ERICSSON

Mobile Communications

EDACS SITE CONTROLLER

Maintenance Manual

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REFERENCES

LBI-38762 - Installation Manual - Basic and Level 1 EDACS Installation and Field Acceptance Test
LBI-38812 - Maintenance Manual - EDACS Interface Panel
LBI-38174 - Maintenance Manual - GETC Trunking Card
LBI-38513 - Maintenance Manual - EDACS Telephone Interconnect System
LBI-31939 - Maintenance Manual - EDACS Test and Alarm Unit
LBI-38980 - Maintenance Manual - EDACS 900 MHz Test Unit
LBI-38875 - Maintenance Manual - EDACS Cable Duct System
LBI-38138 - Installation Manual - EDACS Site Controller (Old Configuration)

INTRODUCTION

DEFINITIONS

The EDACS (Enhanced Digital Access Communications System) Site Controller is all that standard and optional equipment housed in the single cabinet that houses the Controller.

The Controller is the computer itself, currently a DEC model CT-UXXXF-EK. This model is characterized by the DEC model KDJ11 CPU module and modular RJ11-type connectors on the back. Information about earlier PDP and VAX models, characterized by a separately-mounted, 32-port distribution panel (Emulex or Dilog), are not included in this manual. However, most information in this manual (except information relating to the EDACS Interface Panels and connections to the Controller) applies to these earlier models.

GENERAL

The intent of this instruction manual is to provide information about how the individual pieces of equipment are connected and work together as the EDACS Site Controller, and how they are connected and work with other pieces of equipment at the site or other locations. The information is organized in the following sections by the question the information answers:

Description:	What is it? Where is it? What does it do?
Installation:	How do I hook it up?
Operation:	How does it work?
Troubleshooting:	How do I fix it?

For additional information, refer to the instruction manual for that piece of equipment. (Current LBI numbers are listed as References following the Table of Contents.)

DESCRIPTION

OVERVIEW

The EDACS Site Controller consists of the following standard PST25 package of equipment, including a 69-inch cabinet with a 6-outlet AC power strip, 2-outlet AC power strip, and exhaust fan.

- EDACS Interface Panels
- Downlink GETC
- Controller (Computer)
- System Manager Modem
- 13.8 VDC Power Supply
- Uninterruptible 120 VAC Power Supply

In addition to the standard equipment, the EDACS Site Controller may also include some or all of the following optional equipment:

- Power Monitor Unit
- Local Telephone Interconnect
- Redundant Downlink GETC
- Test and Alarm Unit
- 230 VAC Modification
- Optional Cabinets

Figure 1 shows the normal position of the standard and optional equipment in an EDACS Site Controller cabinet.

STANDARD EQUIPMENT

EDACS Interface Panels

The two EDACS Interface Panels are mounted in the back of the cabinet. Panel #1 provides connection points for audio and data communications cables to other EDACS equipment, such as repeater cabinets. Panel #2 provides connection points for the Downlink and Redundant Downlink to the multisite/console switch, and the local telephone lines for the Local Telephone Interconnect option.

Downlink GETC

The Downlink GETC is mounted in a pull-out shelf and serves as the data communications interface between the Controller (or the Backup Controller) and the Downlink to the multisite/console switch.

If a problem at the site causes the Control Channel GETC to switch the Station GETCs to Failsoft Trunking, the Downlink GETC serves as the data communications interface between the Station GETCs and the Downlink to the multisite/console switch.

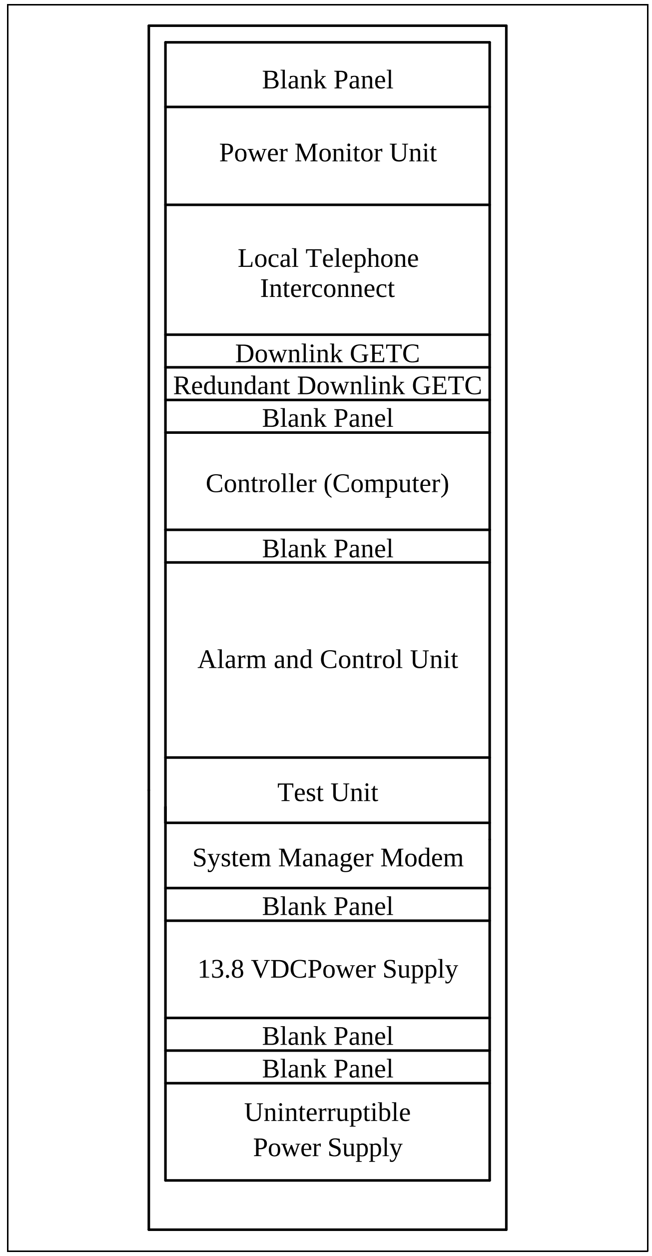


Figure 1 - Equipment Mounting In EDACS Site Controller

Controller (Computer)

