T1 or E1 interface, e.g., KVF.5. Only channels of such modules are available for selection on the LCD. Note that the selected channel must actually use a timing mode which supports the connection of an external timing reference, e.g., the DTE2 mode for synchronous data channels, the TE or LT mode for ISDN channels, or loopback timing for T1 or E1 interfaces). A is the KILOMUX-2000 slot number (7 thru 18). B is the module channel number, 1 or 2 **Default: INT**	NO
CLK_FBACK	Selects the alternate (fallback) timing reference for the main link transmit path, to be used in case the master reference fails. This parameter is displayed under the same conditions the CLK_MASTER parameter is displayed. **Note** If you selected one of the channels as main source, do not select the same channel as fallback source	NONE No fallback source is used A:B Same selections as for CLK_MASTER **Default: NONE**	NO

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Table 3-3. System Parameters (Cont'd)

Designation	Function	Values	DWLD
DWLD_BW	Controls the use of the in-band management channel	NO The management channel is not used MIN The management channel is used. The channel data is multiplexed in the main link data stream and is automatically allocated one bandwidth unit (see Table 1-1). **Default: MIN**	NA
ML_MODE	Controls the main link operating mode	SINGLE single main link operation REDUND the two KML modules operate as a redundant pair DUAL_LNK the two KML modules provide two independent links PRI_BMP the two KML modules provide two parallel links with priority bumping SW_BACK switched backup mode: one of the KML modules provides the main link and the other module provides a switched backup link **Default: SINGLE**	YES
ACTIVE_ML	When redundancy is enabled, allows the selection of the active KML module	AUTO Automatic selection of active module ML-A Module KML-A is selected (redundancy switching is overridden) ML-B Module KML-B is selected (redundancy switching is overridden) **Default: AUTO.** In this case, upon power-up, the KML-A module is selected as default if both KML modules are installed and operating normally	YES

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3.5 Main Link Configuration Parameters

Table 3-4 lists the available main link parameters that can be configured from the front panel, and their functions. The table also lists the parameter values included in the KILOMUX-2000 default configuration.

The available parameters depend on the type of main link module installed in the KILOMUX-2000 enclosure (for a complete description of all the configuration parameters of main link modules, including the parameters that can be configured only through the supervision port, refer to the corresponding section in Part II of this manual).

Note that when two main link modules of the same type are installed in the KILOMUX-2000 enclosure, the selected parameter values are used by both KML modules; parameters used by modules serving only for backup may differ.

The DWLD column indicates whether a parameter can be downloaded from the master to the slave when downloading is enabled.

Table 3-4. Main Link Parameters

Designation	Function	Values	DWLD
SPEED	Determines the main link rate. The supported data rates depend on the main link module type (refer to the corresponding module Installation and Operation Manual)	9.6 14.4 19.2 28.8 32 48 56 64 128 192 256 384 512 768 } Data rate in kbps **Default: 64**	NO
TIMING	Determines the system timing mode. For the modules KML.1 through KML.4, also selects the main link interface type	**KML.1, KML.2, KML.3 and KML.4:** DTE DTE timing DCE DCE timing E-DCE External DCE timing **Default: DTE** **KML.5, KML.6, KML.7, KML.8 and KML.F:** INT Internal timing LBT loopback timing **Default: DTE**	NO

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Table 3-4. Main Link Parameters (Cont'd)

Designation	Function	Values	DWLD
BUFFER_SIZE	Determines the size of the main link receive buffer used in the DTE and E-DCE modes (supported by modules KML.1 through KML.6 only). This parameter is not displayed when the main link interface is DCE	8 ±8 bits 256 ±256 bits, recommended for use on satellite links **Default: 8**	YES
INTERFACE	Displays the physical interface selected by means of an adapter cable for the KML.3 module	V.35 V.35 interface X.21 X.21 interface	
DSR&CTS	Determines the handling of the DSR and CTS signals for the modules KML.1, KML.2 and KML.3. When these signals are logically OFF, the transmit data line would be held to MARK	EXT When DSR and/or CTS signals are OFF, the transmit data line is held at MARK. INT The states of the external DSR and/or CTS signals are disregarded; and both signals are assumed to be continuously ON (the transmit data is then not held to MARK when the state of either external line is OFF) **Default: INT**	NO
I TS CODE	Selects the code transmitted to fill idle (empty) time slots in the frames transmitted on the T1 or E1 line by the KML.7 and KML.8 modules	The available selections are 00 to FF (hexa) **Default: 00 for the KML.7, 3F for the KML.8**	NO
FRAME	Selects the multiframing mode for the KML.7 and KML.8 modules	**KML.7 module:** D4(SF) 12 frames per multiframe ESF 24 frames per multiframe **Default: SF** **KML.8 module:** G732N 2 frames per multiframe G732S 16 frames per multiframe **Default: G732N**	NO
SYNC	Selects the frame synchronization algorithm used by the KML.7 and KML.8 modules, and thus effects the time required to return to normal operation after local loss of synchronization	CCITT Complies with ITU-T Rec. G.732 (on the KML.8 module only) 62411 As required by AT&T TR-62411 (after 10 seconds) FAST After 1 second **Default: FAST**	NO

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Table 3-4. Main Link Parameters (Cont'd)

Designation	Function	Values	DWLD
CRC-4	Enables the generation of check bits in accordance with the CRC-4 polynomial specified by ITU-T Rec. G.704 for the frames transmitted on the E1 line, and the checking of the check bits carried by the received E1 frames. This parameter is available only on the KML.8 module	NO - CRC-4 option disabled YES - CRC-4 option enabled **Default: NO**	NO
CODE	Selects the line coding method used for zero suppression on the T1 link of the KML.7 module	TRAN Transparent (AMI) coding, no processing for zero suppression B7ZS B7ZS coding B8ZS B8ZS coding **Note** Clear channel capability is available only with B8ZS coding. **Default: B8ZS**	NO
FUNCTION	Displays the function of the link interface of the KML.7 and KML.8 modules	DSU The module has a DSU link interface CSU The module has a CSU link interface (on KML.7 module only) DSU The module has an LTU link interface (on KML.8 module only)	NO
MASK	Controls the transmit signal characteristics of the KML.7 module. The displayed options depend on the link interface hardware (with or without CSU): – When the link interface does not include a CSU, the transmit signal mask can be selected in accordance with the transmit line length, to meet DSX-1 requirements, as specified by AT&T CB-119, or set for compliance with FCC Rules Part 68A – When the link interface includes a CSU, the transmit signal can be attenuated by 7.5, 15, or 22.5 dB, to meet the requirements of FCC Rules Part 68A	**For link interfaces without CSU:** The following selections indicate the line length in feet: Length (ft) / Display 0-133 / 000 - 133-266 / 133 - 266-399 / 266 - 399-533 / 399 - 533-655 / 533 - FCC68A / Compliance with FCC Rules Part 68A **Default without CSU: 0-133** **For link interfaces with CSU:** 0 No attenuation 7.5 Attenuation of 7.5 dB relative to the nominal transmit level 15 Attenuation of 15 dB relative to the nominal transmit level 22.5 Attenuation of 22.5 dB relative to the nominal transmit level **Default with CSU: 0**	NO

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3.6 User Channel Configuration Parameters

The configuration parameters available for each KILOMUX-2000 user module and for their channels are described in the corresponding module Installation and Operation Manual, contained in Part II of this manual.

3.7 Supervisory Port Configuration Parameters

Table 3-5 lists the available supervisory port configuration parameters that can be configured from the front panel, and their functions. The table also lists the parameter values included in the KILOMUX-2000 default configuration.

None of the supervisory port parameters can be downloaded from a master to a slave.

Table 3-5. Supervisory Port Parameters

Designation	Function	Values
SPEED	Selects supervisory port data rate	300, 1200 2400, 4800 9600 } Supervisory port data rate in kbps AUTO Autobaud operation. The KILOMUX-2000 automatically identifies the data rate applied to its supervisory port. To enable positive identification, the transmission must start with three consecutive Carriage Returns. Do not select AUTO when connecting to a RADview station **Default: AUTO**
DATA	Selects the number of data bits in the word format	7 or 8 data bits. **Default: 8**
PARITY	Controls the use of parity	ODD Odd parity EVEN Even parity NONE Parity disabled (only with 8 data bits) **Default: NONE**
INTERFACE	Selects supervisory port interface	DCE The KILOMUX-2000 appears as a DCE for the supervision terminal DTE The KILOMUX-2000 operates as a DTE, for connection via modem to the supervision terminal. A cross-over cable must be used (Appendix A). **Default: DCE**
MANAGEMENT	Enables the use of a remote management station to control the KILOMUX-2000	YES Management by a remote management station is enabled NO Management by a remote management station is disabled **Default: YES**

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3.8 KILOMUX-2000 Operating Instructions

This paragraph covers the following activities:

- Turn-on.
- Normal KILOMUX-2000 operating indications.
- What to do in case of malfunctions.
- Turn-off.

Turn-on

If the KILOMUX-2000 includes a KM-RINGER module, first set the KM-RINGER module power switch to OFF, and then turn the KILOMUX-2000 on as follows:

- For the KPS.1, KPS.2, KPS.4, KPS.6, and KPS.7 modules, set their ON/OFF switches (on the rear panels) to ON.
- The KPS.3 and KPS.5 modules have no power switch, therefore if one of these modules is installed in the enclosure, the KILOMUX-2000 will start operating as soon as the DC power is connected.

Upon turn-on, the KILOMUX-2000 performs self-test (this is indicated by the lighting of the TEST indicator): observe the front-panel indications.
During the self-test, the KILOMUX-2000 displays the software version in the format X.Y:

KILOMUX-2000 REV X.Y SELF TEST

After successfully completing the self-test procedure, the KILOMUX-2000 will switch to the default display - the ALARM BUFFER.

Notes

1. *If the KILOMUX-2000 fails the power-up self-test, the LCD displays the detected failure, for example:*

TEST RESULTS EPROM FAILURE

   Try to scroll the second line to see if there are additional fault messages. The KILOMUX-2000 must be repaired before it can be used again. Refer to Chapter 5 for troubleshooting instructions.

2. *If the configuration data stored by the KILOMUX-2000 is corrupted, a DB1 CHKSUM ERR alarm message is generated. In this case, you must load the default configuration as explained on the next page. The parameter values included in the default configuration are listed in Tables 3-2 thru 3-5.*

If the KILOMUX-2000 includes a KM-RINGER module, you may now turn it by setting its POWER switch to ON. The RING VOLTAGE and BATTERY VOLTAGE indicators must light.

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You can verify the KILOMUX-2000 configuration as explained in section 3-9. If the configuration does not require modification, the KILOMUX-2000 is ready for operation immediately after self-test is completed. To change the configuration, refer to section 3-10.

Normal Indications

- **KPS Module(s):** The ON-LINE front panel indicators of the KPS module(s) light to indicate proper operation.
- **KML Module(s):** The ON-LINE indicator of the active module must light. The TXD and RXD indicators will light in accordance with the activity on the corresponding line.
- **KCL Module:** After the initial power-up self-test, the TEST indicator turns off. It may turn on again after a test is initiated.
- **KM-RINGER Module:** The RING VOLTAGE and BATTERY VOLTAGE indicators must light, to indicate proper operation.
- **KAI Module**: The KAI module, when installed, reproduces the indications displayed on the KILOMUX-2000 front panel.

If the other communication equipment on the link is not yet operative, the ALARM indicator, and/or LOCAL SYNC LOSS, and/or REMOTE SYNC LOSS indicator may light. These indicators must turn off as soon as the link with the remote unit is established.

If the ALARM indicator continues to light, this indicates the presence of alarms in the alarm buffer. After the alarms are cleared, the ALARM indicator should turn off.

What to do in Case of Malfunction

In case a malfunction occurs, perform the following preliminary checks and actions:

- Check that the modules have properly installed and inserted in the slots specified by the installation plan.
- Check that all the cable connections were made in accordance with the installation plan.
- If upon turn-on the KILOMUX-2000 displays a DB CHKSUM ERR message, refer to Chapter 2 and perform the following activities:
  - Turn the KILOMUX-2000 off.
  - Remove the KCL module, set section 5 of switch S1 to ON, and reinstall the KCL module.
  - Turn the KILOMUX-2000 on, wait until the self-test is successfully completed, then turn the unit off.
  - Remove the KCL module, set section 5 of switch S1 to OFF, and reinstall the KCL module.

  The default data base configuration has now been loaded. You may now start the configuration activities based on the known set of default parameter values.

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- Check the settings of the DIP switches on the KCL module:
  - Section 2 – PSWRD: OFF
  - Section 3 – SP-PAR: OFF
  - Section 4 – DEBUG: OFF
  - Section 5 – DB INIT: OFF
- Check that all the communication equipment serving the main links operates properly.
- Check all the configuration parameters against the prescribed set of parameters.
- Press the RESET push-button of the KCL module.

If these actions do not correct the problem, refer to Chapter 5 to identify the fault and replace the corresponding module.

Turn Off

When you want to stop equipment operation, use the following procedure:

- If the KILOMUX-2000 includes a KM-RINGER module, first turn the KM-RINGER off before the KILOMUX-2000.
- Turn the KILOMUX-2000 off by setting the ON/OFF switches of the KPS modules installed in the enclosure to OFF. For the KPS.3 and KPS.5 modules, disconnect the power.

3.9 Front Panel Operating Instructions

Organization of KILOMUX-2000 Display

The KILOMUX-2000 display has two rows of 16 characters each:

- **Upper row**. Shows the name of the displayed function, group of configuration parameters, or test option, and when applicable, the number of the I/O module and module channel that is being configured.
- **Lower row**. The lower row displays:
  - Parameter name and value.
  - Status messages.
  - Test status.
  - Error messages.
  - Diagnostics messages.

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Using the Front-Panel Push-buttons

KILOMUX-2000 operation is controlled by means of the display and the three push-buttons designated CURSOR, SCROLL and ENTER.

The same control actions are consistently used for all the activities:

CURSOR You use this push-button to indicate what you want to change. Pressing the CURSOR push-button moves the cursor among the fields in the current display. The cursor is a bar that underlines the selected field.

Some fields list several different items, and then you move the cursor under the desired item. The item above the cursor will be changed ("scrolled") when you press SCROLL.

SCROLL Press repeatedly to display the alternatives for the current field/item indicated by the cursor. Holding the push-button depressed causes automatic scrolling of the available alternatives.

ENTER Press it once to select the value displayed in the field/item indicated by the cursor.

Pressing ENTER also confirms the selection of all the other values in the group being currently displayed in the top row, e.g., SYSTEM, LINK, etc. For CH PARM, the pressing of the ENTER push-button confirms the parameters selected for all the channels of the current module. Therefore, you need press ENTER only once for each parameter group, or for each module.

When you press the ENTER push-button, the KILOMUX-2000 checks the validity of the new value. If the selected value is valid, the KILOMUX-2000 displays CONFIG ENTER, and the new value takes effect immediately.

If you make an incorrect selection, the selection is not accepted. In this case, you see a **CONFIG ERROR** message with a two-digit code in the second display row. The code indicates what is wrong. After a short time, the error message disappears and you see again the original display. Now you can correct the error.

If alarms are present in the alarm buffer and the configuration activities are interrupted (that is, no push-button is pressed) for more than one minute, the KILOMUX-2000 automatically exits the configuration state and shows the ALARM BUFFER/SCROLL CLEAR message. Note that in such a case any changes made on the display without pressing the ENTER key are discarded.

Appendix B explains the codes and what to do to correct the error, and section 3-11 explains the use of the test options.

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Checking Current Operating Configuration

Review section 3-4 thru 3-7 for an explanation of the KILOMUX-2000 configuration parameters that can be modified from the front panel.

The following table provides instructions for displaying the current configuration parameters (diagnostic and test functions are not included), and for modifying the supervisory port parameters when necessary. The instructions are presented in a step-by-step format, that will help you familiarize with the use of front-panel push-buttons.

If you only want to check the current configuration, without modifying any parameters, do not press the ENTER push-button during the procedure described below, to prevent accidental change of parameters.

Step	Action	Key	Display
1	Bring the cursor under the top row (if not already there)	CURSOR	
2	Scroll to display SYSTEM PARAMETER in the top row	SCROLL	Second row shows the first system parameter, CLK_MASTER, and its current selection
3	Bring the cursor under the left-hand field in the second row	CURSOR	
4	Scroll to see the other system parameters	SCROLL	After each SCROLL pressing, the second display row shows the current value of the next system parameters. Continue until the first parameter, CLK_MASTER, appears again.
5	Bring the cursor under the top row	CURSOR	
6	Bring to display the next group of configuration parameters - LINK PARAMETER	SCROLL	The second row shows the first main link parameter - SPEED and its current value
7	Repeat steps 3, 4 to see the other main link parameters	SCROLL	
8	Scroll to display CH PARM in the top row	SCROLL	The right-hand field of the top row identifies the channel being handled now in the format A:B, where A is the I/O module slot number (7 thru 18), and B is the module channel number. Thus, the first channel number is 7:1.
9	To change the number of the displayed channel, move the cursor under the top row right-hand field, and scroll to display the desired channel identification	CURSOR, SCROLL	The second row shows the first parameter of the selected channel. The parameter being displayed depends on the type of channel - see the applicable module Installation and Operation Manual contained in Part II.
10	Bring the cursor under the left-hand field in the second row	CURSOR twice	
11	Scroll to see the other para-meters of the selected channel		

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Cont'd

Step	Action	Key	Display
12	Bring the cursor under the right-hand field in the top row	CURSOR	
13	Scroll to display the next desired channel	SCROLL	
14	Repeat steps 10, 11 to display all the parameters of this channel	CURSOR SCROLL	
15	Repeat steps 1 thru 4 to display the supervisory port parameters - SP PARAMETERS	CURSOR, SCROLL	

Normal Indications

The top display shows ALARM BUFFER. During normal operation, the second row should show EMPTY (no alarm messages). If the alarm buffer contains alarms, you will see SCROLL in the left-hand field of the second row, and CLEAR in the right-hand field.

To interpret the messages displayed in the second row, refer to Appendix B. There are two types of alarms, designated as state and event:

- A message indicating a state alarm is displayed only when the alarm condition is present, and is automatically removed when the condition is cleared (if the alarm is being displayed, it will disappear only when the display is refreshed by scrolling).
- A message indicating an event alarm persists even after the event that caused the alarm condition is cleared.

If the KILOMUX-2000 operates normally, but event alarm messages are still displayed, you can clear the event alarm messages by the following procedure:

Step	Action	Key	Display
1	Bring the cursor under the second row, under the CLEAR message	CURSOR	
2	Press ENTER to clear the event messages stored in the alarm buffer	ENTER	If no state alarms are present, the second row will now show EMPTY

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3.10 Local Configuration Set-up Procedure

Before starting any configuration action:

- Review the relevant configuration parameters given in section 3-4 thru 3-7.
- Obtain a list of the required parameters from your system administrator.

KILOMUX-2000 configuration is set-up by a simple three-step procedure:

1. Select the system parameters.
2. Select the main link parameters.
3. Set the channel parameters.

The KILOMUX-2000 presents only those parameters available for the modules installed in the enclosure in the currently selected mode, therefore you should perform the configuration according to the order specified above.

In addition, when a supervision terminal is used to control the KILOMUX-2000, the communication parameters of the supervisory port must also be defined.

Note *For control of KILOMUX-2000 test options, refer to section 3-11.*

General Configuration Procedure

The following steps are used to perform any configuration activity. The general procedure given below is followed by special considerations for each group of parameters.

Notes

1. *Before starting the configuration procedure, always disconnect all the user-initiated loopbacks (select OFF on TEST OPTIONS).*
2. *Refer to Appendix B for an explanation of the configuration error messages the KILOMUX-2000 displays when you make an error.*

Step	Action	Key	Display
1	Bring the cursor under the top row (if not already there)	CURSOR	
2	Scroll to display the desired group of parameters in the top row **Note** For channel parameters, the top row includes an additional field (at the rightmost side of the top row): this field is used to select the channel. In this case, use the CURSOR key to bring the cursor to the channel identification field, then SCROLL to show the desired channel.	SCROLL	Second row shows the first parameter in the selected group and its current value

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(Cont'd)

Step	Action	Key	Display
3	Bring the cursor under the left-hand field (parameter name) in the second row	CURSOR	
4	Scroll to display the desired parameter in the selected group	SCROLL	The second row shows the parameter name and its current value
5	Bring the cursor under the right-hand field (the parameter value) in the second row	CURSOR	
6	Scroll to set the required value for the displayed parameter	SCROLL	The second row shows the available values
7	Repeat steps 3 thru 6 until values are assigned to all the parameters in the group	SCROLL	The second row shows the current selection
8	When the last parameter in this group is displayed, select the new parameter values **Note** You must press ENTER after changing parameters of a certain group, e.g., SYSTEM, LINK, or those of a given module, etc. If you change parameter values, but return the cursor to the first field and scroll to another group without pressing ENTER, the changes made so far in this group are discarded and you will see the message CONFIG LOST. If downloading is enabled, the relevant parameter changes are also sent to the remote KILOMUX-2000.	ENTER	The KILOMUX-2000 checks the validity of the selected values. If the values are valid, the cursor returns to the first field in the top row. The second row displays shortly CONFIG ENTER, and then returns to the normal display. If an error is detected, you will see a CONFIG ERROR message, then the display returns to its previous state.
9	Repeat steps 1 thru 8 until values are assigned to all the parameters in the desired groups	SCROLL	The second row shows the current selection
10	After completing the configuration actions, you can use steps 1, 2 to return to the ALARM BUFFER. If alarm messages are stored in the alarm buffer, ALARM BUFFER is automatically displayed if no push-button is pressed for one minute.	SCROLL	The top row shows: ALARM BUFFER

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System Parameters-Specific Configuration Instructions

See parameter definitions in section 3-4. Remember that even if downloading is enabled, you must locally configure the CLK_MASTER and CLK_FBACK parameters on both the master and slave KILOMUX-2000 units if the installed main link interface module is KML.1, KML.2, KML.3 or KML.4 (these parameters are not available for KML.5).

CLK_MASTER Select the appropriate source: INT or an external timing reference source, connected to one of the channels of a KLS.1, KHS.1, KVF.4/NS0, KVF.4/S0, KHS.U/S, KHS.U/D, KVF.5/E1/M, or KVF.5/T1/M module. In this case, you must select the CLOCK MODE of this channel as DTE2 (otherwise, you will see CONFIG ERROR 01).

CLK_FBACK Select NONE or a source different from that selected as master. If you select as external source a channel that is not configured for operation in the DTE2 mode, you will see CONFIG ERROR 02.

To disable switching to the fallback source, select NONE. In this case, the default fallback clock source is the KILOMUX-2000 internal clock oscillator.

DWLD_BW Select the desired mode: NO to disable the management channel, or enable the management channel by selecting either MIN, or a specific value in the range of 0.4 through 19.2 kbps. ***Whenever main link bandwidth is available, select MIN***.

Note *The DWLD_BW parameter can be selected only on the KILOMUX-2000 configured as master: on a slave KILOMUX-2000, the management channel is always used, therefore the effective value of DWLD_BW is always MIN.*

ML_MODE When the KILOMUX-2000 includes two KML modules, you must define how to use the modules:

- SINGLE - Single main link operation.
- REDUND - The two KML modules operate as a redundant pair.
- DUAL LNK - The two KML modules provide two independent links.
- PRI BMP - The two KML modules provide two parallel links with priority bumping.
- SW BACK - One of the KML modules serves as the main link and the other module serves as a switched backup link.

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Notes

1. *Only the SINGLE and REDUND modes can be actually configured from the front panel. The other modes appear only for compatibility with the supervision terminal. If one of the other modes is selected, you will see CONFIG ERROR 19.*
2. *If the KILOMUX-2000 is equipped with only one KML module, and you are trying to select any mode except SINGLE, you will see CONFIG ERROR 51.*

ACTIVE_ML When redundancy is enabled, you must specify the active KML module:

- AUTO - Automatic selection of active module, in accordance with the redundancy switch-over criteria. The module selected as default after power-up is KML-A.
- ML-A - Module KML-A is selected as the active module. Redundancy is disabled.
- ML-B - Module KML-B is selected as the active module. Redundancy is disabled.

Note *You can use the ML-A and ML-B selections to enforce the selection of a certain active module, and then enable again the redundancy function by selecting AUTO.*

Main Link Parameters - Specific Configuration Instructions

See parameter definitions in section 3-5. Remember that even if downloading is enabled, you must locally configure the main link SPEED and TIMING on both the master and slave KILOMUX-2000 units.

SPEED Select the main link data rate specified for your KILOMUX-2000: 9.6, 14.4, 19.2, 28.8, 32, 48, 56, 64, 128, 192, 256, 384, 512, or 768 kbps.

Notes *If you are reducing the main link data rate, the following error conditions may occur while the main link rate is reconfigured:*

1. *The total data rate of the currently-active channels may exceed the new rate. This will result in CONFIG ERROR 07 (bandwidth overflow).*
2. *With a main link data rate of 256 kbps, it is not possible to select a KHS.1 channel rate of 192 kbps. This will result in CONFIG ERROR 9.*
3. *With a main link data rate of 768 kbps, it is not possible to configure a KVC.1 module (this module is not supported at this main link rate). This will result in CONFIG ERROR 9.*

To correct the problem, change the channel parameters as required.

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TIMING Select the timing mode specified for your KILOMUX-2000:

- When the installed module is KML.1, KML.2, KML.3 or KML.4, the available selections are DTE, DCE or E-DCE. With DCE and E-DCE, a reference timing source must be selected as explained for the system parameters.
- When the installed module is KML.5, KML.6, KML.7, KML.8, or KML.F, the available selections are INT and LBT.

When the timing reference is the internal oscillator (irrespective of the installed main link module), it is not recommended to select clock mode DTE2 for data channels.

BUFFER_SIZE If the selected interface type is DTE or E-DCE, select the appropriate buffer size, in accordance with the communication link media: ±256 bits for satellite links and ±8 bits for any other medium.