The Controller is a 32-port computer responsible for directing the following functions (some parameters required for these functions can be reconfigured by the System Manager):

- Repeater Trunking (including partitioning)
- Local Telephone Interconnect option
- Power Monitor Unit option
- Alarm and Control Unit option
- Test Unit option

The Controller supports the following functions directed by other equipment:

- System Manager Site Database
- System Manager Activity Reports
- Downlink to the multisite/console switch
- Redundant Downlink to the multisite/console switch

In addition, the Controller manages the following features used with one or more functions (some parameters required for these features can be reconfigured by the System Manager):

- Call Validation (Logical and Group ID)
- Toll Call Restrictions
- Line Rotations
- Call Queueing
- Eight Priority Levels
- Recent-User Priority
- Alarm Management
- Activity Logging
- Patch
- Simulselect
- Dynamic Regrouping
- Fault Detection
- Unit Enable/Disable

System Manager Modem

The standard configuration for connecting the System Manager to the Controller is to use a telephone line for the data link, with a modem at each end. (The modems can be omitted if the distance is short and a full RS-232 data link is available.)

If the System Manager Modem is used, it is mounted on a shelf below the Test Unit, and serves as the data communications interface between the Controller and either a dedicated or a dial-up telephone-line data link to the System Manager.

13.8 VDC Power Supply

The 13.8 VDC Power Supply is a regulated power supply that converts the AC line voltage to +13.8 VDC for the following equipment:

- Downlink GETC
- Redundant Downlink GETC option
- Local Telephone Interconnect option
- Test and Alarm Unit option
- Power Monitor Unit option

Uninterruptible 120 VAC Power Supply

The Uninterruptible 120 VAC Power Supply (UPS) is a battery-driven, inverter power supply that provides approximately 10 minutes of uninterrupted 120 VAC to the following equipment, after losing AC line voltage to its input:

- Controller (Computer)
- System Manager Modem

OPTIONAL EQUIPMENT

Power Monitor Unit Option

The Power Monitor Unit option consists of a basic control monitor unit and external RF sensors, to determine the status of each channel's output RF path to an antenna. Unidirectional RF sensors are located at the output of each transmitter, and bi-directional RF sensors at the output of each transmitter combiner.

Local Telephone Interconnect Option

The Local Telephone Interconnect is a 2-wire telephone switch manufactured by IDA. A fully-equipped Local Telephone Interconnect is capable of connecting up to 32 telephone lines to up to 20 repeaters, under the direction of the Controller. The Local Telephone Interconnect allows authorized radios to make calls to, and receive calls from, a telephone system without dispatcher assistance.

The Local Telephone Interconnect is made up of a shelf with up to 2 PLA (Phone Line Adapter) boards, a LIC (Line Interconnect Controller) plug-in module, and up to 8 LIX (Line Interconnect and Cross Bar) plug-in modules.

The PLA boards mount on the back plane of the shelf. Each board provides a modular jack and 2 gas-tube surge protectors for each of 16 telephone line connections.

The LIC module controls up to 8 LIX modules under the direction of the Controller, and generates pulse dialing when needed.

The LIX modules make the actual cross connections between the telephone lines and the repeaters. Each LIX module can connect 4 telephone lines individually to any of 20 repeaters. The LIX module also detects ringing on the telephone lines, and contains the line buildout network board which contains 4 equalizer circuits to normalize each of the 4 telephone lines (so that the 4-wire/2-wire hybrid transformer in each repeater interface will remain balanced regardless of which telephone line is connected to it).

Each EDACS repeater to be used for telephone interconnect calls, must be equipped with a Repeater Interconnect Controller (RIC) The RIC provides the necessary interface between the repeater and the Local Telephone Interconnect (including the hybrid transformer mentioned above).

The RIC connects the repeater's receive audio to the repeater's transmit audio for radio-to-radio calls, or connects the repeater's receive and transmit audio through a hybrid transformer to a 2-wire audio line to the LIX module for radio-to-telephone interconnect calls. The RIC also generates dial tone, multiple frequency tones, and DTMF tones as directed by the Controller. The RIC also detects and reports to the Controller any DTMF tones from the radio or the telephone line, and dial tone from the telephone line.

Redundant Downlink GETC Option

The Redundant Downlink GETC is mounted in a pull-out shelf, and serves as the data communications interface between the Controller (or the Backup Controller) and the Redundant Downlink to the multisite/console switch, if the Downlink GETC, Downlink, or Uplink GETC fails.

If a problem at the site causes the Control Channel GETC to switch the Station GETCs to Failsoft Trunking, the Redundant Downlink GETC serves as the data communications interface between the Station GETCs and the Redundant Downlink to the multisite/console switch.

Test and Alarm Unit Option

The Test and Alarm Unit (TAU) option is made up of the Alarm and Control Unit (ACU), and the Test Unit (TU). The TU is mounted in the pull-out shelf at the bottom of the ACU. The ACU can also be ordered and operated without the TU, but the TU can't be operated without the ACU (because the TU depends upon interface circuitry in the ACU to communicate with the Controller).

The ACU monitors up to 32 alarm inputs, provides up to 8 control relay outputs, displays the status of up to 56 site parameters, houses the TU, and provides the data interface between the TU and the Controller. (Alarm inputs and control outputs must be configured by the Controller or System Manager before they can be used.)

The TU is basically a mobile radio with special TU software that operates under the direction of the Controller. The TU is responsible for monitoring and reporting the health of the Control Channel, and for making test calls (that simulate mobile-originated channel-request sequences) and reporting the health of the Working Channels used for the test calls. The TU also directs the switching of the ACU and TU to the Backup Controller (if installed).

The VHF, UHF, and 800 MHz TU can be operated in the User Call Mode, allowing service personnel to use the TU like a normal EDACS mobile.

230 VAC Modification Option

The 230 VAC Modification option substitutes the following parts for their 120 VAC equivalents:
230 VAC 6-Outlet Power Strip

- 230 VAC Cabinet Fan
- Uninterruptible 230 VAC Power Supply
- 230 VAC to 13.8 VDC Power Supply
- 230 VAC System Manager Modem

Optional Cabinets

The EDACS Site Controller may also be mounted in optional cabinets of various sizes. See the description of cabinet size in the Installation section.

INSTALLATION

OVERVIEW

See the Basic and Level 1 EDACS installation manual for complete installation instructions. Only the issues directly concerning the EDACS Site Controller are covered here.

SITE REQUIREMENTS

Protective Grounding

Protective grounding is probably the most important single factor in reducing maintenance time and expense. These recommendations are thought to be adequate, but because lightning intensity and frequency of occurrence are unpredictable, the user may wish to use larger ground wires, shorter distances, and/or additional protective devices based on experience.

Each cabinet should have its own AWG 6 annealed copper wire connecting the inner welded structure of the cabinet to an AWG 4 annealed copper ground buss, in an over-cabinet or under-cabinet cable duct. This ground bus should be connected to the site's ground, no farther than 25 feet away. All the EDACS equipment should be connected to the site ground at the same point.

The EDACS Site Controller requires that all telephone lines, alarm inputs, control outputs, and data links to the System Manager and Multisite Coordinator, enter the equipment room via protected punch blocks or equivalent protection.

A coaxial cable grounding kit should be installed at the top end of each coaxial cable run on the tower. A second kit should be installed on the cable at the bottom of the tower. A third kit should be installed on the cable at the point where the cable enters the building if the tower-to-building distance is greater than 20 feet. For cable runs on the tower that are greater than 200 feet, additional kits should be installed at each 200 foot interval.

A lightning arrester should be installed on the AC power line at the point where the cable enters the building.

Environment

The EDACS Site Controller should be operated in a controlled environment, between 17 and 27 degrees C (60 and 80 degrees F) and 50% relative humidity.

Although the maintenance manuals for the individual pieces of equipment that make up the EDACS Site Controller give higher temperature limits, those limits are for that one piece of equipment out in the open. When all of these pieces are assembled together in a cabinet, the ambient room temperature outside the cabinet must be significantly lower to assure that the temperature inside the cabinet does not exceed the limits for the equipment.

CAUTION

Remember to check and clean the air filter in the cabinet door at regular intervals. Failure to do so may cause the equipment to overheat and fail.

AC Power

The EDACS Site Controller requires an AC power source of 121 VAC ±20% at 60 Hz ±2% with a receptacle for the standard US 120 VAC grounding plug. The receptacle should be protected by a 20-amp circuit breaker and located within 4 feet of the cabinet, either in an above-cabinet cable tray or on a wall near the cabinet.

The 230 VAC option requires an AC power source of 230 VAC ±15% at 50 Hz ±2% protected by a 10-amp circuit breaker. A standard European plug is provided on the end of the cabinet's power cord for this option.

MECHANICAL CONSIDERATIONS

Cabinet Size

The standard cabinet for the EDACS Site Controller is a 69-inch high x 23-inch wide x 21-inch deep enclosed cabinet. An 83-inch high enclosed cabinet and an 86-inch high open rack are used as options. Extra deep 69-inch and 83-inch cabinets are also sometimes used as special options and have an additional 4 inches of depth.

Cabinet Location

The length and quantity of interconnecting site cables between EDACS cabinets are based on using standard floor plans and on using cabinet-top cable ducts. For installations which require other than the standard floor layout or cable routing, the interconnections may require additional materials or other special considerations. Standard floor plans are shown in the Basic and Level 1 EDACS installation manual.

Cabinet Mounting

A hole is located near each of the bottom 4 corners of the cabinet for fastening the cabinet to the floor with 1/2-inch diameter bolts.

Cabinet-Top Cable Duct Option

If optional cabinet-top ducts are used, see the maintenance manual for the EDACS Cable Duct System.

ELECTRICAL CONNECTIONS

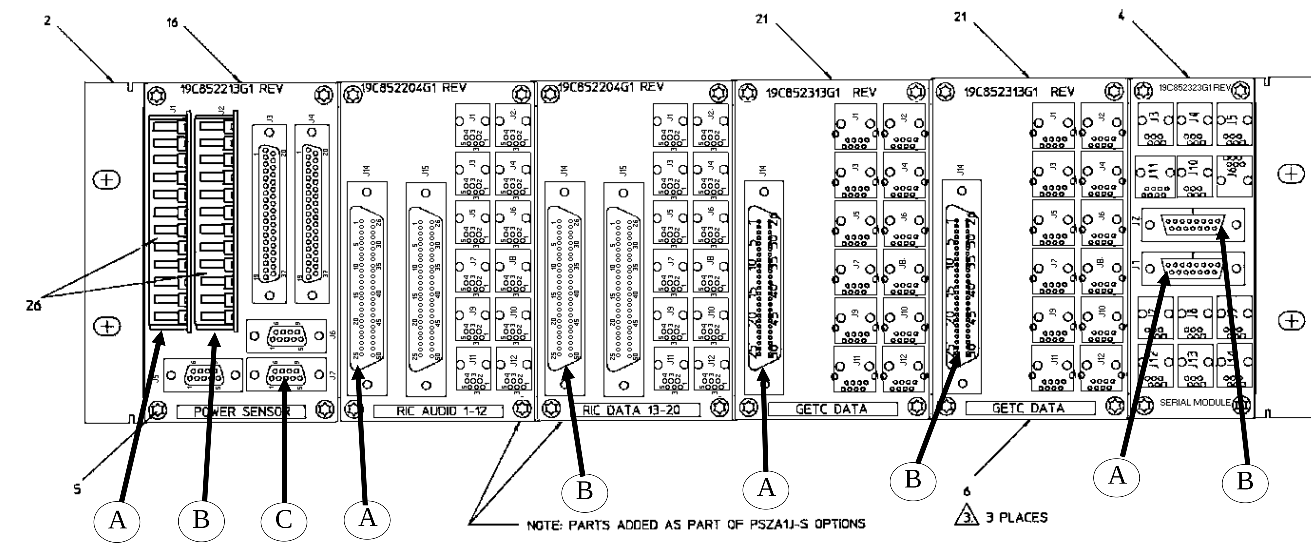
EDACS Interface Panel Connections

Overview

Most audio and data connections between EDACS cabinets are made using 25-pair cables with 50-pin connectors that plug into EDACS Interface Panel #1, mounted in the back of each EDACS cabinet. Figure 2 shows where these external cables connect to the EDACS Interface Panel #1 in the EDACS Site Controller cabinet.