DSR&CTS If the installed interface module is KML.1, KML.2, or KML.3, select the desired method of handling the DSR and CTS lines: INT if you want these lines to be ignored, or EXT if you want the transmit data to be held at MARK when either of these lines is OFF.

Channel Parameters - Specific Configuration Instructions For specific configuration instructions, refer to the module Installation and Operation Manual contained in Part II of this manual.

SP Parameters - Specific Configuration Instructions See parameter definitions in section 3-7. You must always configure the supervisory port parameters locally, irrespective of the use of downloading.

SPEED Select AUTO whenever feasible. In this case, start the communication with three Carriage Returns, to ensure positive identification of terminal data rate.

Note *The automatic baud rate recognition procedure should be repeated after the DTR line in the SP connector had been switched to OFF and then ON again.*

DATA Select the required number of data bits (same as on the terminal).

PARITY Select the required parity (same as on the terminal).

INTERFACE

- Select DCE when directly connected to the supervision terminal. In this case, you need a straight cable.
- Select DTE when connected to a modem. In this case, use a cross-over cable for connection to the modem.

MANAGEMENT Select YES when the KILOMUX-2000 will be managed by a RADview network management station. Select NO in any other case.

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3.11 KILOMUX-2000 Test Options

Diagnostic Functions, General

The diagnostic functions accessed by means of TEST OPTIONS include three groups:

LED Monitoring of a selected user channel by means of the front panel indicators.

ML Control and indication of main link loops:

- Local main link loop.
- Remote main link loop.
- Local ITU-T Rec. V.54 loop (ITU-T Rec. V.54 loop 2).
- Remote ITU-T Rec. V.54 loop (ITU-T Rec. V.54 loop 3).

A:B Control and indication of channel loops and tests (A indicates the module slot number, and B indicates the module channel number):

- Local channel loop.
- Remote channel loop.
- Indication of local ITU-T Rec. V.54 loop 2 state (for the KLS.1 module, it is also possible to initiate loop 2).
- Indication of remote ITU-T Rec. V.54 loop 3 state (for the KLS.1 module, it is also possible to initiate loop 3).
- Tone injection (for voice channels only).
- PRBS (pseudo-random sequence) transmission, for data channels only.
- BERT (bit error rate test), for data channels only. Can be performed only if downloading is enabled.

In addition, you can see the test state at the remote KILOMUX-2000. This function is available only when downloading is enabled.

Chapter 5 explains the test connections for each loop. This paragraph provides instructions for activating and deactivating the available tests.

Special Considerations

When using the KILOMUX-2000 diagnostic functions, pay attention to the following points:

- When you select a channel for monitoring, the monitoring of any previously-selected channel is automatically interrupted.
- In general, at any time, only one loop of a given type can be activated on the main link, and on each of the user channels. However, the signal paths formed when certain loops or tests are active inherently disconnect the signal paths required by other loops.

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As a typical example, consider the case of a main link remote loop: if such a loop is activated on the local KILOMUX-2000 in response to a command sent through the management channel by the remote KILOMUX-2000, then the operator of the local KILOMUX-2000 can no longer activate a local main link ITU-T Rec. V.54 loop.

- On the local KILOMUX-2000, the following combinations of loops are not possible:
  - Simultaneous activation of local and remote main link loops (CONFIG ERROR 3).
  - Simultaneous activation of main link ITU-T Rec. V.54 loop 2 and loop 3 (CONFIG ERROR 3).
  - Simultaneous activation of local and remote loops on the same channel (CONFIG ERROR 4).
  - Simultaneous activation of local loop and PRBS transmission on the same data channel (CONFIG ERROR 4).
  - Simultaneous activation of local loop and BERT test on the same channel (CONFIG ERROR 4).
  - Simultaneous activation of local loop and tone injection on the same voice channel (CONFIG ERROR 4).

Table 3-6 lists the allowable combinations of tests when downloading is enabled (***local*** means the KILOMUX-2000 unit from which the test functions are activated).

The codes used in Table 3-6 are as follows:

OK	This combination of loops is allowed
10, 11, 12, 13, 14, 15	The loop combination is not allowed. When you try to activate a loop while the other loop of this combination is already activated, you will see a CONFIG ERROR message with the listed code.
N/A	This combination of loops is not applicable (it is not technically possible).

Note that the conditions listed for channel pairs (the lower right-hand quarter of the table) refer only to tests on the same channel.

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Table 3-6. Loop Combination Rules with Downloading Enabled

Loop Activated by the	Loop Activated by the Remote KILOMUX-2000										
Local KILOMUX-2000	**ML REM**	**ML LOC**	**ML LP2**	**ML LP3**	**CH. LOC**	**CH. REM**	**CH. TONE**	**CH. PRBS**	**CH. BERT**	**CH. LP2**	**CH. LP3**
ML REM	10	OK	10	10	OK	10	OK	OK	10	OK	10
ML LOC	OK	OK	OK	OK	OK	11	OK	OK	11	OK	11
ML LP2	10	OK	14	14	OK	14	OK	OK	14	OK	14
ML LP3	10	OK	14	15	OK	15	OK	OK	15	OK	15
CH. LOC	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
CH. REM	10	11	14	15	OK	12	12	12	12	OK	12
CH. TONE	OK	OK	OK	OK	OK	12	OK	N/A	N/A	N/A	N/A
CH. PRBS	OK	OK	OK	OK	OK	12	N/A	OK	12	OK	12
CH. BERT	10	11	14	15	OK	12	N/A	12	13	OK	12
CH. LP2	OK	OK	OK	OK	OK	OK	N/A	OK	OK	OK	OK
CH. LP3	10	11	14	15	OK	12	N/A	12	12	OK	12

When downloading is disabled, some combinations are no longer available, mainly because in such a case remote loops are connected on the local KILOMUX-2000 toward the remote unit, and not vice versa. In addition to the loops listed above with respect to the local KILOMUX-2000, without downloading, it is not possible to activate loops on the remote KILOMUX-2000 unit.

Test Options Operating Instructions

The following sections provide detailed instructions for:

- Deactivating all the tests initiated by the local KILOMUX-2000.
- Activating/deactivating the monitoring of a selected channel.
- Activating/deactivating a main link loop.
- Activating/deactivating a channel loop.
- Activating/deactivating PRBS transmission on a data channel.
- Activating/deactivating BERT testing on a data channel.
- Activating/deactivating tone injection on a voice channel.
- Displaying the state of channel ITU-T Rec. V.54 loops (for KLS.1 – also activation/deactivation).
- Displaying the state of loops initiated at the remote KILOMUX-2000 unit.

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Deactivating all the Tests

Step	Action	Key	Display
1	Bring the cursor under the top row (if not already there)	CURSOR	
2	Scroll to display TEST OPTIONS in the top row	SCROLL	Second row displays the active test (or the first active test, when several tests are simultaneously active)
3	Bring the cursor under the right-hand field in the top row, and scroll to display OFF in this field	CURSOR	
4	Press ENTER	ENTER	The tests are deactivated and the TEST indicator on the front panel of the KILOMUX-2000 turns off

Activating/Deactivating the Monitoring of a Selected Channel

Step	Action	Key	Display
1	Bring the cursor under the top row (if not already there)	CURSOR	
2	Scroll to display TEST OPTIONS LED in the top row	SCROLL	Second row displays the state of the monitoring function: • MONITOR OFF – no channel is being monitored • MONITOR A:B – the front panel LED's show the status of channel B of the module installed in slot A
3	To change, bring the cursor under the right-hand field in the second row and scroll to display the desired module:channel number or OFF	CURSOR, SCROLL	
4	Press ENTER	ENTER	If this is the only active test on this KILOMUX-2000, the state of the front panel TEST indicator changes

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Activating/Deactivating a Main Link Loop

Step	Action	Key	Display
1	Bring the cursor under the top row (if not already there)	CURSOR	
2	Scroll to display TEST OPTIONS ML in the top row	SCROLL	Second row displays the first type of main link loop and its state, e.g., REMOTE LOOP: OFF
3	To change, bring the cursor under the left-hand field in the second row and scroll to display the desired type of main link loop	CURSOR, SCROLL	The available selections are: • REMOTE LOOP – if downloading is disabled, the remote loop is connected on the local KILOMUX-2000 toward the remote unit. If downloading is enabled, the remote loop is connected on the remote KILOMUX-2000. • LOCAL LOOP • LOOP3 V.54 – commands the modem connected to the main link interface to activate a local loop • LOOP2 V.54 – commands the remote modem that communicates with the modem connected to the main link interface to activate a remote loop
4	To change the state of the selected loop, bring the cursor under the right-hand field in the second row and scroll to display the desired state: ON or OFF	CURSOR, SCROLL	
5	Press ENTER	ENTER	If this is the only active test on this KILOMUX-2000, the state of the front panel TEST indicator changes

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Activating/Deactivating a Channel Loop

Step	Action	Key	Display
1	Bring the cursor under the top row (if not already there)	CURSOR	
2	Scroll to display TEST OPTIONS A:B in the top row	SCROLL	Second row displays the first type of channel loop and its state: e.g., LOCAL LOOP: OFF
3	To change, bring the cursor under the left-hand field in the second row and scroll to display the desired type of channel loop	CURSOR, SCROLL	The available selections are: • LOCAL LOOP • REMOTE LOOP – if downloading is disabled, the remote loop is connected on the local KILOMUX-2000 toward the remote unit. If downloading is enabled, the remote loop is connected on the remote KILOMUX-2000. • TONE_INJECT – displayed only for voice channels. • PRBS – displayed only for data channels. If you intend to use this function to check for transmission errors, you must also connect a physical loopback, or activate an appropriate loop (e.g., a local or remote main link loop, or a remote channel loop). • BERT – displayed only for data channels, provided the downloading function is enabled. • LOOP3 V.54 – displays the state of the loop 3 activation line in the selected channel connector. For the KLS.1, it can also activate loop 3 on a remote tail end circuit. • LOOP2 V.54 – displays the state of the loop 2 activation line in the selected channel connector. For the KLS.1, it can also activate loop 2 on a remote tail end circuit
4	To change the state of the selected loop, bring the cursor under the right-hand field in the second row and scroll to display the desired state: ON or OFF	CURSOR, SCROLL	
5	Press ENTER	ENTER	If this is the only active test on this KILOMUX-2000, the state of the front panel TEST indicator changes.

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Activating/Deactivating PRBS Transmission on a Data Channel

After the pseudo-random sequence (PRBS) transmission test is activated on the selected data channel, as explained in the previous section, the next time you select TEST OPTIONS for this channel, the second display row shows the current test results:

- PRBS [GOOD]: ON – PRBS transmission is being performed on this channel, and no error has been detected on the data channel.
- PRBS [BAD]: ON – PRBS transmission is being performed on this channel and at least one error has been detected. This indication is normal if no loopback is connected.

Activating/Deactivating BERT Test on a Data Channel

Same as PRBS test, except that when the BERT test is initiated, a remote channel loop command is automatically sent to the remote KILOMUX-2000. In this case, a BERT [BAD]:ON display always means that errors have been detected.

Activating/Deactivating Tone Injection on a Voice Channel

After tone injection is activated on a voice channel, the remote subscriber connected to this channel should hear the test tone (an 1 kHz tone) clearly and loudly. If downloading is enabled, you can also activate a remote loop: in this case, the test tone is also heard by the local subscriber.

Activating/Deactivating and Displaying the State of Channel ITU-T Rec. V.54 Loops

When the user data equipment (DTE) is connected to a data I/O module channel, the user's DTE can initiate ITU-T Rec. V.54 loops on the KILOMUX-2000 channel by means of the dedicated loop activation lines. The state of the loop activation lines can be displayed on the front-panel LCD.

For KLS.1 data channels, it is also possible to transfer end-to-end the state of the dedicated loop activation lines. This provides transparent transfer of ITU-T Rec. V.54 loop control requests to initiate the loops at the remote end of the link, instead of initiating these loops on the data I/O module channel. Moreover, requests for the activation of the ITU-T Rec. V.54 loops can also be issued using the Test Option control function. Note that the additional end-to-end transfer capability is available under the following conditions:

- Two KLS.1 modules are operated in a link.
- The data channels of the KLS.1 at one end of the link are configured with DCE interfaces, and those of the KLS.1 at the other end are configured as DTE.

The direction of transfer of ITU-T Rec. V.54 loop requests is from the DCE side to the DTE side. Loops initiated using the Test Option function are activated at the DTE side.

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Note that the response to a ITU-T Rec. V.54 loop request depends on the downloading function:

- If downloading is disabled, a request for ITU-T Rec. V.54 loop 3 results in the activation of a local loop on the local channel. Requests for ITU-T Rec. V.54 loop 2 have no effect, but the state of loop 2 activation line is nevertheless displayed to facilitate system troubleshooting.
- If downloading is enabled:
  - For the KLS.1, if the configuration is DCE-to-DTE, a request for a ITU-T Rec. V.54 loop results in the activation of the appropriate loop control line at the remote KILOMUX-2000 channel. This activates the requested loop on the equipment connected to the KILOMUX-2000 channel.
  - For other cases, a request for ITU-T Rec. V.54 loop 3 results in the activation of a local loop on the local channel, and a request for ITU-T Rec. V.54 loop 2 results in the activation of a remote loop (on the remote KILOMUX-2000 channel).

Displaying the State of Loops Initiated at the Remote KILOMUX-2000 Unit

When downloading is enabled, you can use the following procedure to display the state of the loops initiated at the remote KILOMUX-2000 unit:

Step	Action	Key	Display
1	Bring the cursor under the top row (if not already there)	CURSOR	
2	Scroll to display REM TEST ST in the top row	SCROLL	The left-hand field of the first row shows REM TEST ST. The right-hand field shows: • OFF – indicates that no test is active at remote unit. • ML – indicates that a main link loop is active on the remote unit. The second display row indicates the type of main link loop. • A:B – indicates that a channel loop is active on the remote unit. The second display row indicates the type of channel loop
3	To display the other loops of the same module or module channel, move the cursor to the left-hand field of the second row, and scroll	SCROLL	If on this module there is an additional loop of a different type, it is displayed after you press SCROLL
4	To see if there are additional modules with loops, move the cursor to the right-hand field of the top row and scroll to the next module	CURSOR, SCROLL	If there are additional modules or module channels with loops, the next one is displayed after you press SCROLL

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Chapter 4

Management Using Supervision Terminal

4.1 General

This chapter provides instructions for controlling the operation of the KILOMUX-2000 from a supervision terminal connected to the KILOMUX-2000 SP port.

The information presented in this chapter includes:

- Description of supervision terminal hardware requirements, and handshaking procedures - section 4-2.
- Preparation for use of supervision terminal - section 4-3.
- Description of supervision terminal set of commands: syntax, options, protocol and descriptions - section 4-4.
- General operating instructions, including start-up, routine operations, and stopping of remote control - section 4-5.

For an explanation of the error messages that may be displayed on the supervisory terminal, refer to Appendix B.

The initial configuration of a KILOMUX-2000 must always be performed by means of a supervision terminal connected to its supervisory port, using the procedures described in this Chapter. However after initial configuration, the KILOMUX-2000 can also be managed by means of a RADview network management station. For RADview management procedures, refer to the RADview User's Reference Manual.

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4.2 Hardware Requirements

Terminal Characteristics

Any standard ASCII terminal ("dumb" terminal or personal computer emulating an ASCII terminal) equipped with an RS-232 communication interface can be used to control KILOMUX-2000 operation. Make sure to initialize the KILOMUX-2000 for correct terminal operation as explained, otherwise some of the commands may not work properly.

The software necessary to run the KILOMUX-2000 supervision program is contained in the program EPROM of the KCL module of the KILOMUX-2000. Moreover, the KILOMUX-2000 stores all the configuration information generated or altered during the communication with the terminal: no information is stored in the terminal.

Supervisory Port Interface Characteristics

The KILOMUX-2000 has an RS-232 asynchronous DCE port, designated SP (CONTROL-DCE), located on the KCL.1 module. This port has a 25-pin D-type female connector, and is intended for direct connection to terminals. Since terminals usually have DTE interfaces, the connection to this port is made by means of a straight-through cable. For connection to a modem, you need a cross cable (also called null modem cable).

An additional port with DTE interface, designated DP (CONTROL-DTE), is available as an option. This port has a 9-pin D-type male connector, and is intended for direct connection through a straight-through cable to a dial-up modem, for automatic reporting of alarms.

The user can select, for each port, the data rate (0.3, 1.2, 2.4, 4.8, or 9.6 kbps), and the word format (number of data bits, parity type, and number of stop bits). The default communication data rate is 9.6 kbps. The default word format consists of one start bit, eight data bits, no parity, and one stop bit.

The SP (CONTROL-DCE) supervisory port continuously monitors the incoming data stream and will immediately respond to any input string received through this port; moreover, when configured to support management by RADview, messages in the RADview protocol are automatically identified and processed.

Connection Methods

This section presents typical methods for the connection of a supervision terminal or RADview station to a KILOMUX-2000 unit.

Connection of Supervision Terminal

A supervision terminal can be connected either directly to the KILOMUX-2000 SP (CONTROL-DCE) supervisory port, or through a modem or any other type of full-duplex data link. The KILOMUX-2000 supports only dial-in, that is, it cannot dial out. Figure 4-1 shows typical connections.

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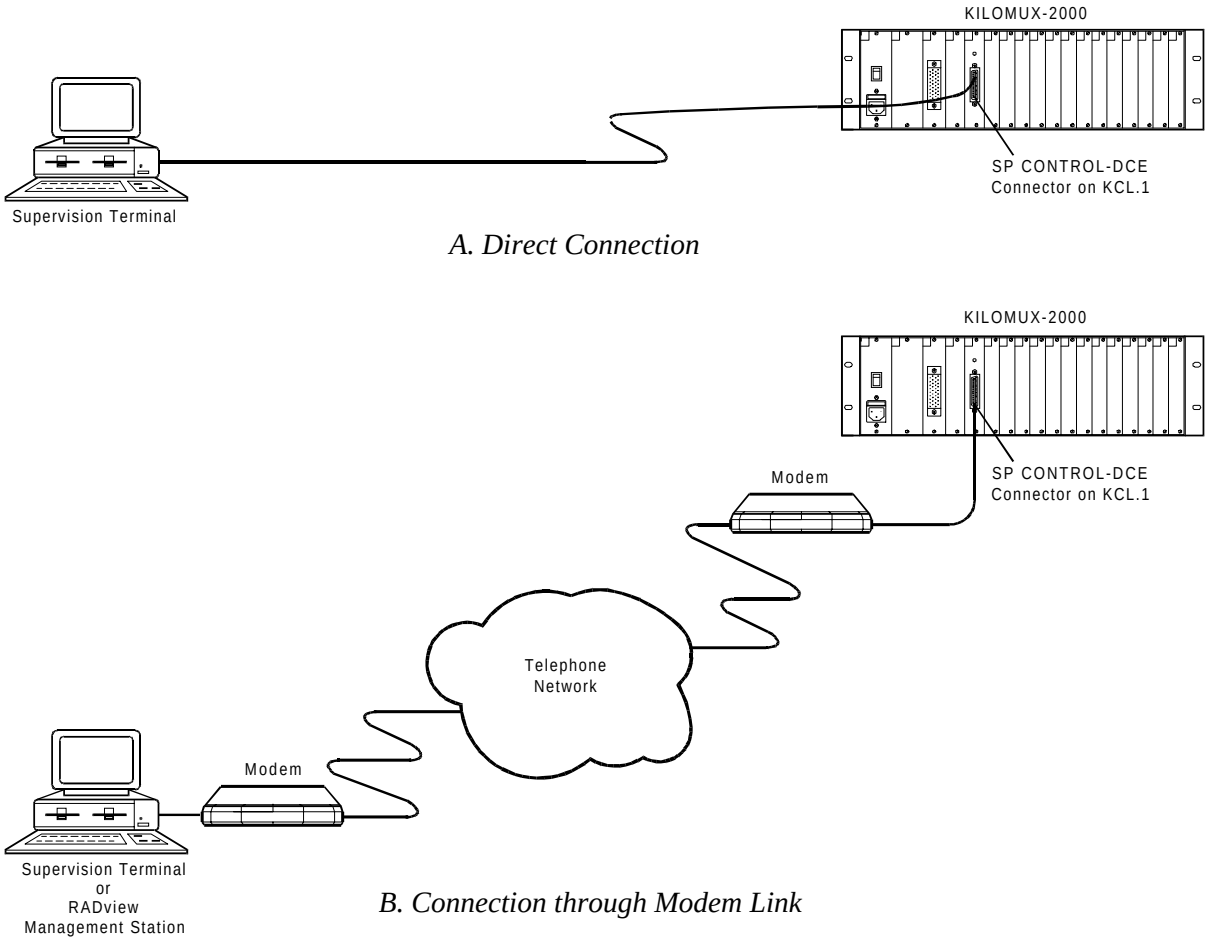

Figure 4-1. Typical Supervision Terminal Connections

Multidrop Configuration

When several KILOMUX-2000 units are located in close proximity to each other (e.g., installed in the same rack or in the same room), you may use a multidrop configuration to connect their supervisory ports to a common terminal or modem. For example, you can connect their ports in a daisy chain configuration, as shown in figure 4-2. Alternately, you can use multidrop modems or digital sharing devices to connect a single terminal to several KILOMUX-2000 units.

For such configurations, each KILOMUX-2000 can be assigned a node address in the range of 1 through 255. Assigning address 0 to the KILOMUX-2000 means that it will accept and answer any message: this is not permitted when the terminal can simultaneously communicate with several KILOMUX-2000 units. Address 0 is however recommended for use when the terminal is directly connected to the KILOMUX-2000 unit, and also when the terminal is connected by a point-to-point link, or when you use dial-up to connect to a remote KILOMUX-2000 unit.

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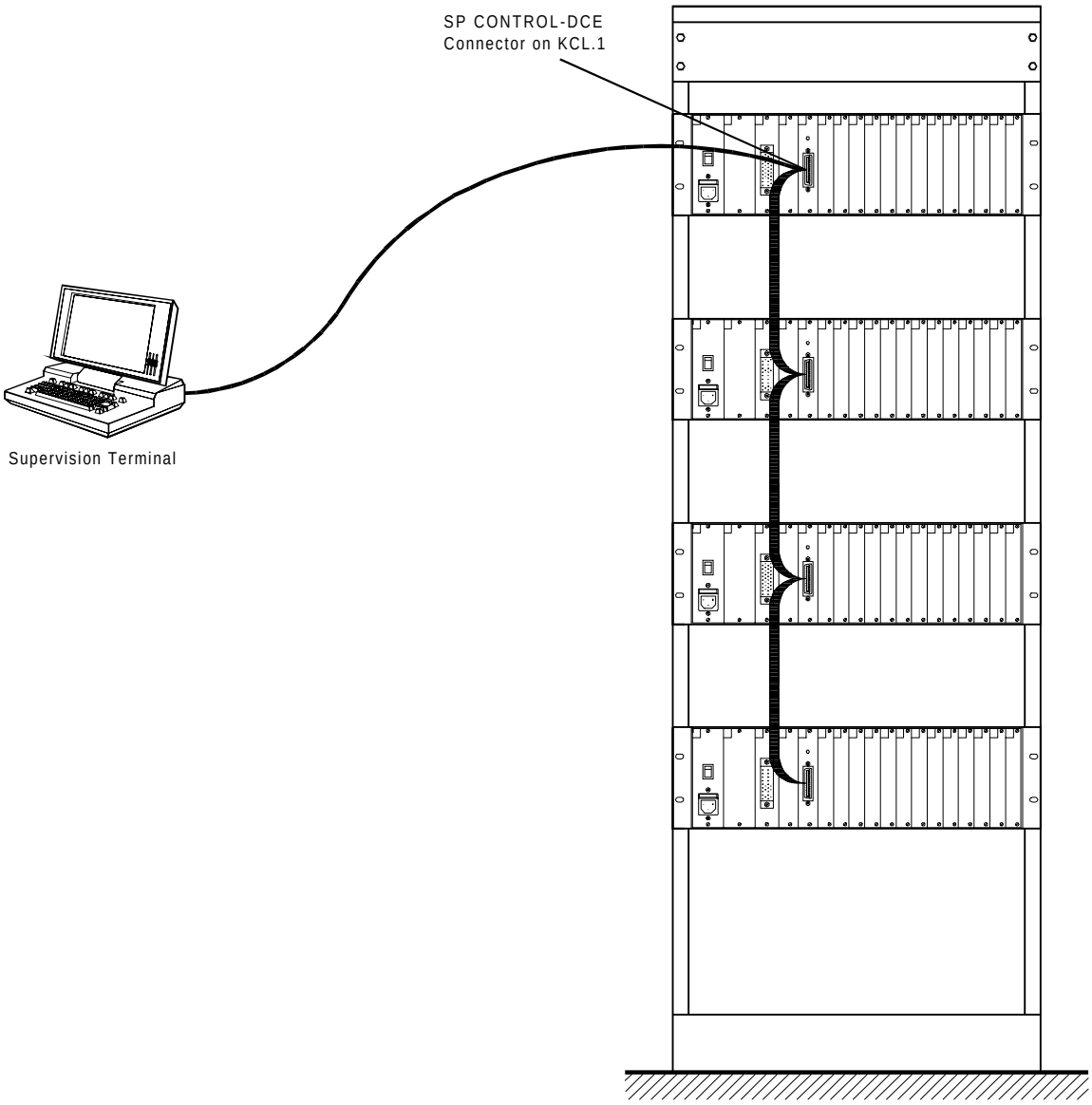

Figure 4-2. Typical Multidrop Connection for Supervision Terminal

Connections for RADview Management

The connection of a RADview network management station is generally made using the multidrop configuration (figure 4-2) described in the previous section. However, in case only one KILOMUX-2000 is managed by the RADview station, direct connection is also possible, as shown in figure 4-1.