If a particular cable needs to go to several cabinets, the cabinets are daisy-chained together (EDACS Interface Panel to EDACS Interface Panel) by a series of individual cables. The EDACS Site Controller cabinet is connected to the closest of the cabinets, and the daisy-chain continues from there. The Basic and Level 1 EDACS installation manual shows this daisy-chaining method for typical configurations.

Figure 3 shows where the external cables connect to EDACS Interface Panel #2 in the EDACS Site Controller cabinet.

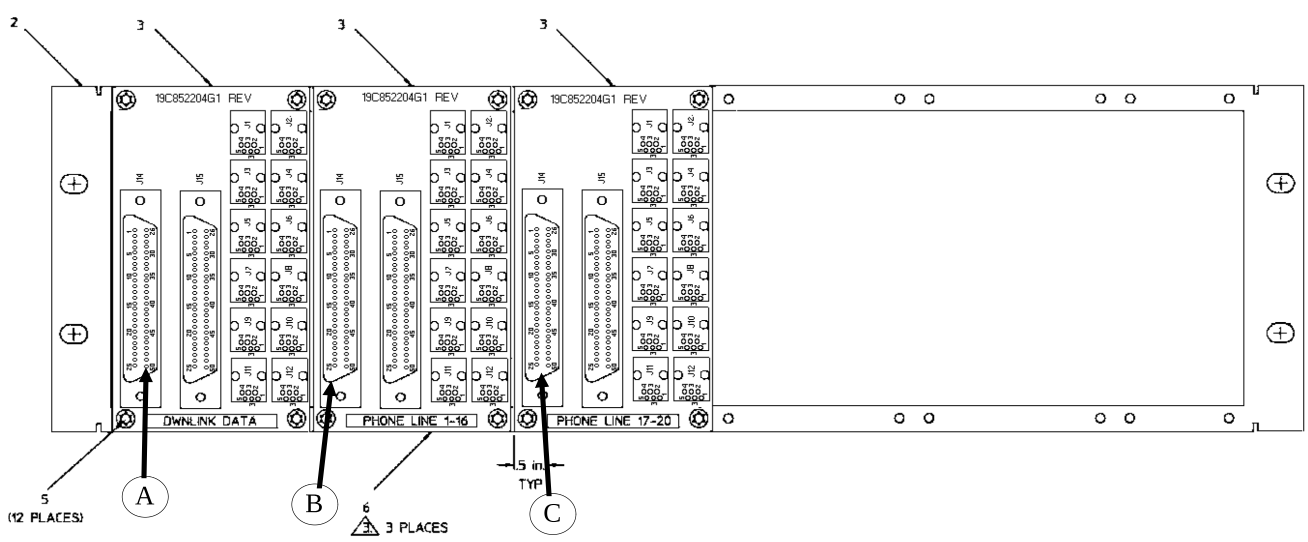


A: Daisy-chain to channels 1-10 (2 repeaters per cabinet), or 1-12 (3 repeaters per cabinet).
Plug with shorting jumpers (shown above) must be moved to the end of daisy chain.

B: Daisy-chain to channels 11-20 (2 repeaters per cabinet), or 13-20 (3repeaters per cabinet)
Plug with shorting jumpers (shown above) must be moved to the end of daisy chain.

C: Daisy-chain to antenna sensors.

Figure 2 - External Connections To EDACS Interface Panel #1



A: Downlink GETC and Redundant Downlink GETC Data Link to Multisite Coordinator.

B: LIX 2-wire audio links for telephone lines 1-16.

C: LIX 2-wire audio links for telephone lines 17-32.

Figure 3 - External Connections To EDACS Interface Panel #2

Power Monitor Sensor Jumpers

NOTE

All unused sensor inputs must be jumpered (shorted) at an EDACS Interface Panel.

The "POWER SENSOR" board in EDACS Interface Panel #1 comes with two 19C852379G1 jumper modules, plugged into J1 and J2. If a site interconnect cable needs to be connected to J1 or J2, the jumper module must be moved to the EDACS Interface Panel at the other end of this site interconnect cable or (if daisy chained) at the end of the daisy chain.

These jumper modules come with all circuits jumpered, so jumpers for the circuits being used must be removed. See the Interconnect Drawings 6A and 6B, at the back of this manual, to determine which jumper applies to which circuit.

NOTE

The power sensors for transmitters 11 and 12 can be connected to J1 (for sites with 2 repeaters per cabinet - see Interconnection Diagram 6A) or to J2 (for sites with 3 repeaters per cabinet - see Interconnection Diagram 6B). Therefore there are 2 jumpers in parallel for each of these 2 circuits and both jumpers must be removed (one for J1 and one for J2) if a power sensor is connected to the circuit for transmitter 11 and/or 12.

Downlink and Redundant Downlink Connections

The "DOWNLINK DATA" board in EDACS Interface Panel #2 provides a 50-pin connector for connection of the Downlink and Redundant Downlink from the Multisite Coordinator. Pin identification for the 50-pin connector is shown in Table 1.

J14 Pin #	Data Direction		Data Circuit
1 26	+ –	Outgoing	Downlink
2 27	– +	Incoming	Downlink
3 28	+ –	Outgoing	Redundant Downlink
4 29	– +	Incoming	Redundant Downlink

Table 1 - Downlink Connection Pin Identification

CAUTION

These data lines must come through protected punch blocks or equivalent protection before being connected to the EDACS Interface Panel.

Telephone Line Connections

The "PHONE LINE 1-16" and "PHONE LINE 17-32" modules in EDACS Interface Panel #2 provide two 50-pin connectors for connection of up to 32 external 2-wire telephone lines, for use with the Local Telephone Interconnect option. Pin identification for the two 50-pin connectors is shown in Table 2.