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Handshaking Protocol - CONTROL DCE Port

The handshaking between the KILOMUX-2000 and the equipment connected to it (supervision terminal, RADview management station, modem, etc.) uses the control lines in the KILOMUX-2000 SP connector.

The control lines being used in the DCE and DTE interfacing mode, and the direction of the control signals, are detailed in the following chart.

Control Line	Interface Type	
	DCE	DTE
CTS	Out	Not used
DCD	Out	Out
DSR	Out	Out
DTR	In	In
RI	Not used	In
RTS	In	In

Data Terminal Ready (DTR)

The equipment connected to the SP port must set the DTR line ON (active) to gain control over the KILOMUX-2000 and start a management session. When the DTR is ON, the KILOMUX-2000 front panel controls are disabled, and the LCD shows: **`TERMINAL ON LINE`**.

To end the current session, the DTR line is switched OFF (inactive). This ends the control connection, and returns the control to the KILOMUX-2000 front panel. If password protection is used, the password must be entered again the next time the DTR line is switched ON to start a new session.

Request to Send (RTS)

The RTS line is normally ON (active) during a management session.

When the RTS line is OFF (inactive), the KILOMUX-2000 interprets any data received from the terminal on the TD line as MARK.

Clear to Send (CTS)

The state of the CTS line is determined by the CTS parameter:

- **ON** The CTS line is always ON (active).
- **=RTS** The CTS line follows the RTS line.

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Data Carrier Detect (DCD)

The state of the DCD line depends on the communication address (node number):

- When the node address is 0, the DCD line is always ON (active).
- When a non-zero node address is used (multidrop operation), the DCD line is switched ON (active) when data is detected on the RD line, provided the KILOMUX-2000 recognizes its own address in the data stream. To simulate DTE operation, the delay between these events can be set by the user (by means of the DCD_DEL parameter).

Ring Indication (RI)

The RI line is used only with dial-up modems (DTE interface mode).
The RI line is normally OFF (inactive); when the modem attached to the KILOMUX-2000 SP connector detects an incoming call, the RI line is switched ON (active). See also the DSR line.

Data Set Ready (DSR)

- Usually, the DSR line is configured to track the DTR line. In this case, if the supervisory port interface is DTE, the DSR line will be switched ON for 5 seconds when the RI line is ON while the DTR line is OFF.
- If the supervisory port interface is DCE, the DSR line can also be configured to be continuously ON. However, if the DTR line switches to OFF, the DSR line will also switch to OFF for 5 seconds.
  In addition, the KILOMUX-2000 always switches the DSR line OFF (inactive) for 5 seconds when the EXIT command is executed, and when the disconnect time-out expires.

AUTOBAUD Function

When the AUTOBAUD function is enabled, the KILOMUX-2000 can identify the rate of incoming data by analyzing the timing of three consecutive pairs of Carriage Return and Line Feed characters (generated by pressing three times the carriage return key). The detected data rate is then used for the current communication session. The automatic baud rate identification procedure is performed (or repeated) whenever three consecutive carriage returns are received after one of the following events occurs:

- The DTR line has been switched OFF.
- The EXIT command has been executed.
- The idle disconnect time-out expired because no data has been exchanged with the supervision terminal.

In case one of these events occurred, the KILOMUX-2000 assumes that the current communication session has been terminated. Therefore, when the password protection is enabled the password must be entered again before the supervision terminal can resume communication with the KILOMUX-2000.

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The AUTOBAUD function cannot be used with the RADview station, and therefore when RADview management is disabled, you must turn off AUTOBAUD.

Handshaking Protocol with Dial-up Modem

The handshaking procedure between the KILOMUX-2000 and a dial-up modem uses the control signals in the optional DP (CONTROL DTE) connector, and is essentially similar to the handshaking with a terminal, except the directions of the control signals are reversed relative to their direction in the SP (CONTROL DCE) connector when the SP interface is set to DCE. The control lines and the direction of the control signals in the DP (CONTROL DTE) connector is detailed in the following chart.

SP (CONTROL DTE) Control Line	Direction
CTS	In
DCD	In
DSR	Out
DTR	In
RI	In
RTS	Out

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4.3 Preparation for Use of Supervision Terminal

Initial Preparations

When starting a management session for the first time, it is recommended to prepare the KILOMUX-2000 for communication with the supervision terminal as explained below. The preparations include the setting of switch SW1 on the KCL.1 module (see section 2-4 for detailed instructions), and the connection of the terminal to the KILOMUX-2000.

Internal KILOMUX-2000 Settings

The default settings of all the sections of the switch SW1 on the KCL.1 module are OFF. To ensure successful establishment of communication with the terminal, you may need to change the settings of two sections:

SP-PAR Section This section is used to enforce the default communication parameters for the supervisory port. The default parameters are Autobaud (automatic recognition of data rate), one start bit, eight data bits, no parity, and one stop bit.

PSWRD Section In general, you must enter a password when you start a management session, and in addition you may need to use a node address. If the password and/or node address is incorrect, the KILOMUX-2000 will not respond. The PSWRD section is used to restore the default KILOMUX-2000 password (RAD), and change the node address to the default value of 0.

With these sections in the OFF position, you can define your own communication parameters, password and node address. To change to the default values, set the sections to ON, and then press the RESET push-button of the KCL.1 module (if not, the change will take effect the next time the KILOMUX-2000 is turned on). The default values are then loaded and stored.

After performing this procedure, return the switch sections to OFF.

Supervision Terminal

Configure the terminal for the communication parameters you selected for the KILOMUX-2000 SP port (default values are listed above), select the full-duplex mode, and turn terminal echo off.

Connections

Refer to section 4-2.

After making the required connections, turn the supervision terminal on. When applicable, also turn on the modems and any other communication equipment used to connect the terminal to the KILOMUX-2000.

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Initial Configuration

The prompt **PASSWORD>** indicates that password protection is enabled, and you must enter the current password to proceed. However, if you set the PSWRD section of the DIP switch to ON, a null password and node address is used, therefore after pressing <CR> you will obtain the working prompt.

Press the <CR> key several times to see the working prompt of the KILOMUX-2000, which is by default >.

After the KILOMUX-2000 prompt is displayed on the terminal, define the terminal control sequences using the command **F**. Typical terminal control sequences are given in the following chart.

Function	Terminal Type				
	TV920	**VT52**	**VT100**	**Freedom 100/110**	**Freedom 220**
Clear Screen	1B2A0000	N/A	1B5B324A	1B2A0000	1B5B324A
Cursor Home	1E000000	1B480000	1B5B4800	1E000000	1B5B4800
Cursor Right	0C000000	1B430000	1B5B3143	0C000000	1B5B3143

If the KILOMUX-2000 system is not yet configured, use the command **DEF SYS** to define at least one PS module and one KCL.1 module.

Supervisory Port Configuration

After completing the procedure given above, the supervisory port of the KILOMUX-2000 uses the default values. If necessary, change the configuration of the SP (supervisory) port of the KILOMUX-2000 by entering the command **DEF SP**. You will see the supervisory port configuration data form. A typical form with the default values is shown below:

```
SPEED     DATA     PARITY     INTERFACE     CTS     DCD_DEL     DSR
AUTO      8        NONE       DCE           ON      10          ON

POP_ALM   PWD      LOG_OFF    MANAGEMENT
NO        NO       NO         NO
```

After selecting the required parameters, you may have to change the configuration of the supervision terminal, to match the new values.

To define a new node address for the KILOMUX-2000, use the **DEF NODE** command.

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4.4 KILOMUX-2000 Supervision Language

This paragraph presents the KILOMUX-2000 supervision language syntax, usage, and commands.

Command Language Syntax

- Commands can be entered only when the KILOMUX-2000 supervisory port prompt is displayed. The prompt always appears at the beginning of a new line, and the cursor appears to the right of the prompt.
- The prompt identifies the data base being edited:
  - When you are working on the currently active data base, the prompt is **<KM2000>**.
  - When you are working on the alternate data base, the prompt is **<ALT_DB>**.
- Commands are case-insensitive, e.g., you can type commands in either lower case and/or upper case letters.
- To correct typing errors, backspace by pressing the BACKSPACE key until the error is cleared, and then type the correct command again.
- Use space as a separator between command fields and/or parameters.
- Commands must end with a carriage return <CR>.
- To use a command with the existing parameters, type the command name and press <CR>.
- To cancel the current command, press the BREAK key, or CTRL-C (that is, hold the CTRL key down and type C). You will obtain the KILOMUX-2000 prompt again.

Command Options

The following general types of options are available with some commands. See details in the command set index, Table 4-1.

Option	Meaning	Example of Usage
/A	All	CLR ALM /A Clears all the alarms stored by the alarm buffer
/C	Clear	DSP ALM /C Display all the alarms stored by the alarm buffer and then clear all the event alarms
/CA	Clear all	DSP ALM /CA Display all the alarms stored by the alarm buffer and then clear all the alarms
/R	Repeat automatically the execution of the last command. Available only when the node address is 0	DSP PRBS_INJ 7:1 /R Enables you to monitor the updated results of the bit error rate test being run on channel 1 of the module installed in slot 7 of the KILOMUX-2000.
*	Display all the relevant information for the requested item	DSP REV * Displays the hardware and software revisions of all the modules installed in the KILOMUX-2000

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Command Protocol

Starting a Session

- If AUTOBAUD is on, start any session by pressing the <CR> key three times in sequence. This will ensure identification of terminal data rate.
- When the KILOMUX-2000 uses a non-zero node address, it expects an address before responding to the terminal commands. No response will occur until the node number is received and acknowledged by the addressed KILOMUX-2000.
- Acknowledgment is indicated by the echoing of the node address part, i.e., **NODE<SP>nnn<SP>**, where <SP> stands for space.
- The address is in the range of 1 thru 255 (0 indicates that the selective addressing function is disabled). The address is a prefix sent in the following format:**NODE<SP>nnn<SP>.**
- When password protection is on, the displayed prompt is **<PASSWORD>** and the addressed KILOMUX-2000 waits for the password before continuing. After the correct password is received, the KILOMUX-2000 sends the working prompt, **<KM2000>.**
  If password protection is off, this step is omitted and the working prompt appears after the node address conditions are fulfilled.
- The first action to be carried out when starting a session is to check and if necessary, set the correct terminal control codes, using the **F** command.

The terminal control codes, determined by the **F** command, are used to clear the screen, to move the cursor to the screen home position, and to move the cursor to the right by one position. Using the terminal control codes suitable for the type of terminal connected to the KILOMUX-2000 is essential to proper display of the information sent by the KILOMUX-2000 on the terminal screen: certain combinations of codes can lead to unintelligible displays.

If the information on your screen is unintelligible, issue first the INIT F command, and then use the **F** command to set the desired control codes.

Command Evaluation and Execution

- After the working prompt is displayed, every character typed on the terminal keyboard is immediately evaluated by the KILOMUX-2000 and echoed to the terminal screen. Full duplex communication with the terminal is therefore necessary, to provide on-line feedback to the terminal operator.
- Command evaluation starts only when the <CR> key is pressed.
- Certain commands are not accepted by KILOMUX-2000 configured as slave units in a master-slave configuration. The commands are identified by a – in the ***Slave*** column of Table 4-1 (other commands are marked with a + in this column).
- Certain commands, mainly DSP commands, are not accepted for the alternate data base.

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- In case an error is detected during command evaluation, the command is not executed. Instead, the KILOMUX-2000 will send the erroneous command back to the terminal, and you will see **`BAD COMMAND OR PARAMETER. TYPE 'H' FOR HELP`** in the next row. The correct command must then be sent again.
- The command is executed only after it is validated.
- Command execution can be interrupted by pressing BREAK or CTRL-C. This will result in the display of the KILOMUX-2000 prompt, and a new command can be entered.
  Use the BREAK key (or CTRL-C) to stop the automatic repetition of commands (/R option).
- After the command is executed, a time stamp is displayed in the following format:

  `time:HH:MM:SS  data:MM:DD:YYYY`

  The supervisory port prompt is displayed on the line following the time stamp.

Command Fields

- When a command has several fields, use the space bar to move the cursor among the various fields. However, for some commands, the <CR> key is used instead: this is indicated in the command description.
- When a field has a limited range of values, the available values can be displayed by scrolling. Scrolling is performed by bringing the cursor to the desired field, and then pressing the F (forward) or B (backward) key until the desired value is displayed.
- If a certain field is not applicable to the current command, the field shows **`N/A`** and scrolling is not possible. **`N/A`** will appear in two cases:
  - In fields of a DEF command that specify parameters not used in the selected operating mode.
  - When connected to a KILOMUX-2000 configured as the slave unit in a master/slave configuration – in the fields of a DEF command listing parameters that cannot be configured on the slave. Such parameters are identified by NO in the ***DWLD*** column of Tables 3-3 thru 3-6.

Ending a Session

- If an idle disconnect time-out is specified, the KILOMUX-2000 will automatically disconnect the ongoing session if no command is received from the terminal for the specified time-out interval.
- The EXIT command disconnects the supervisory port and transfers the control to the front-panel LCD and push-button.
  After ending a session by the EXIT command, you can press any alphanumerical or editing key to start a new a session. It is recommended to use the <CR> key.

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Index of Commands Table 4-1 lists the KILOMUX-2000 commands in alphabetical order. Note that some commands have both a longhand and an abbreviated format.

Table 4-1. KILOMUX-2000 Command Set Index

Command	Purpose	Options	Slave
CLR ALM	Clear alarms stored in the KILOMUX-2000 alarm buffer	/A	+
CLR LOOP CLR LP	Clear user-initiated loops or tests		+
CLR MONITOR CLR M	Deactivate I/O module channel monitor		+
DATE	Set the date for the KILOMUX-2000 internal clock		+
DEF AGENDA	Define a daily schedule for operation in the switched backup mode		–
DEF CALL	Define the dial-out parameters for the dial-out port		
DEF CH	Configure the parameters of a selected module channel (voice or data)		+
DEF CON	Define the main link and priorities of each module		–
DEF DB FLIP	Define the times of day for the switching (flipping) between the two data bases		+
DEF DP	Define the parameters of the dial-out port		
DEF DWLD	Define the main link that carries the management channel (the link through which downloading takes place)		–
DEF FRAME	Define manually the allocation of main link bits		–
DEF ML	Define parameters for the main link		+
DEF ML CALL	Define the switched backup connection setup parameters (for use in the switched backup mode)		–
DEF NAME	Define the logical name of the KILOMUX-2000		+
DEF NODE	Define the node number (0 to 255) of the KILOMUX-2000		+
DEF PWD	Define new password, and/or display the current password		+
DEF SP	Configure supervisory port parameters		+
DEF SYS	Configure system parameters		+
DSP ALM	Display the contents of the alarm buffer and optionally clear the buffer	/C /CA	+
DSP BERT	Display the result of the BERT test running on an I/O module channel	/R /C	+
DSP CH CON	Display information on connected channels		+
DSP HDR TST	Display hardware faults (detected during the power-on self-test, and during normal operation)		+
DSP FLIP	Display cause of last main link flip		+
DSP PBX	Display the configuration parameters of a group of KVF.5 modules		-
DSP PRBS_INJ	Display the result of the PRBS test running on an I/O module channel	/R /C	+
DSP REV	Display the hardware and software revisions of the modules		+
DSP REM LOOP	Display remote KILOMUX-2000 loop state		+

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Table 4-1. KILOMUX-2000 Command Set Index (Cont'd)

Command	Purpose	Options	Slave
DSP ST FRAME			
DSP ST FR	Display information on current frame usage (current bit allocation), as defined in the active data base		–
DSP ST ML	Display active main link status information		+
DSP ST SLOT	Display I/O module status information		+
DSP ST SYS	Display system status		+
EDIT DB	Select the alternate (not active) data base for editing		+
EXIT	End the current control session		+
F	Select the codes for "clear the screen", "cursor home", and "cursor right"		+
FLIP ML	Change active KML module in a redundant system		–
H	Displays a concise index of commands and option switches		+
INIT DB	Load the default configuration instead of the user configuration. Table 4-2 lists default parameter values		–
INIT F	Set all the codes for "clear the screen", "cursor home" and "cursor right" to 0		+
LOOP			
LP	Activate a specified loopback or test	/T *	+
ML RECOVERY	Recover from a priority bumping event		–
MONITOR			
M	Operate the monitor on the selected I/O module channel		+
TIME	Set the time of the KILOMUX-2000 internal clock		+
RESET LOC	Performs a reset to a KCL module (watchdog must be set to ON).		
RESET REM	Performs a reset to a remote card cage in master/slave mode only (watchdog must be set to ON).		

Command Set Description

This section describes the KILOMUX-2000 commands. The commands are listed in alphabetical order. The description includes command format, use, and options.

The following notation conventions are used:

[ ] square brackets enclose an optional entry/parameter

{ } parentheses enclose a list of entries/parameters from which one must be selected

<CR> indicates the pressing of the carriage return key

<SP> indicates the pressing of the space bar

A indicates an I/O slot number

OP indicates the options slot

B indicates the channel number within the selected I/O slot

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CLR ALM

Purpose Clear the alarm buffer.

Format CLR ALM [LOC] [REM] [/A]

Use

- To clear only the event alarms on the local KILOMUX-2000, type:

  CLR ALM LOC<CR> or **CLR ALM<CR>**

- To clear only the event alarms on the remote KILOMUX-2000, type:

  CLR ALM REM<CR>

- To clear all the alarms on the local KILOMUX-2000, type:

  CLR ALM /A<CR> or **CLR ALM LOC /A<CR>**

- To clear all the alarms on the remote KILOMUX-2000, type:

  CLR ALM REM /A<CR>

- After the desired parameter values are selected, press <CR> to end. The KILOMUX-2000 will display the time and date, followed by the KILOMUX-2000 prompt.

CLR LOOP

Purpose Deactivate the specified user-initiated test or loop. Refer to Chapter 5 for a description of the available tests.

Format CLR LOOP [looptype] { ML A ML B [A:B] }
or
CLR LP [looptype] { ML A ML B [A:B] }

Use

- To deactivate a specific type of loop on main link A, type:

CLR LOOP L ML A<CR>	or	**CLR LP L ML A<CR>**
CLR LOOP R ML A<CR>	or	**CLR LP R ML A<CR>**
CLR LOOP V54.2 ML A<CR>	or	**CLR LP V54.2 ML A<CR>**
CLR LOOP V54.3 ML A<CR>	or	**CLR LP V54.3 ML A<CR>**
CLR LOOP L ML<CR>	or	**CLR LP L ML<CR>**
CLR LOOP R ML<CR>	or	**CLR LP R ML<CR>**
CLR LOOP V54.2 ML<CR>	or	**CLR LP V-54.2 ML<CR>**
CLR LOOP V54.3 ML<CR>	or	**CLR LP V-54.3 ML<CR>**

Note *For main link A, it is not necessary to specify the link, e.g., you can type* **CLR LOOP L ML<CR>** *instead of* **CLR LOOP L ML A<CR>.**

- To deactivate a specific type of loop on main link B, type:

CLR LOOP L ML B<CR>	or	**CLR LP L ML B<CR>**
CLR LOOP R ML B<CR>	or	**CLR LP R ML B<CR>**
CLR LOOP V54.2 ML B<CR>	or	**CLR LP V54.2 ML B<CR>**
CLR LOOP V54.3 ML B<CR>	or	**CLR LP V54.3 ML B<CR>**

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- To deactivate all the loops of a certain main link, type:

  For main link A: **CLR LP ML A<CR>** or **CLR LOOP ML A<CR>**

  For main link B: **CLR LP ML B<CR>** or **CLR LOOP ML B<CR>**

- To deactivate a specific type of channel loop or test, type:

  CLR LOOP L A:B<CR> or **CLR LP L A:B<CR>**
  CLR LOOP R A:B<CR> or **CLR LP R A:B<CR>**
  CLR LOOP PRBS_INJ A:B<CR> or **CLR LP PRBS_INJ A:B<CR>**
  (data channel only)
  CLR LOOP TONE_INJ A:B<CR> or **CLR LP TONE_INJ A:B<CR>**
  (voice channel only)
  CLR LOOP BERT A:B<CR> or **CLR LP BERT A:B<CR>**
  (data channel only)

Note *If the desired module is a module for which it is not possible to loops or tests on a specific channel, e.g., a KLS.2 module, type an asterisk * instead of the channel number, B.*

- To deactivate all the channel loop and tests, type:

  CLR LOOP A:B<CR> or **CLR LP A:B<CR>**

  Use the asterisk under the conditions explained above.

- You will see the time and date, followed by the KILOMUX-2000 prompt.

CLR MONITOR ----------

Purpose Deactivate the monitoring of an I/O module channel.

Format CLR MONITOR or CLR M

Use

- To deactivate the monitoring of the currently selected I/O channel, type:

  CLR MONITOR<CR> or **CLR M<CR>**

- You will see the time and date, followed by the KILOMUX-2000 prompt.

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DATE

Purpose Set the date and day of week for the KILOMUX-2000 internal real-time clock.

Format DATE

Use

- To set the date, type:

```
DATE<CR>
```

- The KILOMUX-2000 sends the date entry form:

```
Date
Day      = 06
Month    = 06
Year     = 1998
Week Day = SUN
```

- Bring the cursor to the first field to be changed by pressing <CR>.
- To change the selected field, press F to increase and B to decrease the displayed value. When done, press <CR> to move to the next field.
- To end, press <CR> after the WEEK DAY field.
  The KILOMUX-2000 will display the time and date fields (note that the date has changed), followed by the KILOMUX-2000 prompt.

DEF AGENDA

Purpose Define the daily schedule of utilization of the switched backup mode. Separate schedules can be defined for each day of week. Each 24-hour schedule includes up to four independent periods, defined by the starting and ending time (hour and minutes). For each period, you can enable or disable the use of a switched backup link.

This command is accepted only by the KILOMUX-2000 selected as the master unit in a master/slave configuration, provided the unit is configured for switched backup operation.

Format

```
DEF AGENDA [day]*
```

where **day** stands for SUN, MON, TUE, WED, THU, FRI or SAT.

Use

- To select the schedule for a specific day, e.g., for Sunday, type:

```
DEF AGENDA SUN<CR>
```

- The first part of the daily schedule parameters data form is displayed. A typical data form is shown below:

```
[—Zone 1—] [—Zone 2—] [—Zone 3—] [—Zone 4—]
START    END/START    END/START    END/START    END
00:00      hh:mm        hh:mm        hh:mm      24:00
```

where:

hh - hour (00 thru 23)

mm - minutes (00 thru 59)

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- Change parameters as follows:
  - Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
  - To change the selected field, press F or B to scroll among the available selections. When the desired selection is displayed, press the space bar to move to the next field.
- After the desired parameter values are selected, press <CR> to end. The KILOMUX-2000 will display the time and date fields, followed by the KILOMUX-2000 prompt.
- After the last change, press the <CR> key. The second line of the data form, used to control the use of the switched backup link, is displayed:

```
[—Zone 1—] [—Zone 2—] [—Zone 3—] [—Zone 4—]
START    END/START    END/START    END/START    END
00:00      hh:mm        hh:mm        hh:mm      24:00
BACKUP:     YES          YES           NO        YES
```

- Use the procedure described above to select the desired value for each period:

  YES The use of the switched backup link is allowed.

  NO The use of the switched backup link is not allowed.
- After the desired parameter values are selected, press <CR> to end. The KILOMUX-2000 will display the time and date fields, followed by the KILOMUX-2000 prompt.

DEF CALL ----------

Purpose Define the call-out parameters for the KILOMUX-2000 dial-out port (connector CONTROL-DTE). The call-out function is enabled by means of the DEF DP port.

The specified call-out parameters are used by the KILOMUX-2000 to build the call command that is sent to the dial-out modem. The modem connected to the CONTROL-DTE connector must be set up as follows (for convenience, the Hayes commands required to select the specified parameters are listed in brackets):

- Auto-answer mode (**AT S0=1**)
- Call set up in response to the **CONNECT** string (**AT X0**)
- No echo (**AT E0**)
- Verbose mode (no codes, e.g., **CONNECT** string instead of **0**) (**AT V1**)

Format DEF CALL

Use
- To define the KILOMUX-2000 call-out parameters, type:

```
DEF CALL<CR>
```

- You will see the first page of the call-out parameters data form. A typical display is shown below.

```
NUM_OF_RETRIES  WAIT_FOR_CONNECT  DIAL_MODE  ALT_NUM_MODE
0               60SEC             TONE       NO
```


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- Change the parameter values as follows:
  - Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
  - To change the selected field, press F or B to scroll among the available selections.
  - When the desired selection is displayed, press the space bar to move to the next field.
- The call-out parameters displayed on the first page of the data form, and their range of values, are as follows:

NUM_OF_RETRIES This parameter is used to control the number of dialing retries.

- 0 - no redialing attempts are made in case the call is not established on the first attempt.
- 1 through 8 - in case the call is not established on the first attempt, the KILOMUX-2000 will redial the specified number of times.

The NUM_OF_RETRIES parameter applies to both the primary and the alternate numbers:

- If the call is not established after dialing the primary directory number the specified number of times, the KILOMUX-2000 attempts to establish the call by dialing the alternate directory number (provided the use of an alternate number is enabled by means of the ALT_NUM_MODE parameter).
- If the call cannot be established within the specified number of redialing attempts on neither of the two directory numbers, the KILOMUX-2000 stops the call attempts. When a new alarm report must be sent, the call attempts are started again.

The user is notified that the call attempts failed by a message recorded in the alarm buffer (separate messages are provided for each directory number).

WAIT_FOR_CONNECT This parameter specifies the time the KILOMUX-2000 will wait for an answer after each dialing attempt. If the called station does not answer within the specified time, the KILOMUX-2000 disconnects. If additional call attempts are allowed, the KILOMUX-2000 will redial immediately after disconnecting.

The available selections are 30, 45, or 60 seconds.

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DIAL_MODE This parameter is used to select the dialing mode:

- TONE - the modem is instructed to use DTMF dialing.
- PULSE - the modem is instructed to use pulse dialing.