J14 Pin #	Polarity	EDACS Interface Modules	
		"PHONE LINE 1-16" Line #	"PHONE LINE 17-32" Line #
1 26	Ring Tip	1	17
2 27	Ring Tip	2	18
3 28	Ring Tip	3	19
4 29	Ring Tip	4	20
5 30	Ring Tip	5	21
6 31	Ring Tip	6	22
7 32	Ring Tip	7	23
8 33	Ring Tip	8	24
9 34	Ring Tip	9	25
10 35	Ring Tip	10	26
11 36	Ring Tip	11	27
12 37	Ring Tip	12	28
13 38	Ring Tip	13	29
14 39	Ring Tip	14	30
15 40	Ring Tip	15	31
16 41	Ring Tip	16	32

Table 2 - Telephone Line Connection Pin Identification

CAUTION

These telephone lines must come through protected punch blocks or equivalent protection before being connected to the EDACS Interface Panel.

Direct Connections

Overview

Most connections to user-supplied devices bypass the EDACS Interface Panels and connect directly to a specific piece of equipment within the EDACS Site Controller cabinet. The following direct connections to user-supplied devices may be required:

- 32 alarm inputs and 8 control outputs connecting to the ACU (Alarm and Control Unit) option.
- An antenna connecting to the TU (Test Unit) option.
- A data link to the System Manager connecting to the System Manager Modem.
- The AC power connection.

The locations of these direct connections to user-supplied devices are shown in Figure 4.

Use cable ties to secure the cables to the side rails of the EDACS Site Controller cabinet so that access is allowed to the internal equipment without moving the cables, and so that the appearance is neat and orderly.

CAUTION

Avoid routing any cables near the sharp end of mounting screws, and route the cables so that mounting screws can be removed and re-installed without damaging the cables.

Alarm and Control Unit (ACU)

CAUTION

Never make a direct connection between a power circuit or ground in the external equipment, and a power circuit or ground in the ACU.

The Alarm and Control Unit provides two 50-pin connectors for up to 32 alarm inputs (A1 through A32) to user-supplied, alarm-sensing devices. Typical alarm input configurations are shown in Figure 5. Alarm input connections are shown in Table 3.

The alarm and Control Unit also provides one 50-pin connector for up to 8 control outputs (C1 through C8) to user-supplied control devices. Typical control output configurations are shown in Figure 6. Control output connections are shown in Table 4.

CAUTION

These alarm inputs and control outputs must come through protected punch blocks or equivalent protection before being connected to the ACU.

Test Unit (TU)

The coaxial cable to the Test Unit antenna (if needed) is connected to the end of the attenuator at the back of the Test Unit. See Figure 4. If the coaxial cable leaves the building, a coaxial cable grounding kit should be installed where the cable enters the building.

System Manager Modem

If the System Manager Modem is used, connect the telephone-line data link from the System Manager to the right-hand, 4-pin modular phone jack on the rear of the System Manager Modem. See Figure 4.

CAUTION

This data link must come through a protected punch block or equivalent protection before connecting to the modem.

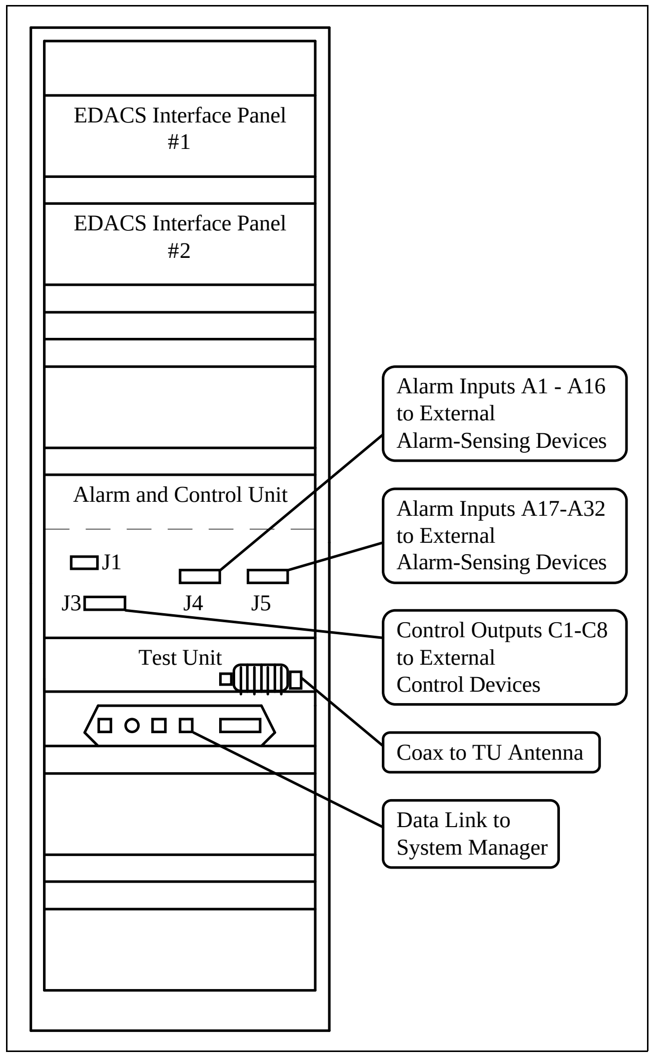


Figure 4 - External Connections Directly To Other Equipment (Rear View)

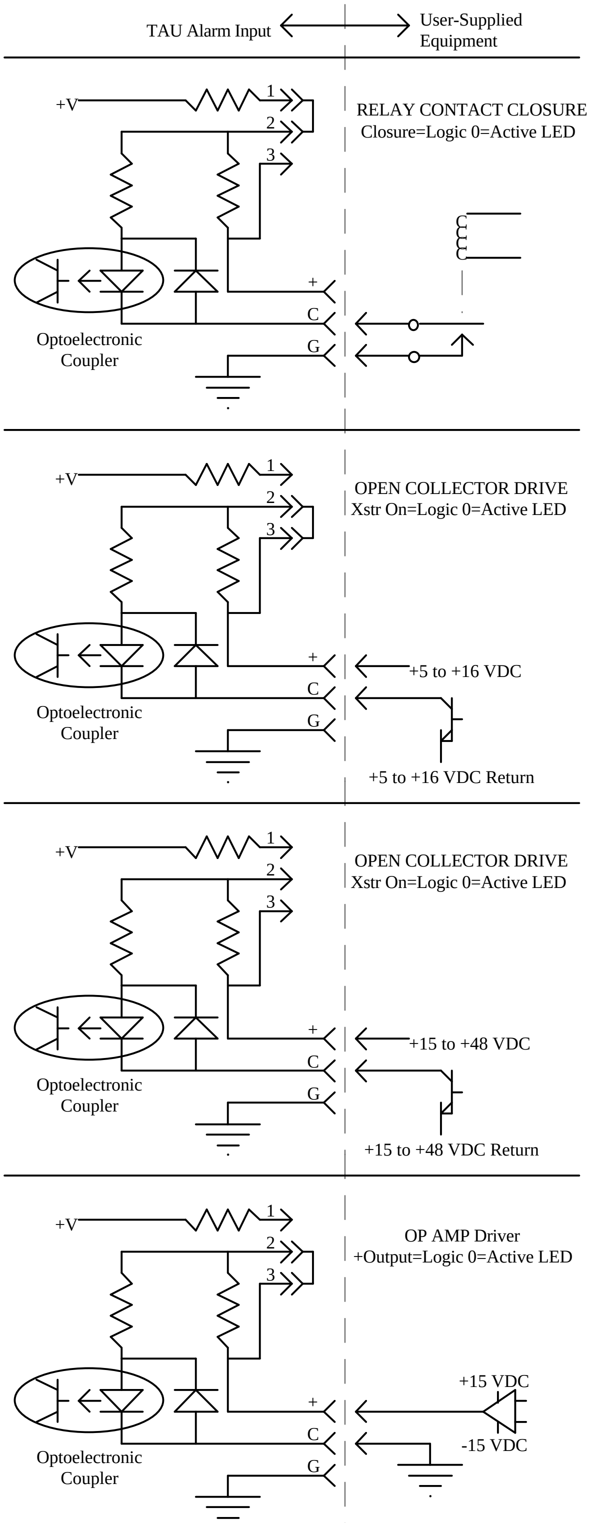


Figure 5 - Typical Alarm Input Configuration

Function	Connector J4		Connector J5	
	Pin#	Alarm #	Pin #	Alarm #
+ C G	26 1 27	A1	26 1 27	A17
+ C G	2 28 3	A2	2 28 3	A18
+ C G	29 4 30	A3	29 4 30	A19
+ C G	5 31 6	A4	5 31 6	A20
+ C G	32 7 33	A5	32 7 33	A21
+ C G	8 34 9	A6	8 34 9	A22
+ C G	35 10 36	A7	35 10 36	A23
+ C G	11 37 12	A8	11 37 12	A24
+ C G	38 13 39	A9	38 13 39	A25
+ C G	14 40 15	A10	14 40 15	A26
+ C G	41 16 42	A11	41 16 42	A27
+ C G	17 43 18	A12	17 43 18	A28
+ C G	44 19 45	A13	44 19 45	A29
+ C G	20 46 21	A14	20 46 21	A30
+ C G	47 22 48	A15	47 22 48	A31
+ C G	23 49 24	A16	23 49 24	A32
+13.8 VDC*	25	---	25	---
PWR GND	50	---	50	---

* Requires jumper on the Alarm/Control Interface Board: jumper J40 for connector J4, jumper J41 for connector J5. See cautions about power circuits in text.

Table 3 - Alarm Input Connections Pin Identification

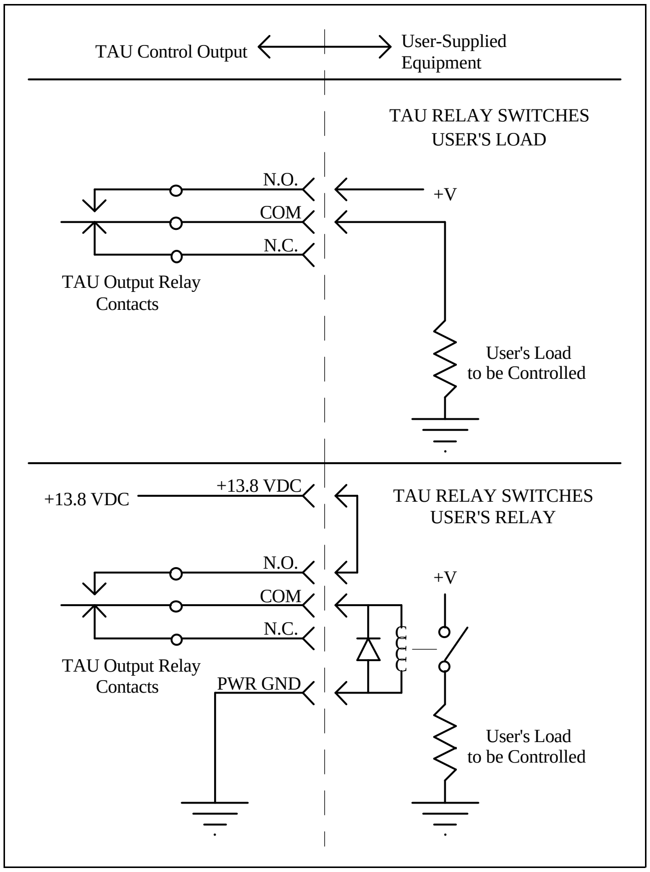


Figure 6 - Typical Control Output Configurations

Function	Connector J3			
	Pin#	Control #	Pin #	Control #
N.O. COM N.C.	26 1 27	A1	32 7 33	A5
N.O. COM N.C.	2 28 3	A2	8 34 9	A6
N.O. COM N.C.	29 4 30	A3	35 10 36	A7
N.O. COM N.C.	5 31 6	A4	11 37 12	A8
+5 VDC +5 VDC LOG GND LOG GND +13.8 VDC +13.8 VDC PWR GND PWR GND	13 38 14 39 15 40 16 41	+5 VDC requires jumper P38 on the Alarm/Control Interface Board. +13.8 VDC requires jumper P39 on the Alarm/Control Interface Board. See cautions about power circuits in text.		