The appropriate dialing mode depends on the dialing mode supported by the telephone network.

ALT_NUM_MODE This parameter is used to control the use of an alternate number. The alternate number is dialed used after the specified number of call attempts on the primary number failed:

- NO - no alternate number. In this case, the KILOMUX-2000 stops the call attempts after the specified number of call attempts on the primary number failed.
- YES - the use of an alternate number is enabled.

- When done, press <CR> to display the second page of the call-out parameters data form. A typical display is shown below.

```
NEW PRIMARY NUMBER [MAX 20 CHARS] =
CURRENT PRIMARY NUMBER            = 'primary number'
```

The second page is used to enter a new primary directory number, and the second row displays the current primary directory number. The directory number can include up to 20 digits, including the * and # symbols.

- After entering the desired directory number, press <CR>:
  - If the ALT_NUM_MODE parameter is NO (no alternate number), the KILOMUX-2000 will display the TIME and DATE fields, followed by the KILOMUX-2000 prompt.
  - If the ALT_NUM_MODE parameter is YES, you will see the third page of the call-out parameters data form, used to enter a new alternate directory number. A typical display is shown below.

```
NEW ALTERNATE NUMBER [MAX 20 CHARS] =
CURRENT ALTERNATE NUMBER           = 'alternate number'
```

- After entering the desired directory number, press <CR> to end.

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DEF CH

Purpose Define the configuration parameters of a module or module channel. Refer to Part II of this manual for a complete listing of the available parameters, and for typical channel parameter data forms for each module.

Format DEF CH {[A:B] [A:*]}

Use

- To define the parameters of a specific module channel, type:

  DEF CH A:B<CR>

- Where **A** is either OP (to select the options slot) or a number in the range of 7 thru 18, and **B** depends on the number of configurable channels of the module installed in the specified slot.
- To define the parameters of all the module channels, type:

  DEF CH A:*<CR>

- The data form of the selected module or module channel is displayed. The form presents the current parameter values as defaults.
- Change parameters as follows:
  - Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
  - To change the selected field, press F or B to scroll among the available selections. When the desired selection is displayed, press the space bar to move to the next field.
- After the desired parameter values are selected, press the <CR> key to end. The KILOMUX-2000 will display the time and date fields, followed by the KILOMUX-2000 prompt.

DEF CON

Purpose Define the main link to be used by each I/O module.

The command is relevant only for dual-link configurations. When using the priority bumping or switched backup mode, this command is also used to define the priority of each module.

Format DEF CON

Use

- Type:

  DEF CON<CR>

- The main link selection screen is displayed. The screen lists the I/O slots (including the options slot) and the main link currently used by each slot. A typical display is shown below:

```
SLOT:  7      8      9      ...    18     OP
LINK:  ML-A   ML-B   ML-A   ...    ML-A
```

- Use the space bar to move the cursor to the desired slot number, and press the F or B key to change the main link used by this slot.

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- When the desired selections are obtained for all the slots, press <CR>. A third line appears: if priority bumping is used, this line shows the priority assigned to each module when a flip occurs from main link A to main link B.

```
SLOT:        7       8       9       ...    18      OP
LINK:        ML-A    ML-B    ML-A    ...    ML-A
PB[A→ÄB]:    LOW     HIGH    HIGH    ...    LOW
```

  If priority bumping and switched backup are disabled, this line shows N/A for all the slots.

- Use the space bar and the F and B keys to change the priorities as necessary. When done, press <CR>. A fourth line appears, showing the priorities for flips from main link B to main link A.

```
SLOT:        7       8       9       ...    18      OP
LINK:        ML-A    ML-B    ML-A    ...    ML-A
PB[A→ÄB]:    LOW     HIGH    HIGH    ...    LOW
PB[B→ÄA]:    LOW     LOW     HIGH    ...    HIGH
```

  - If the two main links operate at the same data rate or the switched backup mode is used, the KILOMUX-2000 automatically sets the same priorities for flips in either direction. Then this line shows N/A for all the slots.
  - If the data rates of the two main links are different and the priority bumping mode is used, you can select the priorities for each I/O slot using the same procedure as above.

- When done, press <CR>.

DEF DB FLIP ----------

Purpose Define the times of day (hour and minutes) for switching from one data base to the other, or cancel this function.

This command can be used only when an alternate data base has already been defined.

Format DEF DB FLIP

Use

- Type:

```
DEF DB FLIP<CR>
```

- The first line of the data base flip time definition screen is displayed. A typical display is shown below:

```
                                HH:MM
FLIP TIME TO DATA BASE 1 :      00:00
```

  where:

  HH – the desired flipping hour (00 thru 23), or NA to disable the switching

  MM – the desired flipping minute (00 thru 59), or NA to disable the switching.

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- Change parameters as follows:
  - Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
  - To change the selected field, press F or B to scroll among the available selections. When the desired selection is displayed, press the space bar to move to the next field.
- After the desired parameter values are selected, press the <CR> key to display the second line of the data base flip time definition screen.

```
                                HH:MM
FLIP TIME TO DATA BASE 2 :        00:00
```

- Define the second flipping time.

Note *To disable the switching between the two data bases, select NA for all the four fields. You should always select **NA** if the switched backup data base is **ALTERNATE** (see **DEF ML CALL** command).*

- After the desired values are selected, press the <CR> key to end. The KILOMUX-2000 will display the time and date fields, followed by the KILOMUX-2000 prompt.

DEF DP ----------

Purpose Define the communication parameters of the dial-out port, and control the use of the call-out function. The communication parameters of the dial-out port can be different from the communication parameters of the supervisory port, which are selected by means of the DEF SP command.

Format DEF DP

Use

- Type

```
DEF DP<CR>
```

- The dial-out port parameters data form is displayed. A typical form is shown below. The form presents the current parameter values as defaults.

```
          SPEED     DATA    PARITY    CALL_OUT_MODE
AUTO        7     EVEN  ALL
```

- Change the parameter values as follows:
  - Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
  - To change the selected field, press F or B to scroll among the available selections.
  - When the desired selection is displayed, press the space bar to move to the next field.
- When done, press <CR> to end.

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Parameter Values The dial-out parameters and their range of values are as follows:

SPEED This parameter selects the dial-out port data rate. The available selections are 300, 1200, 2400, 4800, and 9600 bps.

DATA This parameter selects the number of data bits in the dial-out port word format: 7 or 8 data bits.

PARITY This parameter controls the use of parity:

- ODD - Odd parity
- EVEN - Even parity
- NO - Parity disabled (only available with 8 data bits).

CALL_OUT_MODE This parameter controls the use of the call-out function:

- NONE - the call-out function is disabled.
- ALL - the KILOMUX-2000 will initiate a call after each new alarm.
- MAJOR - the KILOMUX-2000 will initiate a call after each new major alarm.

DEF DWLD ----------

Purpose Define the main link module, KML-A or KML-B, to which the management channel will be routed. The KILOMUX-2000 downloading function is then applied only on the selected main link.

This command is accepted only on the KILOMUX-2000 configured as master unit in a master-slave V configuration, provided the main link mode is dual link (mode selection is made by means of the DEF SYS command), and downloading is enabled (DOWNLOAD=MIN).

The master-slave V configuration is illustrated in figure 4-3. This configuration allows one master KILOMUX-2000 to control the links to two locations with slave KILOMUX-2000 units, provided the following arrangements are made:

- The V configuration requires the installation of one main link module in each slave, but in different slots (one in slot 3, the other in slot 4).
- The active I/O modules of each slave are installed in different slots, e.g., slots 7 thru 10 in one unit and 11 thru 18 in the other. Each I/O module must be connected to the appropriate main link module (depending on the installed module).

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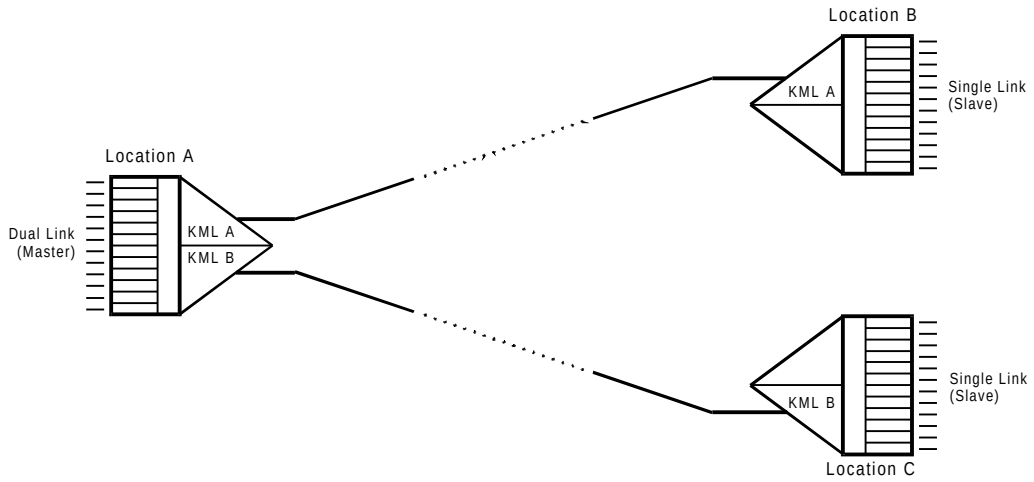

Figure 4-3. Master-Slave V Configuration

Format DEF DWLD [A] [B]

Use

- To route the management channel to main link module A, type:

  DEF DWLD <CR> or DEF DWLD A <CR>

- To route the management channel to main link module B, type:

  DEF DWLD B <CR>

DEF FRAME ----------

Purpose Define manually the allocation of bits in the main link frame. This activity is necessary when a KDI module is used to bypass data between the KILOMUX-2000 main links.

Manual allocation is enabled by means of the DEF SYS command.

The DEF FRAME command must be repeated after each change in the main link data rate, and/or in the data rate of KILOMUX-2000 channels.

Format DEF FRAME

Use

- To perform manual bit allocation on the desired main link, type:

  DEF FRAME A<CR> or DEF FRAME B<CR>

- A typical DEF FRAME screen is shown below.

SLOT	OPERATED_HIGHWAY	SIZE	DATA START
007	ML-A	013	000
012	ML-A	012	014

The screen displays the current main link used by each module (in ascending order of slot numbers) and number of main link bits required for each module. The screen fields are as follows:

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OPERATED_HIGHWAY	Displays the main link on which the module installed in the corresponding slot is allocated bandwidth (this parameter is selected by means of the DEF CON command).
SIZE	Displays the total number of bits assigned to the module installed in the corresponding slot (this parameter is determined by the parameters selected for the corresponding by means of the DEF CH command).
DATA_START	Displays the number of the first bit in the block of bits assigned to the module installed in the corresponding slot.

- You can change the order in which modules are assigned blocks of bits on the main link. To perform the change, bring the cursor to the desired field and then scroll using the F and B keys to display the desired number.

Note *Appendix B in the Installation and Operation Manual of the KDI module contains planning forms to help you in the allocation task.*

- When the allocation is completed, press <CR>. The supervision terminal will display the time and date fields, followed by the KILOMUX-2000 prompt. To verify the allocation, use the DSP ST FRAME command.

DEF ML ----------

Purpose Define main link parameters. The applicable parameters depend on the type of main link module and on the main link mode. Refer to Part II of this manual for a complete listing of the available parameters, and for typical parameter data forms for each type of main link module.

Format DEF ML {A B}

Use

- If the main link mode is SINGLE, type:

  DEF ML <CR>

  This command defines the parameters of the installed module, irrespective of the enclosure slot in which it is located (slot 3 for main link A, or slot 4 for main link B).

- To define the parameters of main link A in a dual-link configuration, type:

  DEF ML <CR> or **DEF ML A <CR>**

- To define the parameters of main link B in a dual-link configuration, type:

  DEF ML B <CR>

- The corresponding main link parameters data form is displayed. Make the desired changes, and after the desired parameter values are selected, press <CR> to end. The KILOMUX-2000 will display the time and date fields, followed by the KILOMUX-2000 prompt.

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DEF ML CALL ----------

Purpose Define the parameters used to control the setup of a backup dial-up connection when the KILOMUX-2000 operates in the switched backup mode. The switched backup mode is selected by means of the DEF SYS command.

Before using this command, define the configuration parameters of the two main link modules using the DEF ML command.

Format DEF ML CALL

Use

- Type the command corresponding to the KML.10 module installed in slot 4 :

```
DEF ML CALL <CR>
```

- The main link call parameters data form is displayed. The data form depends on the type of main link module installed in slot 4, the KML.10 ISDN interface module, or other type of module.

Data Form for KML.10 Modules

Typical lines of the data form for a KML.10 module (configured in European ISDN Standards - ETSI,NTT) is shown below:

```
IN_NUM_MODE      CALL_TIME_OUT    SW_BACKUP_DB
ALL              30 SEC           ONLINE

LOCAL SUB ADDRESS [----] =
LOCAL DIRECTORY NUMBER [--------------------] =
TEI NUM [--] =

BACKUP SUB ADDRESS [----] =
BACKUP CALL NUMBER [--------------------] =
```

- Enter the values by keying them in and press enter (↵) when finished.

IN_NUM_MODE Controls the handling of incoming calls:

- For the KILOMUX-2000 unit configured as master, always select **NONE**, to cause the KML.10 module to reject all incoming calls (the master unit need only initiate calls).
- For the KILOMUX-2000 unit configured as slave, you can select **ALL**, to cause the KML.10 module to accept incoming calls from all the source addresses, or **LOCAL**, to cause the KML.10 module to accept calls only from the address specified in the **BACKUP_CALL_NUMBER** field.

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CALL TIME OUT Specifies the maximum time the KILOMUX-2000 will wait for the connection of the switched backup link. If this time expires, the KILOMUX-2000 aborts the connection attempt, and generates alarm message 22. The available selections are 30, 45, 60, and 120 seconds.

SW_BACKUP_DB Selects the data base that will be used to determine the configuration of the backup link when the switched backup mode is used.

- **ONLINE** - The currently active (on-line) data base. The channels to be carried by the backup link must be assigned HIGH priority, using the **`DEF CON`** command.
- **ALTERNATE** - When switching to the backup link, the KILOMUX-2000 automatically switches to the alternate data base. For this mode, the alternate data base is dedicated only to backup configuration, and must not be used for other purposes (see **`DEF DB FLIP`** command). The channels to be carried by the backup link must be assigned HIGH priority, using the **`DEF CON`** command. After the main link returns to normal operation and the backup link is disconnected, the KILOMUX-2000 automatically returns to the main data base.

LOCAL SUB ADDRESS Enter the sub-address for the local ISDN number (up to four digits).

LOCAL DIRECTORY NUMBER Enter the ISDN directory address of the line connected to the local KML.10 module (up to 20 digits).

BACKUP SUB ADDRESS Enter the sub-address for the destination ISDN number (up to four digits).

BACKUP_CALL_NUMBER For the KILOMUX-2000 unit configured as master, enter the ISDN directory address to be dialed to set up the switched backup link to the destination (slave) KILOMUX-2000 (up to 20 digits).

For the KILOMUX-2000 unit configured as slave, enter the ISDN directory address of the master KILOMUX-2000 from which calls will be accepted (CLI) (up to 20 digits).

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TEI NUMBER — This field appears only when in the DEF ML B command the **STATIC** parameter in the TEI STATE field is defined. A value between 0 and 63 must be entered in this filed according to the ISDN service provide's specifications.

- After the desired selections are made, press <CR> to display the next page of the call parameters data form.
- If the ISDN standard selected by means of the **DEL ML** command is **ATT/5ESS** (AT&T 4ESS and 5ESS switches), **NI1** (Bellcore National-ISDN1 switch), or **NT/DMS100** (Northern Telecom DMS-100 switch), the typical lines of the data form will be as follows:

```
IN NUM MODE    CALL TIME OUT    SW_BACKUP_DB
ALL            30 SEC           ONLINE

ABSTRACT TERMINAL #1
SUB ADDRESS [----] =
DIRECTORY NUMBER [--------------------] =
SPID [--------------------] =
TEI NUM [--] =

ABSTRACT TERMINAL #2
SUB ADDRESS [----] =
DIRECTORY NUMBER [--------------------] =
SPID [--------------------] =
TEI NUM [--] =

FIRST BACKUP SUB ADDRESS [----] =
FIRST BACKUP CALL NUMBER [--------------------] =
SECOND BACKUP SUB ADDRESS [----] =
SECOND BACKUP CALL NUMBER [--------------------] =
```

- **ABSTRACT TERMINAL #2** and its accompanying parameters only appear when the **NUM OF ABSTRACT TERMINALS** parameter in the DEF ML command receives the value 2. The **ABSTRACT TERMINAL** parameters are as follows:

IN_NUM_MODE — Controls the handling of incoming calls:

- For the KILOMUX-2000 unit configured as master, always select **NONE**, to cause the KML.10 module to reject all incoming calls (the master unit need only initiate calls).
- For the KILOMUX-2000 unit configured as slave, you can select **ALL**, to cause the KML.10 module to accept incoming calls from all the source addresses, or **LOCAL**, to cause the KML.10 module to accept calls only from the address specified in the **BACKUP_CALL_NUMBER** field.

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CALL TIME OUT — Specifies the maximum time the KILOMUX-2000 will wait for the connection of the switched backup link. If this time expires, the KILOMUX-2000 aborts the connection attempt, and generates alarm message 22. The available selections are 30, 45, 60, and 120 seconds.

SW_BACKUP_DB — Selects the data base that will be used to determine the configuration of the backup link when the switched backup mode is used.

- **ONLINE** - The currently active (on-line) data base. The channels to be carried by the backup link must be assigned HIGH priority, using the **`DEF CON`** command.
- **ALTERNATE** - When switching to the backup link, the KILOMUX-2000 automatically switches to the alternate data base. For this mode, the alternate data base is dedicated only to backup configuration, and must not be used for other purposes (see **`DEF DB FLIP`** command). The channels to be carried by the backup link must be assigned HIGH priority, using the **`DEF CON`** command. After the main link returns to normal operation and the backup link is disconnected, the KILOMUX-2000 automatically returns to the main data base.

SUB ADDRESS — Enter the sub-address for the local ISDN number (up to four digits).

DIRECTORY NUMBER — Enter the ISDN directory address of the line connected to the local KML.10 module (up to 20 digits).

SPID — Enter the Service Profile ID supplied by the ISDN service provider. Thid number represents the type of service provided (up to 20 digits).

TEI NUMBER — This field appears only when in the DEF ML B command the **`STATIC`** parameter in the TEI STATE field is defined. A value between 0 and 63 must be entered in this filed according to the ISDN service provide's specifications.

- After the desired selections are made, press <CR> to end. The supervision terminal will display the time and date fileds, followed by the KILOMUX-2000 prompt.

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Data Form for Other Module Types

- A typical data form for the main modules KML.1, KML.2, KML.3 and KML.4, is shown below:

```
BACKUP_MODE    CALL_TIME_OUT    SW_BACKUP_DB
PSTN           60 sec           ONLINE
```

- The display fields are as follows:

BACKUP_MODE Defines the type of switched channel:

PSTN Public switched telephone network. In this mode, the KILOMUX-2000 assumes that analog modems are used.

ISDN Integrated Services Digital Network. In this mode, the KILOMUX-2000 assumes direct connection to a B channel of a basic rate ISDN line, using an external NTU device.

CALL TIME OUT Specifies the maximum time the KILOMUX-2000 will wait for the connection of the switched backup link. If this time expires, the KILOMUX-2000 aborts the connection attempt, and generates alarm message 22. The available selections are 30, 45, 60, and 120 seconds.

SW_BACKUP_DB Selects the data base that will be used to determine the configuration of the backup link when the switched backup mode is used. Refer to the section dealing with the KML.10 module for a description of this parameter.

DEF NAME ----------

Purpose Define the KILOMUX-2000 node name (up to eight alphanumeric characters).

Format DEF NAME

Use

- To define the KILOMUX-2000 node name, type:

```
DEF NAME<CR>
```

- The KILOMUX-2000 displays the node name entry form:

```
ENTER NODE NAME (MAX 8 CHARACTERS) =
CURRENT NODE NAME = 'name'
```

Type the desired node name, and then press <CR>. The name appears on the second line.

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DEF NODE

Purpose Define the node number of the KILOMUX-2000. The allowable range of node numbers is 0 thru 255.

Format DEF NODE

Use

- To define the KILOMUX-2000 node number, type:

  ```
  DEF NODE<CR>
  ```

- The KILOMUX-2000 displays the node entry form:

  ```
  NODE (0 to 255) = 0
  ```

  Type the desired node number, and then press <CR>.

Note *Before entering a node number, make sure that the PSWRD switch located on the KCL module is not set to ON, because in such a case the node number is forced to 0.*

DEF PWD

Purpose Define the user password (remember that the user password can only be used when the PSWRD switch located on the KCL module is set to OFF).

Format DEF PWD

Use

- To define the user password, type:

  ```
  DEF PWD<CR>
  ```

- The password entry screen appears, e.g.,

  ```
  NEW PASSWORD (4 to 8 CHARS) =
  CURRENT PASSWORD = 'password'
  ```

- Type the required password (spaces are recognized as valid characters in a password). The password appears on the second line.
  Carefully check that the specified password has been indeed typed in, and then press <CR>.
- The new password takes effect, and the KILOMUX-2000 prompt reappears.

DEF SP

Purpose Assign values to supervisory port parameters. See section 3-7 for parameter description and allowable ranges, and section 3-10 for practical selection recommendations.

Format DEF SP

Use

- Type

  ```
  DEF SP<CR>
  ```

- The supervisory port parameters data form is displayed. The data form lists the parameters on two separate lines. A typical complete form is shown below. The form presents the current parameter values as defaults.

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```
SPEED     DATA      PARITY    INTERFACE   CTS     DCD_DEL   DSR
AUTO       8        NONE      DCE         ON      10        ON
POP_ALM   PWD       LOG_OFF   MANAGEMENT
NO        NO        NO        NO
```

- Change parameters as follows:
  - Bring the cursor to the beginning of the first field to be changed by pressing the space bar.
  - To change the selected field, press F or B to scroll among the available selections. When the desired selection is displayed, press the space bar to move to the next field.
- After the desired parameter values are selected, press <CR> to end. The KILOMUX-2000 will display the time and date fields, followed by the KILOMUX-2000 prompt.

Note *In addition to the parameters listed in section 3-7, the following parameters can be programmed only from the terminal:*

CTS
- ON — The CTS line is always ON (active).
- =RTS — The CTS line follows the RTS line.

DCD_DELAY
With the KILOMUX-2000 supervisory port defined as DTE, indicates delay (in msec) between DCD=ON and the sending of data.
Values: 0, 10, 50, 100, 200, 300 msec.

PWD
Password protection: select YES or NO

LOG_OFF
Idle disconnect time:
- NO — automatic session disconnection disabled.
- 10_MIN — automatic disconnection after ten minutes if no input data is received by the KILOMUX-2000 supervisory port.

DSR
- ON — The DSR line is continuously on. It will switch to OFF for five seconds after the DTR line is switched OFF.
- =DTR — The DSR line tracks the DTR line. When INTERFACE=DTE, the DSR line will switch to ON for five seconds when the RI line is ON while the DTR line is OFF.

POP_ALM
Controls the automatic display of alarms on the terminal.
- YES — the terminal automatically displays every 10 minutes the alarm status (or whenever a new ON alarm is received, or an ON/OFF alarm changes state from OFF to ON).
- NO — the automatic display feature is disabled.

MANAGEMENT
RADview support is enabled / disabled.
- YES — RADview is enabled.
- NO — RADview is disabled.

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DEF SYS ----------

Purpose Assign values to system parameters.

Format DEF SYS

Use

- To define system parameters, type:

```
DEF SYS<CR>
```

- The first line of the system parameters data form is displayed. A typical form is shown below. The form presents the current parameter values as defaults.