Table 4 - Control Output Connections Pin Identification

If the System Manager Modem is not used, connect the System Manager to Port 0 (SM) on the back of the Controller using the connection shown in Figure 7.

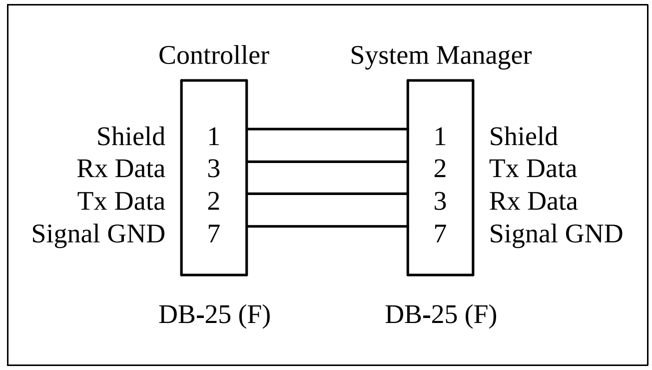


Figure 7 - System Manager To Controller Using Direct Connection

OPERATION

This section concentrates on what general information is passed between pieces of equipment, for what reason, and under what circumstances. The operation of the discrete electronic circuits is left to the individual LBI for that piece of equipment. (Current LBI numbers are listed as References following the Table of Contents.)

CONTROLLER (COMPUTER)

Overview

Although only the DEC model CT-UXXXF-EK Controller, characterized by the DEC model KDJ11 CPU module and modular RJ11-type connectors on the back, is specifically covered in this manual, the operation of earlier PDP and VAX models, characterized by a separately-mounted, 32-port distribution panel (Emulex or Dilog), is the same. For these earlier models, disregard information about PROM location.

The Controller operates by following the Controller Application Software, stored in a set of up to 14 PROMs. The Controller Application Software requires certain information about the specific site where the Controller is located, such as Site ID, equipment available at the site, validation tables by feature and priority for each Logical (individual) ID and Group ID, etc. Initial values of the Controller's Configuration (personality) are stored in a set of 2 PROMs. The position of these PROMs on the DEC model MRV11-D EPROM module is shown in Figure 8.

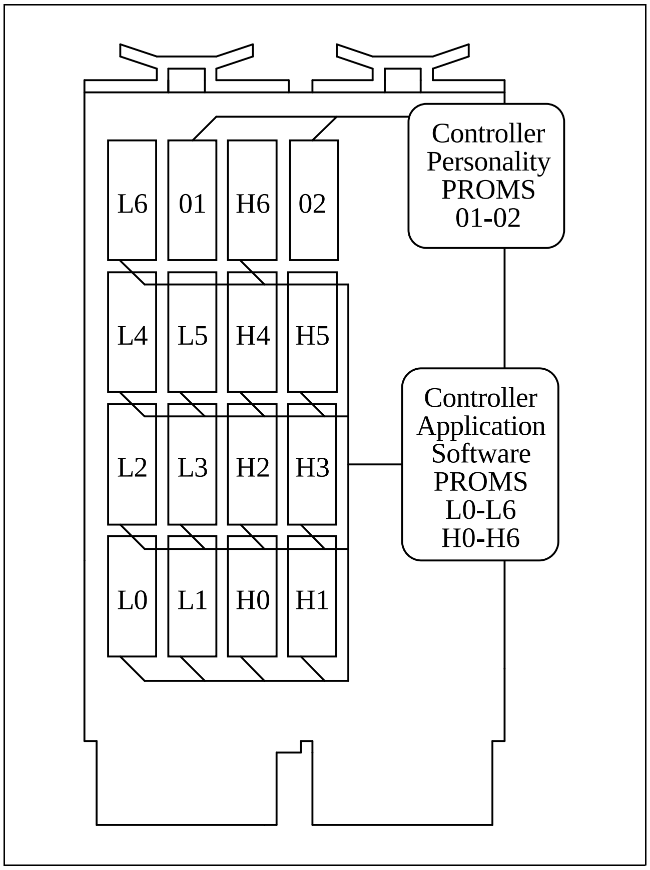


Figure 8 - PROM Mounting In Controller

Power-Up/Reset

Whenever the Controller is turned on or reset, the Controller loads the Application Software from its Application Software PROMs and its Initial Configuration from its Personality PROMs into a volatile working memory. The Controller then requests the current Site Database from the System Manager to update its Initial Configuration. The Controller's updated Initial Configuration becomes its Active Configuration. If for some reason the Controller cannot get the current Site Database from the System Manager, the Controller uses its Initial Configuration as its Active Configuration until it is able to obtain the current Site Database from the System Manager.

Some parts of the Controller's Initial Configuration, such as the Site ID, cannot be reconfigured by the System Manager. If changes need to be made in the Controller's Initial Configuration, whether or not they can be reconfigured by the System Manager, the changes in the Controller Personality PROMs must be made in Lynchburg.

System Manager

The Controller supports the System Manager through the following chores:

- After power up or a reset, the Controller requests the latest Site Database from the System Manager. The System Manager responds by sending the current Site Database to the Controller.
- At any time the System Manager may want to reconfigure the site and send the new information to the Controller.
- The Controller sends stored activity reports to the System Manager when they reach a preset volume or when the System Manager requests them.

Call Validation

All call requests, sent to the Controller from either the Control Channel or Downlink GETC, are checked by the Controller against the Controller's Active Configuration to verify that the caller's Logical (individual) ID is permitted to make that type of call, and that the called Logical ID or Group ID is permitted to receive that type of call. Possible types of calls are Analog Voice, Digital Voice, Data, and Telephone Interconnect. Only permitted requests are given a trunk assignment. These parameters can be reconfigured by the System Manager.

Toll Call Restrictions

The Controller manages 16 levels of toll call restrictions - one for each caller's Logical ID - to limit callers to various groups of area codes. This parameter can be reconfigured by the System Manager.