```
CLK_MASTER  CLK_FBACK  DWLD_BW   ML_MODE   ML_RECOVERY  FRAME_MODE  LINK_CLK
N/A         N/A        NO        DUAL_LNK  AUTO         MANUAL      ML-A
```

- The parameters displayed on the first page are as follows:

CLK_MASTER, CLK_FBACK — Select the main and fallback clock sources when the main links use independent timing, i.e., when NONE is selected for the LINK_CLK parameter.
When using a KDI module for drop and insert purposes, it may be necessary to lock the main link timing, by selecting ML-A or ML-B for the LINK_CLK parameter: in this case, this field shows N/A (not applicable).

DWLD_BW — Controls the use of the management channel.

- NO - disables the management channel.
- MIN - enables the management channel and adapts automatically the bandwidth assigned to the management channel for optimal performance (uses one bit in the main link frame). This is the recommended value.
- 0.4 to 19.2 kbps - management channel is enabled and uses the specified bandwidth.
  The DWLD_BW parameter can be selected only on the KILOMUX-2000 unit configured as master: on a slave KILOMUX-2000, the management channel is always used, therefore the effective value of the DWLD_BW parameter is always MIN.
  When using a KDI module, select NO, because in this case it is not possible to use downloading.

ML_MODE — When the KILOMUX-2000 includes two KML modules, you must define how to use the modules:

- SINGLE - Single main link operation.
- REDUNDANCY - The two KML modules operate as a redundant pair.
- DUAL LINK - The two KML modules provide two independent links.

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- PRIORITY BUMPING - The two KML modules provide two parallel links with priority bumping.
- SWITCHED BACKUP - One of the KML modules provides the main link, and the other module provides the switched backup link.

When using a KDI module, always select the DUAL LINK mode.

ML_RECOVERY When using the redundancy, priority bumping, or switched backup mode, selects the method used to return to normal operation after a failure on the main link is corrected:

- MANUAL - recovery upon manual command.
- AUTO - automatic recovery. The criterion for recovery is controlled by means of the FLIP_INTEG time.

FRAME_MODE Selects the main link bit allocation mode:

- MANUAL – manual allocation. This is the mode required for using the bypassing and multidrop functions supported by the KDI module.
- AUTO – automatic allocation.

LINK_CLK When a KDI module is installed in the KILOMUX-2000, selects the timing reference for the main links:

- ML-A – main link B timing is locked to main link A timing.
- ML-B – main link A timing is locked to main link B timing.
- NONE – main link A and main link B derive their timing references from the same external clock source, which is selected by means of the CLK_MASTER and CLK_FBACK fields.

- After the desired parameter values are selected, press <CR>. The second line of the system parameters data form is displayed:

```
FLIP_INTEG
SHORT
```

The FLIP_INTEG parameter specifies the integration interval for determining whether it is necessary to switch to the backup link, and to detect return to normal operation of a failed link. In general, you should use SHORT. However, when using the AUTO method for main link recovery, if the link is marginal it may be necessary to wait a longer time before declaring that the link has indeed returned to normal operation: in this case select LONG.

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- After the desired value is selected, press <CR>. The third line of the system parameters data form is displayed. A typical line is shown below:

```
SLOT:        3       4          OPTION
TYPE (DB):   KML.1   KML.10     KDI
```

- After the desired modules are selected, press <CR>. The next line of the system parameters data form is displayed. A typical line is shown below:

```
SLOT:      7      8      9      10     11     12     13
TYPE (DB): KLS.1  KLS.2  KLS.1  KLS.1  KLS.2  KLS.1  KLS.1
```

- If you want to include in the KILOMUX-2000 data base a module that is not physically installed, e.g., to preprogram parameters so when the module is installed, it will start immediately to operate in the desired mode, select the desired module type for each empty slot as mentioned above.

Note *You can select a module type only if the slot is empty. If the slot is not empty, it automatically shows the type of the module physically installed in the slot. If the installed module is changed, the module type is automatically changed in the data base.*

- After the desired modules are selected, press <CR>. The last line of the system parameters data form is displayed:

```
SLOT:       14   15   16   17   18
TYPE (DB):
```

- After the desired parameter values are selected, press <CR> to end.

DSP ALM ----------

Purpose Display the contents of the alarm buffer. This buffer can contain up to 100 alarms.

Format DSP ALM [REM][LOC][/C][/CA]

Use

- To display all the local KILOMUX-2000 alarms, type:

  DSP ALM<CR> or **DSP ALM LOC<CR>**

- To display all the remote KILOMUX-2000 alarms, type:

  DSP ALM REM<CR>

- To display all the local KILOMUX-2000 alarms and then clear the event alarms, type:

  DSP ALM /C<CR> or **DSP ALM LOC /C<CR>**

- To display all the remote KILOMUX-2000 alarms and then clear all the alarms stored in the buffer, type:

  DSP ALM REM /C<CR>

- To display all the local KILOMUX-2000 alarms and then clear all the alarms, type:

  DSP ALM /CA<CR> or **DSP ALM LOC /CA<CR>**

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- To display all the remote KILOMUX-2000 alarms and then clear all buffer alarms, type:

```
DSP ALM REM /CA<CR>
```

Display Format Each block of alarms received from a KILOMUX-2000 is preceded by a header. The header lists the KILOMUX-2000 node number and name, and it serves as an easily-identified separator between the alarms transmitted by different KILOMUX-2000 units. The contents of the alarm buffer are displayed as a table with four columns: ALARM NUMBER, ALARM SYNTAX, ALARM STATE, and ALARM OCCURRENCE TIME.

For a description of the alarm messages that can be displayed by the terminal, refer to Appendix B.

DSP BERT ----------

Purpose Display the result of the BER test running on the specified I/O module channel.

Format DSP BERT {A:B} [/R] [/C]

Use

- To display the current result of the BER test, type:

```
DSP BERT A:B<CR>
```

Note *If for the selected module, e.g., for a KLS.2 module, only the composite channel BER test can be performed, type an asterisk * instead of the channel number in all the following commands. For example:*

```
DSP BERT A:*<CR>
```

The terminal displays the current value of the BERT counter of the specified channel. The BERT count range is 0 thru 65535. If the maximum value is reached, the counter holds this value until cleared (see next command option).

- To display the current value of the BER counter, and then clear the counter, type:

```
DSP BERT A:B /C<CR>
```

- For continuous monitoring of the BER test running on the selected channel, type:

```
DSP BERT A:B /R<CR>
```

To stop the monitoring, press BREAK or CTRL-C.

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DSP CH CON ----------

Purpose Display the configuration of all the connected channels, i.e., all the channels for which a main link bandwidth allocation has been defined, even if not actually used.

Format DSP CH CON

Use

- Type:

```
DSP CH CON<CR>
```

- The connected channels configuration table is displayed. A typical screen is shown below:

```
              ML          SPEED       CONTROL SIGNALS
CH. A:1       ML-A        9.6KBPS     LOCAL
CH. A:2       ML-A        19.2KBPS    LOCAL
   .            .           .           .
   .            .           .           .
   .            .           .           .
COMP A:*      ML-B        9.6KBPS     N/A
```

The display fields are explained below:

CH A:B Lists the channel identification.
For modules for which there are no configurable channels, e.g., for KLS.2 modules, only the composite data can be displayed; in this case, the display shows COMP A:*.

ML Indicates the main link to which the channel is currently connected.

SPEED Shows the channel data rate, in kbps.

CONTROL SIGNALS Displays the control signal support mode for the corresponding channels. The following codes can appear:

LOCAL	Channel configured for local control signal support (data channel only)
RTS	Channel configured for end-to-end transmission of RTS line state (data channel only)
DTR&RTS	Channel configured for end-to-end transmission of DTR and RTS lines states (data channel only)
SIGNALING	Channel configured for end-to-end transmission of E and M signaling (voice channel only)
N/A	Not applicable: displayed in lines with COMP A:*.

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DSP FLIP ----------

Purpose Display the cause of the last switching (flip) from one main link to the other.

This command is accepted only when the KILOMUX-2000 operates in the switched backup, priority bumping, or redundancy mode.

Format DSP FLIP

Use Type:

```
DSP FLIP<CR>
```

- The following message is displayed:

```
LAST FLIP CAUSED BY: 'cause'
```

The following 'cause' descriptions can be displayed:

NO FLIP	No flip occurred.
FORCED FLIP	Flipping occurred as a result of operator's command (FLIP ML).
ML CTS OR DSR IS OFF	Flipping occurred because the CTS or DSR line in the interface of the KML module serving the previously used link had been switched off by the modem. This cause can appear only when the DSR&CTS main link parameter is set to EXT.
ML HARDWARE FAILURE	Flipping occurred after a hardware failure has been detected in the KML module serving the previously used link.
ML LOCAL SYNC LOSS	Flipping occurred because the local KML module serving the previously used link lost frame synchronization.
ML REMOTE SYNC LOSS	Flipping occurred because the remote KML module serving the previously used link lost frame synchronization.
ON LINE ML REMOVED	Flipping occurred because the KML module that was previously on-line has been removed from its slot.

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DSP HDR TST ----------

Purpose Display the results of the last hardware test of the KCL and KPS modules (made during power-up self-test and during regular operation).

Format DSP HDR TST

Use To display the hardware test report, type:

```
DSP HDR TST<CR>
```

Display Format The display shows **NO ERROR** if everything checks good, or lists the detected problem:

```
DATABASE 1 CHKSUM ERROR
DATABASE 2 CHKSUM ERROR
I/O EXPANDER ERROR
COUNTER ERROR
PS-A 5 VOLT FAILURE
PS-A 12 VOLT FAILURE
PS-B 5 VOLT FAILURE
PS-B 12 VOLT FAILURE
```

Refer to Appendix B for an interpretation of the error messages.

DSP PBX ----------

Purpose Display the configuration parameters of the KVF.5 modules that comprise a group connected to the PABX interface.

Format DSP PBX

Use Type:

```
DSP PBX<CR>
```

Display Format A typical data form for a T1 group is shown below:

ID	CARD TYPE	TS_GROUP	FROM_PBX	TO_PBX	CCS	ABCD	FRAME	POLARITY	EXIST
07	KVF5/T1/M	07/1,2,3,4	A	B	N/A	0101	SF	NORMAL	YES
08	KVF5/T1/S	07/5,6,7,8	N/A	N/A	N/A	N/A	N/A	N/A	NO

The fields appearing on the data form are as follows:

IO Displays the slot in which each module of the group is installed.

CARD TYPE Displays the module type installed in the corresponding slot: KVF5/T1/F (KVF5/T1/M) or KVF5/T1/S for KVF.5 modules for T1, KVF5/E1/F (KVF5/E1/M) or KVF5/E1/S for KVF.5 modules for E1 interface.

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TS_GROUP	Group of time slots served by the module installed in the corresponding slot. The first element left of the '/' represents the IO slot where the master of the present group is located.
FROM_PBX	Specifies the signaling transmission mode from the PBX into the KILOMUX-2000 enclosure (transmit from PBX).
TO_PBX	Specifies the signaling transmission mode from the KILOMUX-2000 enclosure into the PBX (possible values: A, B, A&B, CROSS A&B, CCS).
CCS	Indicates the CCS timeslot in the frame. When the CCS parameter is selected in the FROM_PBX and TO_PBX fields, this field determines the timeslot that passes as transparent. For the KVF.5/E1/M, any timeslot between 1 and 31 can be chosen when working with G.732N framing mode. For the KVF.5/T1/M, any timeslot between 1 and 24 can be chosen.
ABCD	Specifies the default signaling bits which are not referred to in the signaling TO_PBX field.Those will be forced in the PBX locally (possible values 0000 to 1111 binary).
FRAME	Displays the framing format of the KVF.5 module. • For KVF.5/E1/M modules, displays G732N or G732S. • For KVF.5/T1/M modules, displays SF(D4) or ESF. • For KVF.5/E1/S and KVF.5/T1/S modules, always displays N/A (not applicable).
POLARITY	Indicates the polarity of the signaling bits which are transmitted from the KVF.5.
EXIST	Indicates whether the module includes a sub interface.

DSP PRBS_INJ ----------

Purpose	Display the result of the PRBS test running on the specified I/O module channel.
Format & Use	Same as for the DSP BERT command, except the use of **PRBS_INJ** instead of **BERT.** Note that if the PRBS test is activated without closing a loop along the signal path, errors will always be reported.

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DSP REM LOOP

Purpose Display the loops and tests activated on the remote KILOMUX-2000. This command is available only when the management channel is enabled.

Format DSP REM LOOP or DSP REM LP

Use

- To display the loops and tests activated on the remote KILOMUX-2000, type:

  DSP REM LOOP <CR> or **DSP REM LP <CR>**

- The table of active loops and tests is displayed. The table contains one line for each main link module or channel on which a loop or test is currently activated. A typical display is shown below:

```
                    LOOP
  ML-A              L
CH.   7:1           TONE_INJ
CH.  14:1           PRBS_INJ
COMP 18:*           BERT
```

DSP REV

Purpose Display the list of modules installed in the KILOMUX-2000 module and the hardware and software versions of each module.

Format DSP REV { [*] [A] }

Use

- To display information on all the modules, type:

  DSP REV * <CR>

  The supervision terminal displays the list of slots in which modules that include programmable components can be installed, the type of module installed in each slot, and the module hardware and software revision. The general organization of the display is illustrated below.

```
CARD TYPE        SOFTWARE REV.    HARDWARE REV
SLOT 3 ML        XX.YY  XX.YY
SLOT 4           XX.YY  XX.YY
SLOT 5           XX.YY  XX.YY
SLOT OPTIONS     XX.YY  XX.YY
SLOT 7           XX.YY  XX.YY
SLOT 8           XX.YY  XX.YY
  .              XX.YY  XX.YY
  .              XX.YY  XX.YY
SLOT 18          XX.YY  XX.YY
```

- To display the information related to a specific module, type:

  DSP REV A <CR>

  where A is the number of the KILOMUX-2000 slot of the desired module (3, 4, 5, OP, and 7 thru 18).

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DSP ST FRAME ----------

Purpose Display information on the frame structure and the use of the available main link bandwidth. This command is accepted only by KILOMUX-2000 configured as master units. Refer to Chapter 1 for additional information.

Format DSP ST FRAME {A B} or DSP ST FR {A B}

Use

- To display frame information for main link A, type:

  DSP ST FRAME A<CR> or **DSP ST FR A<R>**

- If the KILOMUX-2000 is equipped with only one main link module, it is not necessary to identify the main link.
- To display frame information for main link B, type:

  DSP ST FRAME B<CR> or **DSP ST FR B<R>**

Display Format - AUTO Frame Bit Allocation

A typical DSP ST FRAME display when the frame bit allocation mode (selected by means of the DEF SYS command) is automatic is shown below:

```
FRAME LENGTH     =   XXX BIT    (XXX KBPS)
BIT WEIGHT       =   XXX KBPS
DATA USAGE       =   XXX KBPS
CONTROL USAGE    =   XXX KBPS
DOWNLOAD USAGE   =   XXX KBPS
SYNC USAGE       =   XXX KBPS
TOTAL USAGE      =   XXX KBPS
TOTAL FREE       =   XXX KBPS
```

The display fields are as follows:

FRAME LENGTH	Total number of time slots contained in one main link frame, and the main link data rate, in kbps.
BIT WEIGHT	Main link bandwidth allocation unit, in kbps.
DATA USAGE	The main link bandwidth allocated to user data, in kbps.
CONTROL USAGE	The main link bandwidth allocated to the transfer of user end-to-end signaling in kbps.
SYNC USAGE	The main link bandwidth allocated to the frame synchronization word, in kbps.
DOWNLOAD USAGE	The main link bandwidth allocated to the management channel, in kbps.
TOTAL USAGE	The total main link bandwidth currently allocated, in kbps.
TOTAL FREE	The total main link bandwidth, in kbps, that is not yet allocated and is free.

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Display Format - MANUAL Frame Bit Allocation

A typical DSP ST FRAME display when the frame bit allocation mode (selected by means of the DEF SYS command) is manual is shown below:

```
FRAME LENGTH = 160 BIT (128.0 KBPS)
BIT WEIGHT   = 0.800 KBPS
BYPASS_START = 16         BYPASS_SIZE = 20

SLOT  CH1_START  CH1_SIZE  CH2_START  CH2_SIZE  CNTRL_START  CNTRL_SIZE  LAST_BIT

07    000        012       000        000       012          001         012

12    014        012       000        000       000          000         025
```

The display shows the number of bits in the frame, and the bit "weight" (main link bandwidth allocation unit), followed by the bypass information and bandwidth utilization of each slot:

BYPASS_START — The number of the first bit in the block of bits being bypassed.

BYPASS_SIZE — The total number of bits being bypassed.

CH_START — The number of the first bit in the block of bits assigned to the channel of the module installed in the corresponding slot.

CH_SIZE — The total number of bits assigned to the channel of the module installed in the corresponding slot.

CNTRL_START — When end-to-end transmission of control signals is used, shows the number of the first bit in the block of bits assigned to carry the control signals of the module installed in the corresponding slot.

CNTRL_SIZE — When end-to-end transmission of control signals is used, shows the total number of bits assigned to carry the control signals of the module installed in the corresponding slot.

LAST_BIT — The number of the last bit in the block of bits assigned to the module installed in the corresponding slot.

DSP ST ML ----------

Purpose Display the status of the desired KML module.

Format DSP ST ML {A B}

Use

- To display the status of the KML module installed in slot 3, type:

  DSP ST ML <CR> or **DSP ST ML A<CR>**

- To display the status of the KML module installed in slot 4, type:

  DSP ST ML B<CR>

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General Display Format

A typical DSP ST display is shown below:

```
ACTIVE ML          =   ML-A
SOFTWARE REVISION  =   XX.YY
HARDWARE REVISION  =   XX.YY
ALARMS             =   NONE
INTERFACE TYPE     =   V.35
ML LOOP            =   NONE
```

The display fields are as follows:

ACTIVE ML — Displays the currently-active KML module: ML-A for the KML module installed in slot 3, ML-B for the module installed in slot 4, or BOTH for a KILOMUX-2000 operating in the dual link, priority bumping or switched backup mode.

SOFTWARE REVISION — The software revision of the KML module.

HARDWARE REVISION — The hardware revision of the KML module.

ALARMS — Displays the alarms related to the corresponding main link

NONE	No alarm has been reported
LOCAL SYNC LOSS	The local KILOMUX-2000 lost frame synchronization.
REMOTE SYNC LOSS	The remote KILOMUX-2000 reports the loss of frame synchronization. This message can appear only when down-loading is enabled.

INTERFACE TYPE — Displays the interface type of the selected KML module.

ML LOOP — Displays the state of the loops on the selected KML module:

NONE	No loop is active
R	Remote loop active
L	Local loop active
L-V54.2	The V.54 loop 2 is active
L-V54.3	The V.54 loop 3 is active

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Display Format - KML.10 Module

A typical DSP ST display for a KML.10 module is shown below.

```
ACTIVE ML=              ML-B
SOFTWARE REVISION=      1.1
HARDWARE REVISION=      1.2
ALARMS=                 NONE
INTERFACE TYPE=              ISDN
ML LOOP=                           NONE

MAIN LINK B INTERFACE - ISDN STATUS PARAMETERS
==============================================

ISDN INTERFACE = S
PIGGYBACK INTERFACE TYPE = IB-SW/'ISDN VERSION' REL. 2.0
ISDN DISCONNECT CAUSE =
ISDN CALL STATUS = CONNECTED
ISDN LAYER1 = CONNECTED
ISDN LAYER2 = CONNECTED
```

The general display fields are as follows:

ACTIVE ML — Displays the currently-active KML module:
ML-A for the KML module installed in slot 3,
ML-B for the module installed in slot 4 or
BOTH for a KILOMUX-2000 operating in the dual-link, priority bumping or switched backup mode.

SOFTWARE REVISION — The software revision of the KML.10 module.

HARDWARE REVISION — The hardware revision of the KML.10 module.

ALARMS — Displays the alarms related to the corresponding main link:

- **NONE** - No alarm has been reported
- **LOCAL SYNC LOSS** - The local KILOMUX-2000 lost frame synchronization.
- **REMOTE SYNC LOSS** - The remote KILOMUX-2000 reports the loss of frame synchronization. This message can appear only when downloading is enabled.

INTERFACE TYPE — Displays the interface type of the selected KML.10 module, ISDN.

ML LOOP — Displays the state of the loops on the KML.10 module:

- **NONE** - No loop is active.
- **R** - Remote loop active.
- **L** - Local loop active.

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The ISDN-specific display fields are as follows:

ISDN INTERFACE — Displays the interface type: S for a KML.10/S module, and U for a KML.10/U module.

PIGGYBACK INTERFACE TYPE — For operation on switched lines, displays the ISDN implementation version currently selected for use on the selected module, and the release number of the ISDN support package installed on the module. For operation on leased lines, displays LEASED LINE.

ISDN DISCONNECT CAUSE — Displays the last disconnect cause code. The codes are in the range of 001 through 127, and they comply with the ITU-T Rec. Q.921.

ISDN CALL STATUS — Displays the status of the ISDN call in which the KML.10 module is engaged:

- **DIALING** - the call is being set up.
- **CONNECTED** - the call is connected.
- **DISCONNECTING** - the call is in the process of being disconnected.
- **DISCONNECTED** - the call has been disconnected.

ISDN LAYER1 — Displays the current state of the layer 1 protocol:

- **CONNECTED** - layer 1 is connected.
- **DISCONNECTED** - layer 1 is not connected.

ISDN LAYER2 — Displays the current state of the layer 2 protocol:

- **CONNECTED** - layer 2 is connected.
- **DISCONNECTED** - layer 2 is not connected.

DSP ST SLOT ----------

Purpose Display information on the module installed in one of the slots OP, and 7 thru 18.

Format DSP ST A

Use To display information on the module installed in the desired slot, type:

```
DSP ST A <CR>
```

where A is the slot number, in the range of 7 thru 18, or OP (for the OPTIONS slot).

Display Format A typical DSP ST SLOT status is shown below:

```
DATABASE:           module type
HARDWARE:           module type
SOFTWARE REVISION: XX.YY
HARDWARE REVISION: XX.YY
HARDWARE FAILURE:  YES, NO
OPERATED HIGHWAY:  ML-A
                    CONNECT   INTERFACE   LOOP
CH A:1              YES       V35         NONE
CH A:2
```


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The display fields are as follows:

DATABASE Lists the module type, as stored in the data base

HARDWARE Lists the module type of each active installed module, as reported by the module itself

SOFTWARE REVISION Lists the software revision of the module

HARDWARE REVISION Lists the hardware revision of the module

HARDWARE FAILURE Indicates whether a hardware failure has been detected in this module during the power-up self-test or during regular operation

OPERATED HIGHWAY Indicates the internal KILOMUX-2000 bus to which the specified module is connected:

- **ML-A** Module connected to the bus of main link A
- **ML-B** Module connected to the bus of main link B
- **NC (PB)** Module is not connected to a main link bus (displayed only when the priority bumping or the switched backup mode is used)

In addition, the display provides the following information for each of the channels available on this module.

The channel number, B, is identified in the left-hand column (CH A:B). If the module installed in the selected slot does not include channels recognizable by the KILOMUX-2000 KCL module, e.g., it is a KLS.2 module, the information is presented only for the module composite channel, and the left-hand column shows COMP A:*.

CONNECT Indicates whether this channel has been allocated bandwidth on the main link (is “connected” to the main link):

- **YES** The channel has been allocated main link bandwidth and therefore it can carry traffic.
- **NO** The channel cannot carry traffic.

INTERFACE Shows the channel interface selected by means of the internal interface changer boards.
This field is relevant only to data I/O modules with selectable interface, e.g., KHS.1: for other modules, this field shows NA (not applicable).

LOOP Indicates the tests and/or loops that are currently activated on this channel, or NONE.
For the list of tests and loops available on each module, refer to the module operator's manual included in Part II of this manual.

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DSP ST SYS ----------

Purpose Display system status information.

Format DSP ST SYS [option]

Use

- To view the current system status, type:

```
DSP ST SYS<CR>
```

Display Format A typical system status display, including typical module type identifications, is shown below:

```
NODE                          = 0
NAME                          = [mux name]
MASTER/SLAVE CONFIGURATION    = MASTER
ON LINE DB                    = 1
NODAL CLOCK                   = INT
ACTIVE ML                     = ML-A
ML MODE                       = SINGLE
MONITOR                       = 7:1
ALARM RELAY                   = OFF

INSTALLED MODULES:
           3     4     5     OPTION  7     8     9     10    11
DATABASE:  ML.1  ML.1  CL.1  ----    ----  ----  ----  ----  ----
HARDWARE:  ML.1  ML.1  CL.1  KDI     KLS.1 KVC.1 KVC.2 ----  KVC.1
           12    13    14    15      16    17    18
DATABASE:  ----  ----  ----  ----    ----  ----  ----
HARDWARE:  ----  KHS.2 ----  ----    ----  ----  ----
```

The display fields are as follows:

NODE	Lists the node number assigned to the KILOMUX-2000. The default is 0.
NAME	Lists the logical name assigned to the KILOMUX-2000.
MASTER/SLAVE CONFIGURATION	Indicates how the KILOMUX-2000 is configured (master or slave).
ON LINE DB	Indicates the number of the active data base: 1 or 2.
NODAL CLOCK	Indicates the source for the link transmit clock: the internal oscillator, a module channel, or the main link (ML). ML can only appear when the main link timing mode is DTE. Refer to section 3-5 for additional information
ACTIVE ML	Indicates the currently-active KML module(s): ML-A for the KML module installed in slot 3, and/or ML-B for the module installed in slot 4, or BOTH for a KILOMUX-2000 operating in the dual link, priority bumping or switched backup mode.

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MONITOR	Indicates the module channel monitored by means of the KILOMUX-2000 front panel indicators, or NONE.
ALARM RELAY	Indicates the status of KILOMUX-2000 alarm relay contacts: ON or OFF.
INSTALLED MODULES	Lists, for each slot, the installed module and the module programmed in the data base.
ML MODE	Indicates the current main link mode: SINGLE, REDUNDANCY, DUAL LINK, PRI_BMP, SW_BACK.

EDIT DB

Purpose Select a data base on which the following commands will be executed. The selected data base is identified by the working prompt:

- <KM2000> for the on-line data base (the data base now used by the KILOMUX-2000).
- <ALT_DB> for the off-line data base.

Format EDIT DB

Use

- To select the other data base while working on the on-line data base, type at the <KM2000> prompt:

  EDIT DB<CR>

  The working prompt changes to <ALT_DB>.

- To select the on-line data base while working on the alternate data base, type at the <ALT_DB> prompt:

  EDIT DB<CR>

  The working prompt changes to <KM2000>.

Note *When you exit the configuration program and return the control to the LCD, the data base currently defined to be on-line (irrespective of the data base being edited) is forced to remain the on-line data base.*

EXIT

Purpose End the current session and return control to the KILOMUX-2000 front panel.

Format EXIT

Use Type:

EXIT<CR>

The DSR line of the SP port is switched off for 5 seconds. The supervisory port prompt disappears, and the **TERMINAL ON LINE** message previously displayed by the KILOMUX-2000 is replaced by the default display, ALARM BUFFER.

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F

Purpose Define the codes used to be sent to the supervision terminal to perform the following terminal control functions:

- Clear screen
- Move cursor to screen home position.
- Move cursor to the right by one position.

This command lets you enter manually the desired codes. However, if you are using a VT-52, VT-100, TV-920, FREEDOM-100, FREEDOM-110, or FREEDOM-220 terminal, or a terminal which is compatible with one of the terminals listed above, you can use the INIT F command to select automatically the corresponding control sequences.

Format F

Use

- To display the current codes, type:

  ```
  F<CR>
  ```

- The terminal function entry screen is displayed. The screen includes three separate lines, displayed one after the other. A typical screen, showing all the three lines, is shown below:

  ```
  CLEAR SCREEN =hhhhhhhh (clear screen code)
  CURSOR HOME  =hhhhhhhh (cursor home code)
  CURSOR RIGHT =hhhhhhhh (cursor right code)
  ```

  where h indicates hexadecimal digits.

- To change a code, bring the cursor under the first digit of the code to be changed, by pressing <CR>, then enter the appropriate hexadecimal digit.
- Repeat the procedure until all the necessary digits are changed.

FLIP ML

Purpose Change the active KML module in a redundant system.

This command is available only on a master KILOMUX-2000.

Format FLIP ML

Use To change the active KML module, type:

```
FLIP ML<CR>
```

HELP

Purpose Display an index of the supervisory port commands and the options available for each command.

Format H

Use To enter the help system, type:

```
H<CR>
```

You will see the HELP page.

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INIT DB ----------

Purpose Load the default parameters values instead of the user configuration in the KILOMUX-2000 data base (see Table 4-2).

This command is available only on a master KILOMUX-2000.

Format INIT DB

Use

- To load the default parameters, type:

  `INIT DB<CR>`

- The KILOMUX-2000 will display the time and date fields, followed by the KILOMUX-2000 prompt.

Table 4-2. KILOMUX-2000 Default Configuration Used with Supervision Terminal

Parameter Type	Parameter Designation	Default Value
General	NOD (node number)	0
System	CLK_MASTER	INT
	CLK_FBACK	NONE
	DOWNLOAD_BW	MIN
	ML MODE	SINGLE
	ACTIVE_ML	AUTO
Link	SPEED	64K
	INTERFACE	DCE
	BUFFER_SIZE	8
Channel	PROTOCOL	ASYNC
	SPEED	NC
	ASYNC_DATA	6
	TIMING	DCE
	CTRL_SIG	LOCAL
	CTS	ON
	RTS_CTS_DEL	MIN
	INTF	4-WIRE
	TX_LEVEL	+8dBm
	RX_LEVEL	+2dBm
	OOS	F-B
SP (Supervisory Port)	SPEED_BPS	AUTO
	DATA	8
	PARITY	NONE
	INTERFACE	DCE
General	CLEAR SCREEN	00000000
	CURSOR HOME	00000000
	CURSOR RIGHT	00000000

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INIT F

Purpose Set all the terminal control codes (cursor home, cursor right, and clear screen) to 0, or select the control codes corresponding to one of the supported terminals: VT-52, VT-100, TV-920, FREEDOM-100, FREEDOM-110, or FREEDOM-220.

If your terminal is not compatible with one of the supported terminals, use the F command to enter manually the required sequences.

The codes used by typical terminals are listed in the following chart:

Function	Terminal Type				
	TV920	VT52	VT100	Freedom 100/110	Freedom 220
Clear Screen	1B2A0000	N/A	1B5B324A	1B2A0000	1B5B324A
Cursor Home	1E000000	1B480000	1B5B4800	1E000000	1B5B4800
Cursor Right	0C000000	1B430000	1B5B3143	0C000000	1B5B3143

Format INIT F 'terminal'

Use 1. To select the control codes for one of the supported terminal types, type:

```
INIT F 'terminal'<CR>
```

where 'terminal' stands for the terminal name.

2. To reset the control codes to 0, type:

```
INIT F<CR>
```

LOOP

Purpose Activate tests. For main link test loops, you can define their duration: after the specified time, the loop is automatically disconnected. If you do not specify the loop duration, it remains permanently connected.

- Refer to section 3-12 for the allowable loop combinations.
- Refer to Chapter 5 of Part I for a description of the loops available on the KILOMUX-2000 main link.
- Refer to the module operator's manual, included in Part II, for a description of the tests available on the corresponding module.

Format LOOP [loopname] {ML A ML B A:B} [/T] or LP [loopname] {ML A ML B A:B} [/T]

Where T is the time, in minutes, the requested loop will remain connected (1 thru 9). This parameter can be used only with main link loops.

Use

- To activate a specific type of loop on main link A, type:

```
LOOP L ML A<CR>       or   LP L ML A<CR>
LOOP R ML A<CR>       or   LP R ML A<CR>
LOOP V54.2 ML A<CR>   or   LP V54.2 ML A<CR>
LOOP V54.3 ML A<CR>   or   LP V54.3 ML A<CR>
```


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- To activate a main link loop for a predetermined duration, add the desired duration (1 thru 9 minutes) as a parameter. For example, to activate a local main link loop for 7 minutes, type:

  LOOP L ML /7 <CR>

- To activate a specific type of loop on main link B, type:

  LOOP L ML B<CR> or **LP L ML B<CR>**
  LOOP R ML B<CR> or **LP R ML B<CR>**
  LOOP V54.2 ML B<CR> or **LP V54.2 ML B<CR>**
  LOOP V54.3 ML B<CR> or **LP V54.3 ML B<CR>**

Note *If the KILOMUX-2000 operates in the SINGLE mode, it is not necessary to specify the link, e.g., you can type* ***LOOP L ML<CR>*** *instead of* ***LOOP L ML A <CR>*** *or* ***LOOP L ML B <CR>.***

- To activate a test or loop on the desired channel, type:

LOOP L A:B<CR> or **LP L A:B<CR>**
LOOP R A:B<CR> or **LP R A:B<CR>**
LOOP PRBS_INJ A:B<CR> or **LP PRBS_INJ A:B<CR>** **(data channel only)**
LOOP BERT A:B<CR> or **LP BERT A:B<CR>** **(data channel only)**
LOOP TONE_INJ A:B<CR> or **LP TONE_INJ A:B<CR>** **(voice channel only)**

ML RECOVERY ----------

Purpose When the KILOMUX-2000 is configured for operation with manually controlled switched backup or priority bumping (see DEF SYS command), this command is used to initiate recovery from a priority bumping or switching to the backup link event, and return to normal operation.

This command is available only on a master KILOMUX-2000.

Format & Use To initiate return to normal operation, type:

ML RECOVERY<CR>

MONITOR ----------

Purpose Select the desired I/O module channel for monitoring.

Format MONITOR A:B or M A:B

Use To select a module channel, type:

MONITOR A:B<CR> or M A:B<CR>

where A is the number of the module slot number (7 thru 18).

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TIME

Purpose Set the time for the KILOMUX-2000 internal real time clock.

Format TIME

Use

- To set the time, type:

```
TIME<CR>
```

- The KILOMUX-2000 sends the time entry form:

```
Time
Hour   = 12
Minute = 25
Second = 16
```

- Bring the cursor to the first field to be changed by pressing <CR>.
- To change the selected field, press F to increase and B to decrease the displayed values. When done, press <CR> to move to the next field.
- Set the time about one minute beyond the current time, and then press <CR> at the correct instant. The KILOMUX-2000 will display the time and date fields (note that time has changed), followed by the KILOMUX-2000 prompt.

RESET LOC

Purpose Performs a reset to the local KCL module and to the entire local system.

Format RESET LOC

Use

- To perform a reset type:

```
RESET LOC <CR>
```

RESET REM

Purpose Performs a reset to the remote KCL module and to the entire remote system when working in MASTER/SLAVE mode.

Format RESET REM

Use

- To perform a reset to a remote cage type:

```
RESET REM <CR>
```


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4.5 Supervision Terminal Operating Instructions

Before using the supervision terminal, make sure the preparations listed in section 4-3 were completed and all the relevant equipment has been turned on.

Power-Up with Supervision Terminal Connected

During the power-up procedure, the KILOMUX-2000 automatically sends information through its supervisory port, to allow the monitoring of the power-up self-test from a supervision terminal.

- Upon power-up, the supervision terminal displays:

```
<BEL>KILOMUX-2000 SUPERVISORY PORT ON LINE. TYPE 'H' FOR HELP
```

  where <BEL> stands for the graphic symbol of the <BEL> code (ASCII 07).

- While the KCL module performs the power-up self-test, the supervision terminal displays:

```
CL Board Self Test In Progress ....
```

- After the self-test is completed, the result, **OK** or **FAILED**, is added to the displayed line. The KILOMUX-2000 starts reading the installed modules, and the supervision terminal displays:

```
Reading Installed Modules .....
```

- After the reading is completed, the state of the installed modules is displayed in the following format:

```
SLOT 1  PS-A    OK
SLOT 2  PS-B    OK
SLOT 3  ML-A    OK
SLOT 4  ML-B    OK
SLOT 5  CL      OK
SLOT 7  I/O 1   OK
SLOT 8  I/O 2   OK
SLOT 9  I/O 3   OK
SLOT 10 I/O 4   OK
SLOT 11 I/O 5   OK
SLOT 12 I/O 6   OK
SLOT 13 I/O 7   OK
SLOT 14 I/O 8   OK
SLOT 15 I/O 9   OK
SLOT 16 I/O 10  OK
SLOT 17 I/O 11  OK
SLOT 18 I/O 12  OK
```

  If you see **FAILED** for any module, replace that module.

Starting a Session - Single KILOMUX-2000

When the terminal is used to control a single KILOMUX-2000, always assign node address 0 to the KILOMUX-2000. Use the following start-up sequence to connect to a KILOMUX-2000 assigned node number 0.

- If you use the AUTO (Autobaud) mode, press the <CR> key three times. This allows the KILOMUX-2000 to identify the terminal data rate.

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- Assuming that the KILOMUX-2000 successfully identified the data rate of the supervision terminal, you will be notified if the KILOMUX-2000 failed the power-up self-test:
  - If you see **KILOMUX-2000 SELFTEST FAILED**, the KILOMUX-2000 must first be repaired before you can continue using it.
  - If KILOMUX-2000 successfully passed the power-up self-test, it sends the following announcement:

<BEL>KILOMUX-2000 SUPERVISORY PORT ON LINE. TYPE 'H' FOR HELP

where <BEL> stands for the graphic symbol of the <BEL> code (ASCII 07).

- After the self-test, the KILOMUX-2000 prompt should already be displayed on the terminal screen, after the ON-LINE announcement. If you see

  PASSWORD>

  this indicates that password protection is enabled. In this case, type:

  'password' <CR>

  where 'password' stands for the current password (four to eight characters). The default password is **RAD**.
  If your password is accepted, you will see the prompt <KM2000>.
- The KILOMUX-2000 is now in session, under your control.
  - On your terminal, you will see the prompt:

    <KM2000>
  - On the KILOMUX-2000 front panel, you will see the message:

    TERMINAL ON LINE

    The front panel controls are disabled as long as the KILOMUX-2000 is under remote control.
- ***Before you continue, use the F command to select the proper cursor control codes, otherwise the DEF commands may not work properly.***

Note *While the supervision terminal is in session with the KILOMUX-2000, the KILOMUX-2000 local operator can regain control by disconnecting the cable from the KILOMUX-2000 SP connector, or by sending the EXIT command. The KILOMUX-2000 will automatically return to front panel control if no commands are received for a certain time (controlled by the LOG_OFF parameter). This time-out can however be disabled.*

Starting a Session - Multiple KILOMUX-2000

When one terminal is used to control several KILOMUX-2000 connected via modems, node addresses are assigned to each KILOMUX-2000. The node addresses, in the range of 1 thru 255, are assigned during the first session, by means of the command NODE. Use the following procedure to establish a session with a specific KILOMUX-2000.

IMPORTANT *If you are using a multidrop configuration, do not assign address 0 to any of the KILOMUX-2000 connected to this terminal.*

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- Press the <CR> key three times.
- Type NODE, space, the desired KILOMUX-2000 node address and another space, then type the desired command and press <CR>. For example, with node address 234, type:

  NODE<SP>234<SP> 'command' <CR>
- If the addressed KILOMUX-2000 does not use password protection, it will immediately execute the command.
- If the addressed KILOMUX-2000 is password protected, you will see the prompt:

  <PASSWORD>

  Type the node address again and then type the password.

  For example, for node address 234, type:

  NODE<SP>234<SP>'password'<CR>

  If the password is correct, the KILOMUX-2000 will execute the command. Otherwise, you will see <PASSWORD>.

Control Session

- During the control session, type the desired commands at the terminal keyboard. You must see the KILOMUX-2000 echo character by character.
  - When you see the correct and complete command in the echo line, press <CR> to execute the command. The KILOMUX-2000 will process the command and display the appropriate response.
    At the end of the command execution, the KILOMUX-2000 displays the current time and date, and then provides a new prompt on the next line.
  - If you changed your mind, and want to abort the command, press BREAK or CTRL-C. You will receive the prompt again, so you can enter another command.

Note *You can use BREAK or CTRL-C to stop the automatic repetition of commands sent with the /R option.*

- If your command is not correct, the KILOMUX-2000 will not execute it, but will echo the command, with a **BAD COMMAND OR PARAMETER. TYPE 'H' FOR HELP** message in the following line. Type again the correct command.

Ending a Control Session

- To end the control session, type:
  EXIT
- The KILOMUX-2000 prompt will disappear. Now you can control the KILOMUX-2000 from its front panel.

Note *A control session may also be terminated by the KILOMUX-2000 if the idle disconnect time-out is enabled, or when the DTR line switches to the inactive (OFF) state.*

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Chapter 5
Diagnostics

5.1 General

This chapter describes the KILOMUX-2000 diagnostic functions. These functions can be used to test the proper operation of the KILOMUX-2000 system and identify efficiently the faulty components. The available functions are:

- Connection of a local or remote test loop on the main link.
- Connection of a local or remote test loop on the modem serving the main link, provided the modem supports the ITU-T Rec. V.54 control pins.
- Connection of a local or remote test loop on the desired I/O module channel.
- Indication of the state of the activation lines for the local or remote ITU-T Rec. V.54 test loops 2 and 3 on a selected channel of a data I/O module.
- Activation of ITU-T Rec. V.54 loop 2 and loop 3 on tail-end modems connected to KLS.1 modules.
- Pseudo-random sequence (PRBS) transmission on a selected channel of a data I/O module.
- Bit error rate test (BERT) on a selected channel of a data I/O module, using a pseudo-random sequence.
- Injection of 1 kHz, 0 dBm0 (digital milliwatt) audio signal for testing the transmit path of the desired voice I/O module channel.

Note that no tests are available for the KCL.1 module, because this module controls the management interface, i.e., the front-panel controls and the interfacing with a supervision terminal or RADview network management station, and the KILOMUX-2000 operation. Therefore, the KCL.1 module is inherently “tested” when a proper response is obtained to any operator request, and the KILOMUX-2000 operates normally.

If it is necessary to replace the KCL.1 module, you can preserve the existing data base in two ways:

- The fastest way is to remove the NVRAM component from the replaced module and installing it on the replacement module.

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- If this is not possible, the replacement module can be preconfigured in another KILOMUX-2000 and then installed in the desired unit. This procedure allows the replacement of a defective KCL.1 module without disrupting the operation of the KILOMUX-2000, because the KILOMUX-2000 can continue to operate even if the KCL.1 module is temporarily removed.

Note however that if you insert a new KCL.1 module in an operating KILOMUX-2000 without first either transferring the NVRAM (or preconfiguring the module), then when the KCL.1 module is inserted in the KILOMUX-2000 the system is reset to the default values.

Test control is effected from the TEST OPTIONS menu. In this chapter you will find information on the tests (loops) available on the main link interface modules and the main link modems.

You will also find a general description of the test functions applicable to I/O modules. ***Specific information on the tests available for each I/O module is provided in the corresponding section in Part II of this manual.***

Note *In this chapter,* ***local*** *means the KILOMUX-2000 unit at which the test command has been given, i.e., it is always assumed the command has been given using the front panel controls of, or a supervision terminal connected to, the* ***local*** *KILOMUX-2000.*

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5.2 Main Link Loops

General

The KILOMUX-2000 supports two types of main link loops:

- Test loops activated on the KML modules. These loops provide information on the functioning of the KML modules. However, since the loops are performed at the interface between the KILOMUX-2000 unit and the other system elements, these loops also provide information on the functioning of the complete unit.
- Test loops activated on the modem serving the main link, provided the modem supports ITU-T Rec. V.54 loops. These loops provide information on the transmission equipment that provides the connection between the two KILOMUX-2000 units.

This section explains the main link loops, describes the front-panel indications that are relevant to the interpretation of the test results, and in addition provide a recommended testing sequence that allows the identification of the general location of a fault.

Local Main Link Loop

Local Main Link Loop – Signal Path

When a local loop is activated on a KML module, the main link transmit signal is returned to the input of the main link receive path at a point just before the line interface. In order to provide a keep-alive signal to the transmission equipment serving the link while the loop is activated, the line interface also transmits the signal to the line. The loop signal path is shown in figure 5-1.

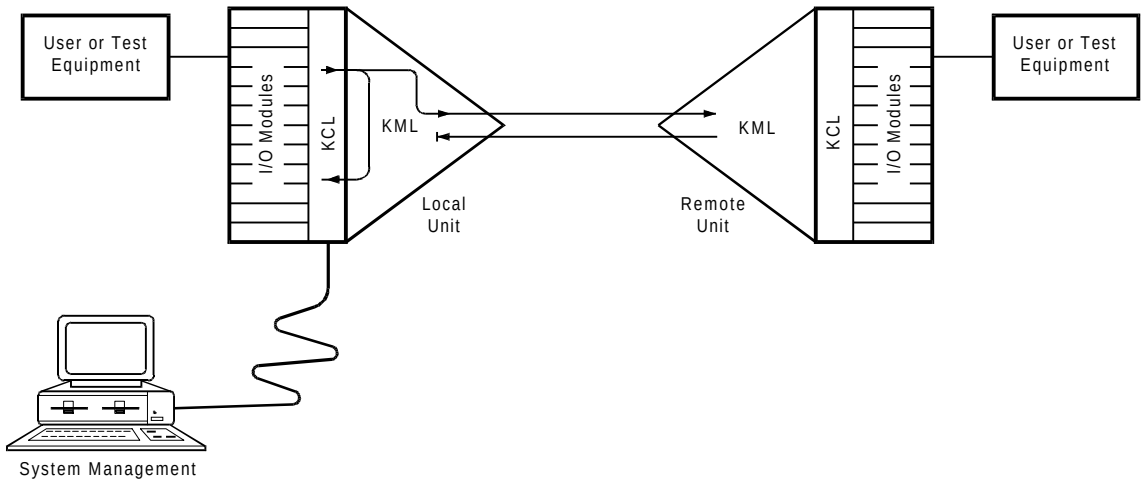

Figure 5-1. Local Main Link Loop, Signal Path

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Local Main Link Loop – Normal Indications and Fault Isolation

- The TEST indicator of the local KILOMUX-2000 lights. If downloading is enabled, the loop will be displayed under the REM TEST ST menu of the remote KILOMUX-2000.
- The TXD and RXD indicators of the local KILOMUX-2000 must light. If not, the local KILOMUX-2000 is defective.
- The SYNC LOSS indicator of the local KILOMUX-2000 must be off. If it lights, the local KILOMUX-2000 is defective.

Remote Main Link Loop

As a rule, always perform a local main link loop on each of the two KILOMUX-2000 units, and only if both units pass the test successfully, do connect the remote main link loop.

Remote Main Link Loop – Signal Path

The signal path depends on the downloading state:

- If downloading is enabled and a remote main link loop is activated at the local KILOMUX-2000 unit, the KML module of the remote KILOMUX-2000 unit loops back the main link receive signal to the local unit via the transmit path. The received signal remains connected as usual to the receive path of that unit. The loop signal path is shown in figure 5-2.A.
- If downloading is disabled, the remote loop is connected on the local KILOMUX-2000 unit, i.e., the local KML module returns the received signal toward the remote KILOMUX-2000. The loop signal path is shown in figure 5-2.B.

Remote Main Link Loop with Downloading Enabled – Normal Indications and Fault Isolation

- The TEST indicators of the local and remote KILOMUX-2000 units light.
- The TXD and RXD indicators of the local and remote KILOMUX-2000 units must light, and the LOCAL SYNC LOSS indicator of the local KILOMUX-2000 unit must be off. If there is a problem, trace the fault by checking the indications in the order given below:
  - If the TXD indicator of the local KILOMUX-2000 unit does not light, the fault occurred in the local KILOMUX-2000 unit: check by performing a local main link loop on the local unit.
  - If the TXD indicator of the local KILOMUX-2000 unit lights but the RXD indicator of the remote KILOMUX-2000 unit does not light, probably there is a problem in the transmit path to that unit. There is however a low probability that the fault occurred in either the local or the remote KILOMUX-2000 units: check by performing local main link loops.
  - If the RXD indicator of the remote KILOMUX-2000 unit lights, but its TXD indicator is off, the remote KILOMUX-2000 unit is defective.

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- If the TXD indicator of the remote KILOMUX-2000 unit lights but the local RXD indicator is off, probably there is a problem in the receive path to the local unit. There is however a low probability that the fault occurred in the local KILOMUX-2000 unit: you can check by performing a local main link loop on the local unit.
- If the RXD indicator of the local KILOMUX-2000 unit lights, but its LOCAL SYNC LOSS indicator lights, a fault is present. The fault is in the local KILOMUX-2000: check by performing local main link loop.

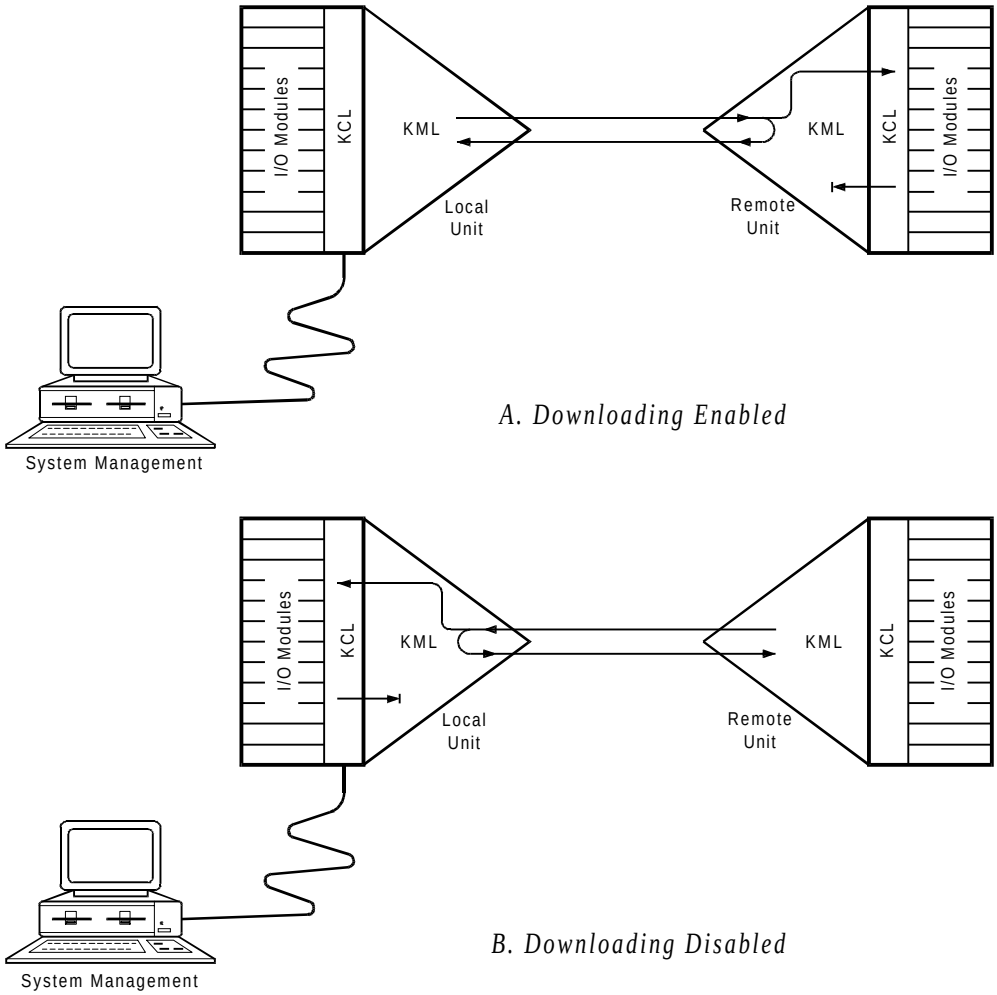

Figure 5-2. Remote Main Link Loop, Signal Paths

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Remote Main Link Loop with Downloading Disabled – Normal Indications and Fault Isolation

- The TEST indicator of the local KILOMUX-2000 lights.
- The TXD and RXD indicators of the local and remote KILOMUX-2000 units must light, and the LOCAL SYNC LOSS indicator of the remote KILOMUX-2000 unit must be off.

If there is a problem, trace the fault by checking the indications in the order given below:

- If the TXD indicator of the remote KILOMUX-2000 unit does not light, the fault occurred in the remote KILOMUX-2000 unit: check by performing a local main link loop on the remote unit.
- If the TXD indicator of the remote KILOMUX-2000 unit lights but the RXD indicator of the local KILOMUX-2000 unit does not light, probably there is a problem in the transmit path to the local unit. There is however a low probability that the fault occurred in the local or remote KILOMUX-2000 units: check by performing local main link loops.
- If the RXD indicator of the local KILOMUX-2000 unit lights, but its TXD indicator is off, the local KILOMUX-2000 unit is defective.
- If the TXD indicator of the local KILOMUX-2000 unit lights but the remote RXD indicator is off, probably there is a problem in the transmit path to the remote unit. There is however a low probability that the fault occurred in the remote KILOMUX-2000 unit: check by performing a local main link loop on the remote unit.
- If the RXD indicator of the remote KILOMUX-2000 unit lights, but its LOCAL SYNC LOSS indicator lights, a fault is present. The fault is in the remote KILOMUX-2000: check by performing a local main link loop.

Local Main Link Modem Loop – Loop 3

The main purpose of the main link modem loop 3 is to check the connections between the KML module and the local modem. Usually, this loop is activated after the remote main link loop fails but both the local and the remote KILOMUX-2000 units successfully pass the local main link loops. If this loop is successful, the next loop to be performed is the remote main link modem loop, loop 2.

Therefore, as a rule, perform loop 3 only after successfully performing a local main link loop on the local KILOMUX-2000 unit.

Main Link Loop 3 – Signal Path

When loop 3 is activated on a modem that supports this function, the KILOMUX-2000 transmit signal is returned by the local modem on the receive path. The loop signal path is shown in figure 5-3.

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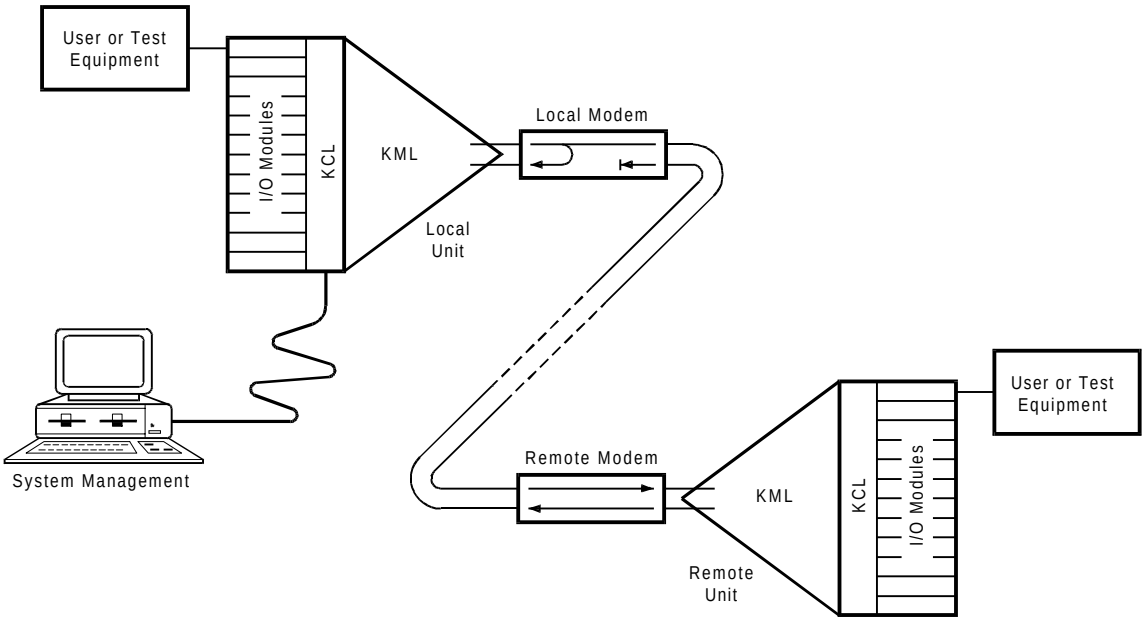

Figure 5-3. Main Link Modem Loop 3, Signal Path

Main Link Loop 3 – Normal Indications and Fault Location

- The TEST indicator of the KILOMUX-2000 lights. If downloading is enabled, the loop will be displayed under the REM TEST ST menu of the remote KILOMUX-2000.
- The TXD and RXD indicators of the local KILOMUX-2000 must light, and the LOCAL SYNC LOSS indicator must be off. If not, the connections to the modem, or the modem itself, are defective.

Remote Main Link Modem Loop - Loop 2

The main purpose of the main link modem loop 2 is to check the link between the two modems that serve the main link. As a rule, perform loop 2 only after successfully performing loop 3 on the local KILOMUX-2000 unit.

Main Link Modem Loop 2 – Signal Path

When loop 2 is activated on a modem that supports this function, the remote modem returns the receive signal toward the local modem, therefore the local KILOMUX-2000 transmit signal is returned to the receive path.

The loop signal path is shown in figure 5-4.

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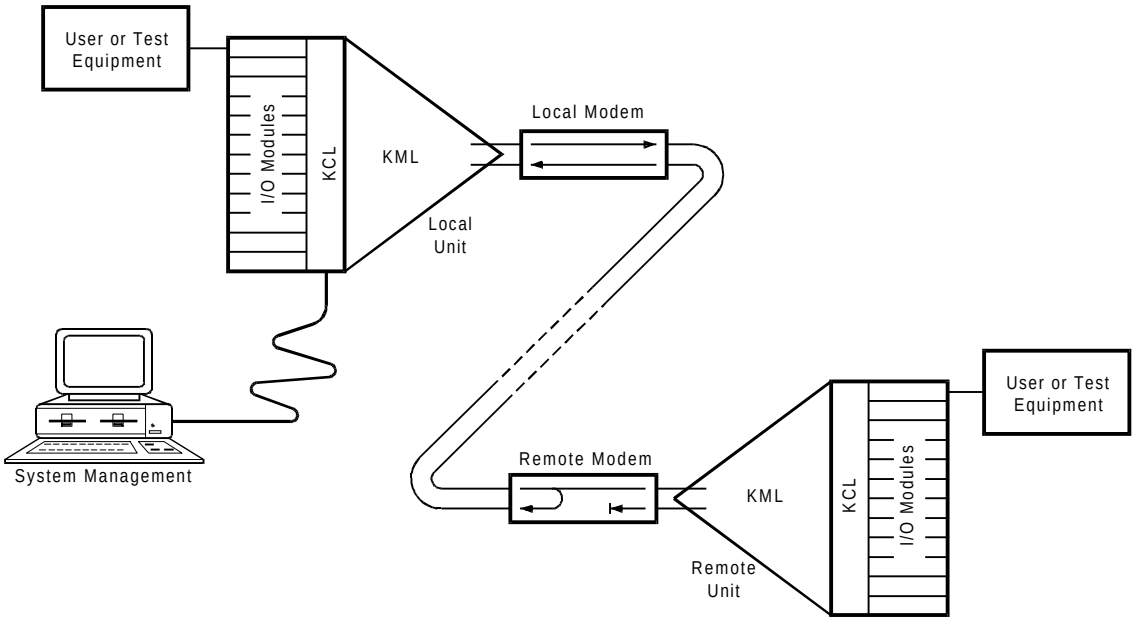

Figure 5-4. Main Link Modem Loop 2, Signal Path

Main Link Modem Loop 2 – Normal Indications and Fault Location

- The TEST indicator of the KILOMUX-2000 lights. If downloading is enabled, the loop will be displayed under the REM TEST ST menu of the remote KILOMUX-2000.
- The TXD and RXD indicators of the local KILOMUX-2000 must light, and the LOCAL SYNC LOSS indicator must be off. If not, the connections and/or the link between the two modems, or the modems, are defective.

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5.3 I/O Module Loops and Tests

General

The tests available for I/O modules depend on the module type, however in general all the I/O modules support local and remote channel loops, and the monitoring of the transmit and receive activity and of the main control signals by means of the front-panel indicators.

In addition, the KILOMUX-2000 supports module-specific tests:

- For data I/O modules, the KILOMUX-2000 provides PRBS transmission and BERT testing on individual channels. PRBS transmission allows to supply a test signal to a data channel, and the BERT test provides a quick qualitative check of transmission performance without requiring external data transmission test equipment.
- For voice I/O modules, the KILOMUX-2000 provides test tone injection. The test tone can be heard by the subscribers connected to the voice channels, thus providing a quick qualitative check of the voice path.

For specific information on the tests available for each I/O module, refer to the corresponding module operator's manual contained in Part II of this manual.

Local Channel Loop

When a local loop is activated on a channel of an I/O module, the channel transmit signal is returned to the channel receive path. The transmit signal is still connected to the transmit path and reaches the remote user. While the loop is connected, the local user equipment must receive its own signal. The loop signal path is shown in figure 5-5. This loop provides a quick check of the connections to the local user equipment.

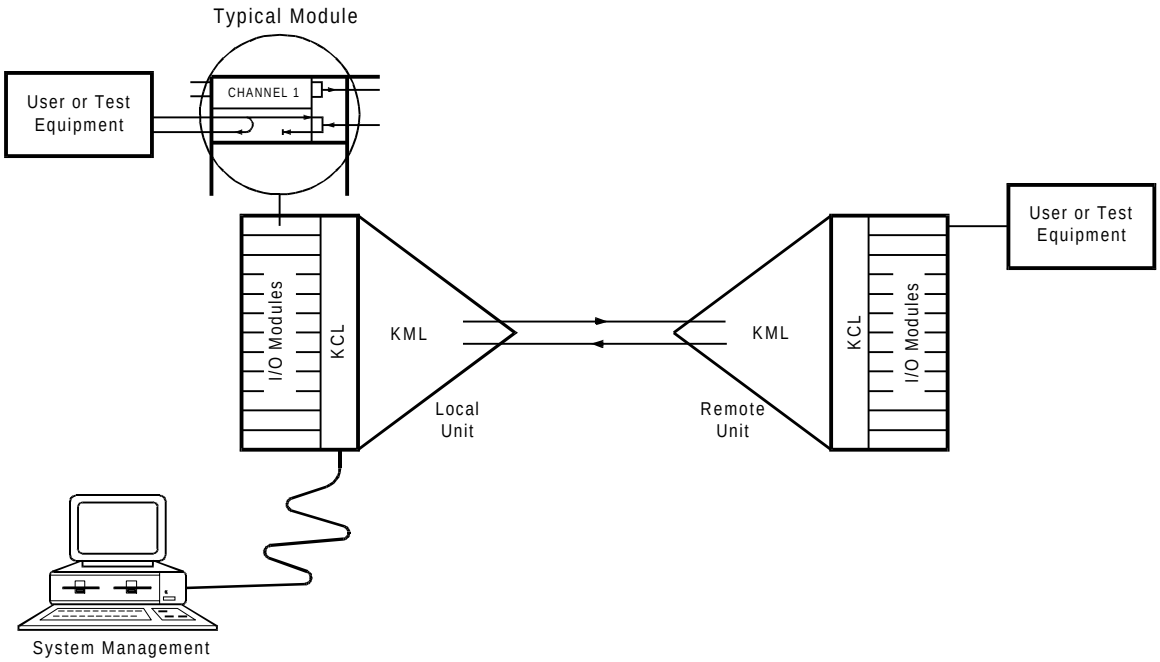

Figure 5-5. I/O Module, Local Loop on Individual Channel

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Remote Channel Loop

The signal path depends on the downloading state:

- If downloading is enabled and a remote channel loop is activated on a channel of the local KILOMUX-2000 unit, the I/O module of the remote KILOMUX-2000 unit loops back the channel receive signal toward the local channel. The received signal remains connected as usual to the receive path of that unit. The loop signal path is shown in figure 5-6.A. This loop allows the local user to perform a quick check of the end-to-end transmission on this channel.
- If downloading is disabled, the remote loop is connected on the local KILOMUX-2000 unit, i.e., the local I/O module returns the receive signal of the tested channel toward the remote KILOMUX-2000. The loop signal path is shown in figure 5-6.B. This loop allows the remote user to perform a quick check of the end-to-end transmission on this channel.

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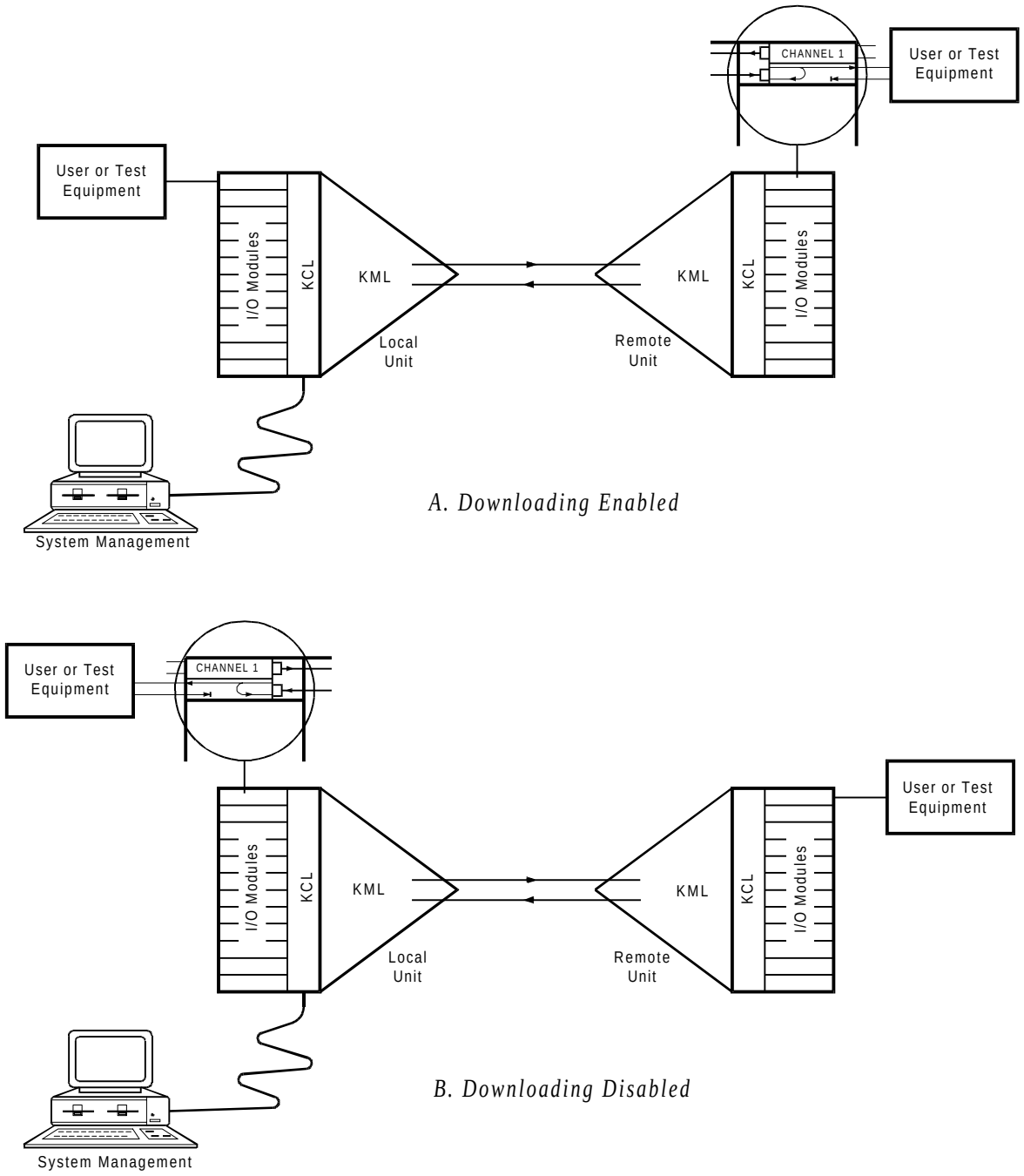

Figure 5-6. I/O Module, Remote Loop on Individual Channel

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Handling of ITU-T Rec. V.54 Loops

The handling of the ITU-T Rec. V.54 loops depends on the module type:

- In general, when the user data equipment (DTE) is connected to a data I/O module channel, the user's DTE can initiate ITU-T Rec. V.54 loops on the KILOMUX-2000 channel by means of the dedicated loop activation lines, and the state of the loop activation lines can be displayed on the front-panel LCD. The following sections explain what happens in this case.
- For KLS.1 data channels, it is also possible to transfer end-to-end the state of the dedicated loop activation lines, as explained in section 3-12 , and to issue loop commands using the Test Option control function. Note that the additional end-to-end transfer capability is available under the following conditions:
  - Two KLS.1 modules are operated in a link.
  - The data channels of the KLS.1 at one end of the link are configured with DCE interfaces, and those of the KLS.1 at the other end are configured as DTE.

  The results of the ITU-T Rec. V.54 loop requests transferred in this way depend on the type of equipment connected to the KLS.1 data channel, and are not covered in this manual.

Local Channel ITU-T Rec. V.54 Loop – Loop 3

The channel ITU-T Rec. V.54 loop 3 command is sent by the user's DTE, using the dedicated loop 3 activation line in the interface connector of a data I/O module channel.

The command activates a local channel loop on the local KILOMUX-2000 channel (loop signal path is shown in figure 5-5).

Remote Channel ITU-T Rec. V.54 Loop – Loop 2

The channel ITU-T Rec. V.54 loop 2 command is sent by the user's DTE, using the dedicated loop 2 activation line in the interface connector of a data I/O module channel.

The response to a ITU-T Rec. V.54 loop 2 command depends on the state of the downloading function:

- If downloading is disabled, a ITU-T Rec. V.54 loop 2 command has no effect.
- If downloading is enabled, a ITU-T Rec. V.54 loop 2 command results in the activation of a remote channel loop (on the remote KILOMUX-2000 channel, as shown in figure 5-6).

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PRBS Transmission

The PRBS transmission function is used to provide a test signal to a channel of a data I/O module. By activating a local or remote main link loop, or a remote channel loop (or by connecting an external loop) while PRBS transmission is activated, this function can also be used to obtain a qualitative evaluation of data transmission without using external test equipment.

Data transmission is checked by applying a 2^9 - 1 (511) bit pseudo-random sequence generated by an internal test sequence generator to the input of the tested channel transmit path. The transmitted data is returned by means of a loop somewhere along the data path (e.g., by connecting a remote channel loop if downloading is enabled, or a local main link loop) to the receive path of the module. The received signal is routed to a test sequence evaluator. The evaluator compares the received data, bit by bit, to the original data and detects any difference (bit error). The output of the evaluator is sampled during module polling, to check whether errors were detected in the interval between consecutive pollings.

The test results are displayed as follows:

- On the LCD located on the KILOMUX-2000 front panel, the result is displayed either as GOOD (no error has been detected during the last interval), or BAD (at least one error has already been detected). Note that if no loop is present along the signal path, the BAD result is expected, and does not indicate any problem.
- On a supervision terminal, the test results are displayed as a number in the range of 0 (no errors detected during the current measurement interval) thru 9999. The number of errors is accumulated from the activation of the PRBS transmission.

During PRBS transmission, the tested channel is disconnected from the user data equipment, and the DSR line is turned off. At any time, PRBS transmission can be activated on only one channel of each data I/O module installed in the KILOMUX-2000 unit.

BERT Testing

The BERT test is used to evaluate data transmission through a selected channel of a data I/O module without using external test equipment. The BERT test can be activated only when the downloading function is enabled, and the link to the remote KILOMUX-2000 operates normally.

The BERT test is similar to the PRBS transmission test, except that before the evaluation of the received data starts, a remote channel loop is activated. This should cause the sequence to be transmitted along the full path. The test results are displayed as for PRBS transmission.

As for PRBS transmission, the BERT test can be activated on only one channel of each data I/O module installed in the KILOMUX-2000 unit, the tested channel is disconnected from the user data equipment, and its DSR line is turned off.

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Tone Injection

The test tone is a data sequence repeating at a rate of 1 kHz. This data sequence is identical to the data sequence that would have been generated if a 1 kHz signal having a nominal level of 1 mW (0 dBm0) were applied to the input of the channel codec.

The test tone is connected directly to the output of the tested channel transmit path, instead of transmitting the subscriber transmit signal. The tone can be connected to only one channel of a voice module at a time. Tone injection automatically disconnects the local subscriber signal.

Figure 5-7 shows the signal paths.

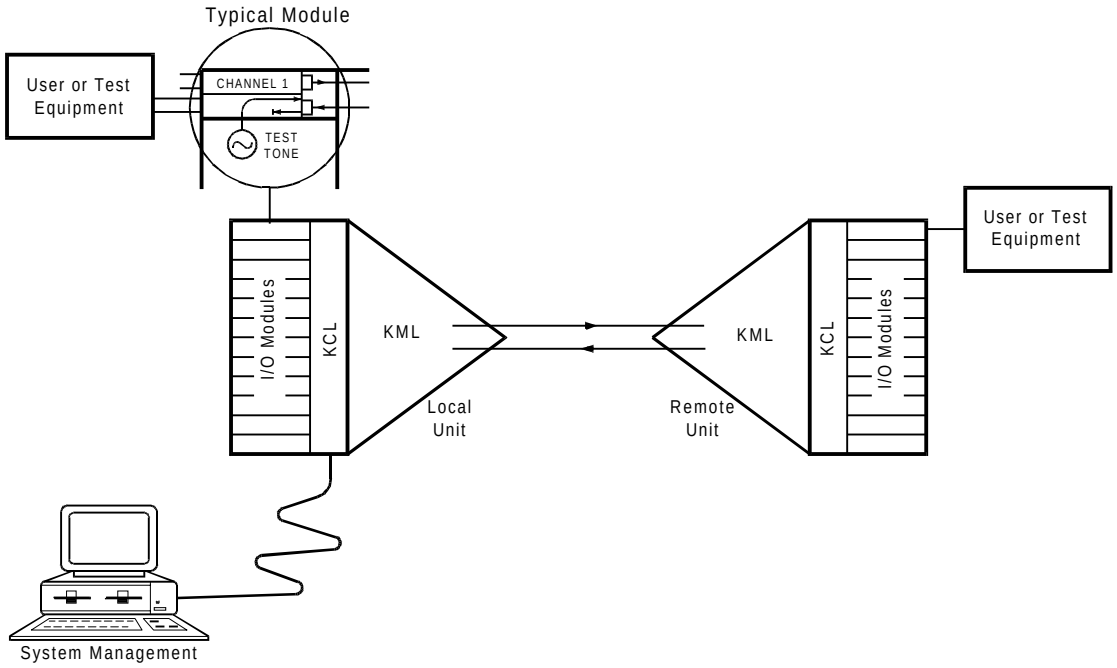

Figure 5-7. Voice I/O Module, Test Tone Injection Path

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Appendix A
Connection Data

A.1 Scope

This Appendix provides information on the type and pin allocation of the interface connectors installed on the various KILOMUX-2000 modules.

In the direction field, the following conventions are used:

IN - input to KILOMUX-2000

OUT - output from KILOMUX-2000

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A.2 Common Logic Module, KCL.1

SP Connector

The module supervision connector is a 25-pin D-type female connector, designated SP (CONTROL DCE).

- The allocation of pins in the SP connector with DCE emulation (used for direct connection to the supervisory terminal) is given in Table A-1.
- The pin functions with DTE emulation (used when a cross-over cable is used for connection to a modem that provides the link to the supervisory terminal) is given in Table A-2.

Table A-1. Common Logic Module KCL.1, SP Connector Pin Allocations for DCE Emulation

Pin	Designation	Direction	Function
1	FGND	–	Frame ground
2	TD	IN	TX data
3	RD	OUT	RX data
4	RTS	IN	Request to send
5	CTS	OUT	Clear to send
6	DSR	OUT	Data set ready
7	SGND	–	Signal ground
8	DCD	OUT	Carrier detect
9	+12V	OUT	See Note 1
10	-12V	OUT	See Note 1
11	RELAY M	IN/OUT	Alarm relay NC contact
12	RELAY F	IN/OUT	Alarm relay common
13	RELAY B	IN/OUT	Alarm relay NO contact
14	ALARM	OUT	Alarm indication
20	DTR	IN	Data terminal ready
25	RI	IN	Ring indicator

Notes

1. *Pins 9, 10 are connected to the +12V and -12V lines through a 300 ohm, 1/2W series resistor.*
2. *Direction: IN - input to KILOMUX-2000*
   OUT - output from KILOMUX-2000

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Table A-2. Common Logic Module KCL.1, SP Connector Pin Allocations for DTE Emulation

Pin	Designation	Direction	Function
1	FGND	–	Frame ground
2	TD	IN	TX data
3	RD	OUT	RX data
4	DCD	IN	Carrier detect
5	CTS	–	Not connected
6	DTR	OUT	Data terminal ready
7	SGND	–	Signal ground
8	RTS	OUT	Request to send
9	+12V	OUT	See Note 1
10	-12V	OUT	See Note 1
11	RELAY M	IN/OUT	Alarm relay NC contact
12	RELAY F	IN/OUT	Alarm relay common
13	RELAY B	IN/OUT	Alarm relay NO contact
14	ALARM	OUT	Alarm indication
20	DSR	IN	Data set ready
25	RI	IN	Ring indicator

Note

1. *Pins 9, 10 are connected to the +12V and -12V lines through a 300 ohm, 1/2W series resistor.*
2. *Direction: IN - input to KILOMUX-2000*
   OUT - output from KILOMUX-2000

DP Connector

The DP connector is a 9-pin female connector, wired in accordance with Table A-3, intended for direct connection to a dial-up modem:

- The connection of the DP connector to a dial-up modem terminal having a 9-pin connector is made by means of a straight cable.
- The connection to a dial-up modem with 25-pin connector should be made using a cable wired in accordance with the ***Connection to Dial-up Modem with 25-pin Connector*** column of Table A-3.

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Table A-3. Common Logic Module KCL.1, DP Connector Pin Allocations

Pin	Line	Direction	Connection to Dial-Up Modem with 25-pin Connector
1	Data Carrier Detect (DCD)	IN	8
2	Receive Data (RD)	IN	3
3	Transmit Data (TD)	OUT	2
4	Data Terminal Ready (DTR)	OUT	20
5	Signal Ground (SIG)	Common reference and DC power supply ground	7
6	Data Set Ready	IN	6
7	Request to Send (RTS)	OUT	4
8	Clear to Send (CTS)	IN	5
9	Ring Indicator (RI)	IN	22

A.3 DC Power Input Connector

The DC input power connector used on the KPS.3, KPS.5, KPS.7, and DC-powered KM-RINGER modules is a circular 3-pin male connector. Connector pin functions are given in Table A-4.

Table A-4. -48 VDC (-24 VDC) Connector Wiring

Pin	Function
1	Ground
2	Not connected
3	Negative supply line (-48 VDC or -24 VDC)

A.4 DC Output Connector

The OUTPUT connector located on the KM-RINGER module is a circular 3-pin female connector. Connector pin functions are given in Table A-5.

Table A-5. OUTPUT Connector Wiring

Pin	Function
1	Ground
2	+72 VDC
3	-48 VDC

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Appendix B
Alarms

B.1 Alarm Messages

The KILOMUX-2000 generates two types of alarms, designated as state and event.

- A message indicating a ***state*** alarm is displayed only when the alarm condition is present, and is automatically removed when the condition is cleared (if the alarm is being displayed, it will disappear only when the display is refreshed by scrolling).
- A message indicating an ***event*** alarm persists even after the event that caused the alarm condition is cleared.

The alarm messages can be displayed on the front-panel LCD, and are also sent to the supervision terminal or management station.

Alarms intended for display on the LCD are stored in the alarm buffer for the LCD display, which can store one alarm event of each type. The KILOMUX-2000 operator can view the contents of the alarm buffer, and can clear event alarms. This procedure is explained in section 3-9.

Table B-1 lists the alarm messages displayed by the KILOMUX-2000. For each alarm, two versions are given: a concise version (maximum 16 characters) displayed on the LCD, and the version sent to the terminal. In addition to the text, each message has a code number. Table B-1 lists the messages in ascending order of their code numbers, and in addition, indicates their type (state or event) and lists the actions required to correct the alarm condition. Perform the corrective actions in the given order, until the problem is corrected.

If the problem cannot be corrected by carrying out the listed actions, have the KILOMUX-2000 checked by the technical support personnel.

Note *In the following table, A indicates the slot number contained in the alarm message.*

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Table B-1. LCD Alarm Messages

Code	Message		Alarm Type	Interpretation
	LCD	Terminal		
1	PHASOR OVF	PHASOR OVERFLOW, SLOT A	Event	Internal overflow in the buffer of the specified module (a KML module - slot number 3 or 4 - data I/O module - slot number 7 through 18), due to difference in clock rates or insufficient buffer size. Make sure that the timing modes of the KILOMUX-2000 main link and I/O module are compatible. If the main link passes through a satellite link, make sure the buffer size is ±256 bits
2	HDR FAILURE	HARDWARE FAILURE, SLOT A	State	A technical failure has been detected in the module installed in the specified slot (3, 4, 7 through 18). Replace the module
3	LOC SYNC LOSS	LOCAL SYNC LOSS	State	The KML module installed in the specified slot (3 or 4) lost synchronization to the incoming data stream. May indicate a configuration error or a technical failure
4	B.R.G FAIL	B.R.G FAILURE, SLOT A		The baud rate generator of the module installed in the specified slot (7 through 18) failed. Replace the module
5	PS-A 5V FAIL	PS-A 5V FAILURE	State	The 5V voltage provided by the KPS-A module is missing or is out of the allowable limits. Replace the module
6	PS-A 12V FAIL	PS-A 12V FAILURE	State	One or both of the ±12V voltages provided by the KPS-A module is missing or is out of the allowable limits. Replace the module
7	PS-B 5V FAIL	PS-B 5V FAILURE	State	The 5V voltage provided by the KPS-B module is missing or is out of the allowable limits. Replace the module
8	PS-B 12V FAIL	PS-B 12V FAILURE	State	One or both of the ±12V voltages provided by the KPS-B module is missing or is out of the allowable limits. Replace the module
9, 10	DB 1 CHKSUM ERR DB 2 CHKSUM ERR	DB 1 CHKSUM ERROR DB 2 CHKSUM ERROR	Event	The checksum of one of the data bases stored by the KCL module does not match the checksum calculated after power-up. The default data base must be loaded

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Table B-1. LCD Alarm Messages (Cont'd)

Code	Message		Alarm Type	Interpretation
	LCD	Terminal		
11	BANDWIDTH OVF	BANDWIDTH OVERFLOW	State	The total bandwidth required for the active channels exceeds the main link data rate. Change channel configuration as required, or increase the main link data rate
12	ALM BUFFER OVF	ALARM BUFFER OVERFLOW	State	The number of alarms stored in the KILOMUX-2000 alarm buffer exceeds the maximum allowable number (100). New alarms are now written over previous alarms
13	FALLBACK CLK USE	CLOCK WAS CHANGED TO FALLBACK	State	The fallback timing reference source has been selected for use
14	INTERNAL CLK USE	CLOCK WAS CHANGED TO INTERNAL	State	The internal oscillator is now used as a timing reference source, as a result of the simultaneous failure of both the master and fallback clock sources
15	CL HDR FAILURE	CL HARDWARE FAILURE	State	A technical failure has been detected in the KCL module circuits. Replace the module.
16	REM SYNC LOSS	REMOTE SYNC LOSS, SLOT A	State	The KML module installed in the specified slot A (3 or 4) of the remote KILOMUX-2000 unit lost synchronization. This message is displayed only when downloading is enabled
17	DOWNLOAD ERROR	DOWNLOAD ERROR	State	Errors are detected in the data received through the management channel
18	I/O SYNC LOS	I/O SYNC LOSS, SLOT A	State	The KLS.2 module installed in the specified slot (7 through 18) of the local KILOMUX-2000 unit lost synchronization
19	ML FLIP MAIN LINK FLIP	OCCURRED OCCURRED	Event	The KILOMUX-2000 switched to operation on the second main link. This message can be displayed only when the redundancy mode is used
20	ML SIGNAL LOSS	ML LOSS OF SIGNAL, SLOT A	State	The KML.5 module installed in the specified slot A (3 or 4) does not receive data (only for KML.5 module)
21	MODULE REMOVE	MODULE WAS REMOVED, SLOT A	Event	The module that was previously installed in the specified slot (3, 4, and 7 through 18) has been physically removed, or has been reset, or the communication with the module failed

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Table B-1. LCD Alarm Messages (Cont'd)

Code	Message		Alarm Type	Interpretation
	LCD	Terminal		
22	BACKUP DIAL FAIL	MAIN LINK BACKUP DIAL FAILURE	Event	The connection of the switched backup link failed. This message can be displayed only when the switched backup mode is selected
23	BACKUP ML ACTIVE	SWITCHED BACKUP ML IS ACTIVE	Event	The switched backup link has been successfully connected and is actively carrying traffic. This message can be displayed only when the switched backup mode is selected
24	ML RECOVERY	MAIN LINK RECOVERY	Event	The main link has returned to normal operation. This message can be displayed only when the switched backup or priority bumping mode is selected
25	PB FLIP TO ML-A ACTIVE	MAIN LINK FLIP, ML-A	Event	Main link A is now the active link, after a flip from link B. This message can be displayed only when the priority bumping mode is selected
26	PB FLIP TO ML-B ACTIVE	MAIN LINK FLIP, ML-B	Event	Main link B is now the active link, after a flip from link A. This message can be displayed only when the priority bumping mode is selected
27	DB SWITCH TO DB1	DATABASE SWITCH TO DATABASE 1	State	The local KILOMUX-2000 unit automatically switched to data base 1, in accordance with the time specified by means of the DEF DB FLIP
28	DB SWITCH TO DB2	DATABASE SWITCH TO DATABASE 2	State	The local KILOMUX-2000 unit automatically switched to data base 2, in accordance with the time specified by means of the DEF DB FLIP
29	PSWRD DW IS ON	PSWRD SWITCH IS ON	Event	The local KILOMUX-2000 unit automatically switched to data base 2, in accordance with the time specified by means of the DEF DB FLIP
30	SP-PAR DW IS ON	SP-PAR SWITCH IS ON	Event	The PSWRD switch of the KCL module is ON. This enforces the default password
31	DB-INIT DW IS ON	DB-INIT SWITCH IS ON	Event	The SP-PARM switch of the KCL module is ON. This enforces the default supervisory port parameters

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Table B-1. LCD Alarm Messages (Cont'd)

Code	Message		Alarm Type	Interpretation
	LCD	Terminal		
32	RTC BATTERY FAIL	REAL TIME CLOCK BATTERY FAILURE	Event	The DB-INIT switch of the KCL module is ON. This will result in the loading of the default data base parameters when the KILOMUX-2000 will be turned on or reset
33	VOICE S.LOS	VOICE SYNC LOSS, CH	State	The voltage of the battery that provides power to the internal real time clock is too low for proper operation and must be replaced as soon as possible. The battery test is performed during the power-up test only
34	MODEM LOOP	TAIL-END MODEM ON LOOP, CH	State	The channel specified by B (1 or 2) of the KVC.2 module installed in the slot specified by A (7 through 18) of the local KILOMUX-2000 unit lost synchronization
35	CSU LBK	CSU LBK, SLOT A	State	The tail-end modem connected to the channel specified by B (1 or 2) of the KLS.1 module installed in the slot specified by A (7 through 18) of the local KILOMUX-2000 unit reports a loop
36	IDLE SEQ	IDLE SEQUENCE, SLOT A	State	The KML.6 module installed in slot A (3 or 4) performs a CSU loopback in response to a network loopback request
37	OUT OF SERV	ML OUT OF SERVICE, SLOT A	State	The KML.6 module installed in slot A (3 or 4) reports the recognition of an idle code in the data received from the network
38	OUT OF FRAME	ML OUT OF FRAME, SLOT A	State	The KML.6 module installed in slot A (3 or 4) reports the recognition of an out-of-service code in the data received from the network
39	DSU LOOPBACK	DSU LOOPBACK, SLOT A	State	The KML.6 module installed in slot A (3 or 4) reports the recognition of an out-of-frame code in the data received from the network
40	LINK ERROR	KTRE/KMBE LINK ERROR, SLOT A	State	The KML.6 module installed in slot A (3 or 4) performs a DSU loopback in response to a network DSU loopback request
41	LAN ERROR	KTRE/KMBE LAN ERROR, SLOT A	State	The KTRE or KMBE module installed in slot A (7 through 18) of the local KILOMUX-2000 unit has lost communication with the remote side

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Table B-1. LCD Alarm Messages (Cont'd)

Code	Message		Alarm Type	Interpretation
	LCD	Terminal		
42, 43	VOICE S.LOS	VOICE SYNC LOSS, CH	State	The KTRE or KMBE module installed in slot A (7 through 18) of the local KILOMUX-2000 unit reports that the LAN insertion process failed
44	KDI FRAME OVF	KDI FRAME OVERFLOW	Event	Frame overflow occurred. This usually happens because the timing of link A is not locked to the timing of link B
45	PIGB HRD ERR	PIGGY-BACK HARDWARE ERROR A	State	The KML.7 module installed in the specified slot reports a hardware problem on the T1 interface board
46	NETWORK LLB	NETWORK LLB, SLOT A	Event	A network-initiated line loopback has been activated. This loopback cannot be disconnected by the system management.
47	NETWORK PLB	NETWORK PLB, SLOT A	Event	A network-initiated payload loopback has been activated. This loopback cannot be disconnected by the system management.
48	DRIVER FAIL	DRIVER FAIL, SLOT A	State	The KML.8 module installed in the specified slot reports a hardware failure in the E1 line driver
49	SIGNAL LOSS	SIGNAL LOSS, SLOT A	State	The KML.8 module installed in the specified slot reports a loss of input signal
50	EXECIVE BPV	EXECIVE BPV, SLOT A	State	The number of coding errors detected in the main link signal received by the active main link module is too high (the bipolar violation rate exceeds 1×10^6 for 1000 consecutive seconds). This may indicate a fault in the link or in the link transmission equipment, or a failure in the active main link module
51	AIS OCCURED	AIS OCCURED, SLOT A	State	The Alarm Indication Signal (AIS), a framed "all ones" sequence, is received on the main link
52	AIS RED ALM	AIS RED ALM, SLOT A	State	The local frame synchronization has been lost because of AIS reception
53	AIS SYNC LOS	AIS SYNC LOSS, SLOT A	State	The local frame synchronization has been lost because of AIS reception
54	RED ALARM	RED ALARM, SLOT A	State	Local main link module lost synchronization to incoming data stream. May indicate a configuration error or a technical failure. For T1 links, this condition is the red alarm

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Table B-1. LCD Alarm Messages (Cont'd)

Code	Message		Alarm Type	Interpretation
	LCD	Terminal		
55	E1.L.SYN LOS	E1 LOCAL SYNC LOSS, SLOT A	State	Local main link module lost synchronization to incoming data stream. May indicate a configuration error or a technical failure. For T1 links, this condition is the red alarm
56	L MF ALARM	LOCAL MF S.LOSS, SLOT A	Event	On an E1 link operating with 256S framing, the local module has lost multiframe synchronization
57	R MF ALARM	REMOTE MF S.LOSS, SLOT A	Event	On an E1 link operating with 256S framing, the remote equipment has lost multiframe synchronization
58	YELLOW ALM	YELLOW ALARM, SLOT A	State	Remote equipment lost synchronization to the incoming data stream. May indicate a configuration error or a technical failure. For T1 links, this condition is the yellow alarm
59	E1.R.SYN LOS: A	E1 REMOTE SYNC LOSS SLOT A	State	The KML.8 module installed in the specified slot reports remote loss of frame alignment (A stands for the main link slot number, 3 or 4)
60	FRAME SLIP	FRAME SLIP, SLOT A	Event	A main link frame slip has occurred. This is usually caused by incorrect selection of clock sources
61	BPV ERROR	BPV ERROR, SLOT A	State	The number of coding errors detected in the main link signal received by the active module is too high (the bipolar violation rate exceeds 1×10^{-6} for 1000 consecutive seconds). This may indicate a fault in the link or in the link transmission equipment, or a failure in the active main link module
62	EXE ERR RAT	EXECIVE ERR RATIO, SLOT A	State	The error rate detected on the frame synchronization bits is high (as defined by ITU-T Rec. G.732), and may indicate hardware problems or defective connections.
63	CRC-4 ERROR	CRC-4 ERROR, SLOT A	Event	The main link module reports the detection of a CRC error.
64	B.R.G FAILE	SFIFO B.R.G FAIL, SLOT A	State	The baud rate generator of the specified module failed. Replace the module

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Table B-1. LCD Alarm Messages (Cont'd)

Code	Message		Alarm Type	Interpretation
	LCD	Terminal		
65	SFIFO SLIP	SFIFO SLIP, SLOT A	Event	The KML.7 module installed in the specified slot reports that a slip occurred in the SFIFO
66	INT CLK USE	INTERNAL CLOCK IN USE, SLOT A	State	The internal oscillator has been selected as a timing reference sources, as a result of simultaneous failure of both the master and fallback clock sources
67	DP - DIAL FAIL	DP CYCLE DIAL FAILED	Event	The dial-out cycle failed, and the redial attempts stopped until a new alarm reported
68	DP PRI CALL FAIL	DP PRIMARY CALL FAILED	Event	The call setup attempts to the primary dial-out directory number failed
69	DP ALT.CALL FAIL	DP ALTERNATE CALL FAILED	Event	The call setup attempts to the alternate dial-out directory number failed
70	FRAMER CARD FAIL	FRAMER CARD FAILED CH	State	The master KVF.5 module failed

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B.2 Configuration Error Messages

The KILOMUX-2000 provides configuration error messages for the LCD and for the supervision terminal.

- The configuration error messages displayed on the LCD have the format CONFIG ERROR, followed by a numerical code.
- The configuration messages have the format ERROR, followed by the numerical code, and a concise textual description of the error condition.

The error messages are explained below:

ERROR 01 **ILLEGAL MASTER CLOCK SOURCE (CARD TIMING/SPEED)**
Illegal source for a master clock timing reference source: the selected channel is not operating in the DTE2 mode.

ERROR 02 **ILLEGAL FALLBACK CLOCK SOURCE (CARD TIMING/SPEED)**
Illegal source for a fallback clock timing reference source: the selected channel is not operating in the DTE2 mode.

ERROR 03 **ILLEGAL ML LOOP COMBINATION**
You are trying to activate simultaneously local and main link loops, or both types of ITU-T Rec. V.54 main link loops (LOOP 2 and LOOP 3). This combination is not allowed (see Table 3-7).

ERROR 04 **ILLEGAL I/O MODULE LOOP COMBINATION**
You are trying to activate simultaneously both a local and remote loop or PRBS transmission, or BERT test, or tone injection, on the same channel. None of these combinations are allowed (see Table 3-7).

ERROR 05 **ILLEGAL COMBINATION OF CHANNEL SPEED AND PROTOCOL**
Conflict in the channel parameters of the KLS.1 module being configured: you are trying to select a data rate of 38.4 kbps, but the channel is configured for asynchronous operation. The maximum data rate for asynchronous operation is 19.2 kbps.

ERROR 06 **ILLEGAL NUMBER OF MODULE CONTROL SIGNALS**
The number of control signals that can be transmitted for any module is none, 1, 2 or 4. You are trying to select a forbidden value, e.g., you cannot select RTS on one channel of a given module, and DTR and RTS on another channel of the same module.

ERROR 07 **BANDWIDTH OVERFLOW - ML-<A or B; nothing or PRIORITY>**
The total bandwidth required for the active channels exceeds the main link data rate. Change channel configuration as required, or increase the main link data rate.
During the definition of channel connections (DEF CON command):

- For dual-link operation: the number of channels you want to connect to a given main link requires a bandwidth that exceeds the available main link bandwidth.
- For priority bumping operation: the number of channels assigned HIGH priority requires a bandwidth that exceeds the available main link bandwidth.

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ERROR 08 **MASTER AND FALLBACK CLOCKS ARE SAME**

You cannot select the same data channel as both main and fallback reference timing source.

ERROR 09 **ILLEGAL COMBINATION OF CHANNEL AND ML-<A or B> SPEED**

- You are trying to select a channel rate of 192 kbps on a KHS.1 channel while the main link data rate is 256 kbps. This combination is not allowed, therefore you must either increase the main link data rate or reduce the channel rate.
- You are trying to connect a KVC.1 card when the main link data rate is 768 kbps. This combination is not allowed.

ERROR 10 **ILLEGAL LOOP COMBINATION INVOLVING ML REMOTE LOOP**

You are trying to activate (on either KILOMUX-2000) an illegal combination of loops which includes the remote main link loop (refer to Table 3-7).

ERROR 11 **ILLEGAL LOOP COMBINATION INVOLVING ML LOCAL LOOP**

You are trying to activate (on either KILOMUX-2000) an illegal combination of loops that includes the local main link loop. This combination is not allowed (refer to Table 3-7).

ERROR 12 **ILLEGAL LOOP COMBINATION INVOLVING I/O REMOTE LOOP**

You are trying to activate (on either KILOMUX-2000) an illegal combination of loops that includes a remote channel loop (refer to Table 3-7).

ERROR 13 **ILLEGAL LOOP COMBINATION INVOLVING I/O BERT**

You are trying to activate a BERT test on both KILOMUX-2000 units.

ERROR 14 **ILLEGAL LOOP COMBINATION INVOLVING ML V.54 LOOP2**

You are trying to activate (on either KILOMUX-2000) an illegal combination of loops that includes a main link ITU-T Rec. V.54 loop 2 (refer to Table 3-7).

ERROR 15 **ILLEGAL LOOP COMBINATION INVOLVING ML V.54 LOOP3**

You are trying to activate (on either KILOMUX-2000) an illegal combination of loops that includes a main link ITU-T Rec. V.54 loop 3 (refer to Table 3-7).

ERROR 16 **ILLEGAL KLS.2 COMPOSITE AND ML-<A or B> SPEED COMBINATION**

The KILOMUX-2000 main link rate is 256 or 384 kbps, and you are trying to configure a KLS.2 module for a composite data rate of 2.4 kbps. This combination of main link and composite data rates is not allowable, because it would require oversampling.

ERROR 17 **ML MODE NOT COMPATIBLE WITH I/O SLOT LINK SELECT**

The selected main link mode is not compatible with the selections made for the I/O modules, i.e., some modules have been connected to main link A and others to main link B, but the current main link mode is SINGLE, REDUNDANCY, or SWITCHED BACKUP.

ERROR 18 **TIMING/SPEED NOT COMPATIBLE WITH ML MODULE TYPE**

You are trying to select a timing mode and/or speed that is not supported by the installed KML module.

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ERROR 19 **ILLEGAL ML MODE FOR WORKING WITH LCD**
The main link mode selected by the operator on the KILOMUX-2000 front panel is not allowed, because the required parameters cannot be defined using the front panel controls and the LCD.

ERROR 20 **ILLEGAL COMMAND, MODULE NOT INSTALLED**
The slot whose number has been specified in the command is empty.

ERROR 21 **ILLEGAL COMMAND, CHANNEL IS DISCONNECTED**
The channel whose number is specified in the command is not connected (NC). You must connect the channel before specifying its number in a configuration command.

ERROR 22 **LOOP IS NOT ACTIVE**
You are trying to deactivate a loop that currently is not activated.

ERROR 23 **ILLEGAL LOOP FOR INSTALLED MODULE**
The loop you are trying to activate is not supported by the module whose number has been specified in the command.

ERROR 24 **ILLEGAL COMMAND FOR CURRENT ML MODE**
The command you have entered is not allowed in the current main link mode.

ERROR 25 **CONFLICT BETWEEN CTRL_SIG PARAMETER AND MODULE TYPE**
The value entered in the CONTROL SIGNALING field is not supported by the module whose number has been specified in the command.

ERROR 26 **MODULE TYPE MISMATCH BETWEEN DATABASE AND HARDWARE**
The module type recorded in the KILOMUX-2000 data base differs from the module sensed by the KILOMUX-2000.

ERROR 27 **ILLEGAL CLOCK SELECTION FOR MODULE TYPE**
The selected timing mode is not supported by the module whose number has been specified in the command.

ERROR 28 **ILLEGAL COMMAND FOR INSTALLED MODULE**
The command you have entered is not supported by the module whose number has been specified in the command.

ERROR 29 **ILLEGAL COMMAND FOR SLAVE MUX**
The command you have entered is not supported by KILOMUX-2000 configured as slave units. You can however perform the required activity by sending the same command to the master KILOMUX-2000.

ERROR 30 **ILLEGAL DCD_DEL AND INTERFACE COMBINATION**
The DCD_DEL parameter is not supported by the selected supervisory port interface (the DCD DEL parameter must be 0 when the supervisory port interface is DCE).

ERROR 31 **ILLEGAL COMMAND, DOWNLOAD NOT SUPPORTED**
The command you have entered cannot be executed when downloading is disabled.

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ERROR 32 **ILLEGAL PROTOCOL AND TIMING COMBINATION**
You are trying to select a channel timing mode for a data channel configured for asynchronous operation.

ERROR 33 **REDUNDANT ML NOT INSTALLED**
No redundant KML module is installed.

ERROR 34 **DISCONNECT LOOP BEFORE CONFIGURATION CHANGE**
You are trying to change the configuration while a loop is activate this is not allowed.

ERROR 35 **ILLEGAL TIME DIVISION DEFINITION (<day>)**
The periods defined by means of the DEF AGENDA commands are not correctly sequenced.

ERROR 36 **ILLEGAL DATA BASE FLIP TIME**
You must define two valid data base flip times.

ERROR 37 **CONFLICT IN INTERFACE AND DSR PARAMETER**
You are trying to select DSR=ON after the supervisory port interface has been set to DTE.

ERROR 38 **ILLEGAL COMMAND, ALTERNATE DATA BASE IS ACTIVE**
The command entered by you is not supported on the alternate data base (only DEF commands are supported by it).

ERROR 39 **ILLEGAL OOS METHOD FOR KVC.2/KVF.1 MODULE**
The KVC.2/E&M and KVF.1/E&M module versions support only the FORCED-IDLE and FORCED BUSY methods of OOS signaling. The other module versions do not support OOS signaling.

ERROR 39 **ILLEGAL COMMAND FOR CURRENT SYSTEM TYPE**
The command entered by you is not supported by the KILOMUX-2004.

ERROR 41 **ILLEGAL COMMAND NO CONNECTED CHANNELS**
You are trying to enter a command that is supported only when the channel specified in the command is connected.

ERROR 42 **CONFLICT IN FRAME MODE AND DOWNLOAD**
You can select manual frame bit allocation only when downloading is disabled.

ERROR 43 **ILLEGAL FRAME ALLOCATION**
An incorrect bit allocation has been detected, i.e., the same bits have been assigned to different channels, or the specified start or end bit number is invalid.<F102P10>

ERROR 44 **ILLEGAL LINK CLOCK AND ML MODE COMBINATION**
You can select the main link clock source only when using the dual-link or priority bumping mode, provided a KDI module is installed in the KILOMUX-2000.

ERROR 45 **ILLEGAL LINK CLOCK AND ML TIMING COMBINATION**
When selecting one main link as the clock source, the timing mode of the other main link cannot be DTE or LBT.
If both main links use LBT or DTE timing, the LINK_CLK parameter must be set to NONE.

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ERROR 50 **ILLEGAL COMBINATION OF INTERFACE AND ECHO CANCELLER**

You are trying to disable the echo canceller of a voice module, e.g., KVC.2, etc., when its interface is 2-WIRE. This is not allowable, because when the link connecting between the subscribers includes hybrids, the quality of transmission without echo cancellers is degraded.

ERROR 51 **ML_MODE AND HARDWARE CONFIGURATION CONFLICT**

The KILOMUX-2000 is equipped with only one KML module, but you are trying to select a main link mode that requires two KML modules (i.e., only the SINGLE mode is allowed).

ERROR 52 **CONFLICT BETWEEN CH1 AND CH2 SPEEDS**

- You are trying to configure channels 1 and 2 of a KLS.1 module to operate with data rates from different groups. This is not allowed.
- For the KVF.4/S0 module, you cannot select a 64 kbps rate for both the B1 and B2 channel.

ERROR 55 **PASSWORD MODE ACTIVE - LCD IS DISABLED**

You are trying to connect to the LCD when the terminal has a password.

ERROR 56 **ILLEGAL START TIME SLOT ALLOCATION**

You are selecting an incorrect starting time slot on the KVF.5 master module.

ERROR 57 **ILLEGAL SIGNALING MODE**

You are trying to define “from PBX signaling mode” that is incompatible to the “to PBX signaling mode”.

ERROR 58 **CONFLICT BETWEEN GROUPS DEFINITION**

You are trying to choose and illegal timeslots group. It is possible that it already occupied by another card that belongs to the group.

ERROR 59 **FRAGMENTATION IN FREE FRAME ALLOCATION**

When working with a KML.10 card as ‘mainlink’ in bonding mode, available space is found in the frame but cannot be filled because it is not continuous.

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