Line Rotations

The Controller manages 15 rotary hunt sequences - one for each caller's Logical ID - used by the telephone equipment to find an available line when a radio requests a telephone interconnect call. This parameter can be reconfigured by the System Manager.

Call Queuing

The Controller manages call queuing when all available Working Channels, for that requested call type, are in use. During this time of full loading, call requests are filled first by priority level and second by time in queue. A special half level incremental priority is given to recent users.

Eight Priority Levels

The Controller manages 8 priority levels when filling queued call requests. The higher of the caller's or the callee's priority is used.

Of the eight priority levels available, the highest priority is reserved for emergency calls. The remaining seven priority levels are assigned to each Logical and Group ID (whether radio or telephone line) for each grade of service (Analog Voice, Digital Voice, Data, and Telephone Interconnect). These priority level assignments are contained in the Controller's Active Configuration and can be reconfigured by the System Manager.

Recent User Priority

The Controller gives a recent user a slight edge when calls are being queued, to help maintain the continuity of a conversation. The Controller increases the priority of a call request half a level if the time between the last call request and the current request is less than the recent call queue interval in its Active Configuration. This interval can be reconfigured by the System Manager.

Alarm Management

The Controller Continuously monitors fault indications from the various diagnostic equipment at the site. Major alarms, identified in its Active Configuration, must be reported to the System Manager immediately. Major and minor alarm classifications, and most alarm parameters, can be reconfigured by the System Manager.

Activity Logging

The Controller continuously monitors the EDACS site and logs all call requests, channel dispositions (assignments and disassignments), channel or equipment failures, and alarm information. These activities are formatted into records and stored. When the stored activity records reach a preset volume, they are sent to the System Manager for later use in compiling various management reports. This preset volume, called the Activity Dump Threshold, can be reconfigured by the System Manager.

If for some reason the Controller cannot communicate with the System Manager before the stored records run out of storage space, the Controller writes over the oldest records first. This allows the most recent records to be sent once communications to the System Manager is restored.

Repeater Control

The Controller sends messages to the Station GETCs telling them which station operates as a Control Channel and which stations operate as Working Channels. The Controller also sends messages to the Station GETCs telling each Working Channel when to start transmitting and when to stop.

The Controller receives messages from the Control Channel GETC requesting trunk assignments, and from Working Channel GETCs telling the Controller when calling radios start and stop transmitting on the assigned trunks.

When a Station GETC does not respond to Poll messages, the Controller assumes that it is defective and does not assign it for use as a Control or Working Channel until it begins to respond to Poll messages again. If the non-responding GETC is the current Control Channel GETC, the Controller selects a new Control Channel and sends the new Control Channel assignment in the next Poll message to that Station's GETC.

The Controller communicates with each Station GETC through a separate 19.2 Kbaud serial data link. Message bytes are made up of 8 data bits, 1 stop bit, and no parity bit. See Interconnection Diagrams 3A and 3B.

SYSTEM MANAGER MODEM

The standard configuration for connecting the System Manager to the Controller is to use a telephone line with a telephone-channel modem at each end. See Interconnection Diagram 2. The modems can be omitted if the distance is short and a full RS-232 data link is available.

If a telephone line is used, it can be a standard dial-up line or a permanently-connected dedicated line. When set up for a standard dial-up line, the modem takes care of placing and answering calls from the telephone system.

The type of data link (dial-up line, dedicated line, or RS-232) must be included in the Controller Personality PROMs so it will interface correctly with the modem (if used) or the full RS-232 data link.

The System Manager Modem is connected to Port 0 (MS) of the Controller with a 19.2 Kbaud data link. Message bytes are made up of 8 data bits, 1 stop bit, and no parity bit. The System Manager Modem converts these RS-232 data levels from the Controller to audio signals for transmission over the telephone-line data link, and audio signals from the telephone-line data link to RS-232 data levels for the Controller.

FULL-FEATURED TRUNKING

The Controller manages Full-Featured Trunking by following the Controller Application Software and trunking parameters in the Controller's Active Configuration. The System Manager has control over the following trunking parameters (parameter values are customer specific - the values indicated below apply when generic Personality PROMs are installed - some parameters have separate values for individual and group calls):

- Which channel is the initial Control Channel - default is channel 1
- Which channels are the initial Working Channels - default is channels 2-20
- Which channels have Control Channel capability - default is channels 1-20
- Enable rotation of Working Channel assignments - default is enable
- Assign ascending or descending rotation - default is ascending
- Assign alternating channel assignment algorithm to avoid intermod - default is disabled
- Which channels are equipped to handle digital voice - default is channels 1-20
- Which channels are equipped to handle data - default is channels 1-20
- Which channels are assigned as test channels - default is none
- Which radios are permitted to use test channels - default is none
- Which channels are permitted to be used in multisite calls - default is channels 1-20
- Which radios are permitted to make multisite calls - default is none
- Time limit for transmission trunked calls - default is 30 seconds
- Time limit for message trunked conversations - default is 30 seconds
- Hang time between unkey and channel drop - default is 0 seconds - note that hang time must be 0 for transmission trunking and more than 0 for message trunking
- Hang time between unkey and channel drop for emergency calls - default is 2 seconds
- Maximum number of simultaneous individual calls permitted - default is 20
- Queue priority for voice calls - default is lowest priority (zero)
- Queue priority for digital voice calls - default is lowest priority (zero)
- Queue priority for data calls - default is lowest priority (zero)
- Time limit between call requests to qualify for recent call priority increment - default is 5 seconds
- Time interval between Morse code ID transmissions on Working Channels - default is 15 minutes
- Time between scramble data calls used to discourage unauthorized monitoring - default is 5 seconds - note that an interval of 0 inhibits this feature

When an EDACS mobile or portable radio is turned on, its receiver scans the channels of the system looking for the Control Channel sending a control message every 30 milliseconds. The radio decodes and synchronizes itself with this periodic control message. When the radio is synchronized with the Control Channel, it is ready to place or receive trunked calls. The following sequence of steps describes a Full-Featured Trunking call:

1. The user of a mobile or portable radio selects the communication mode (analog voice, digital voice, or digital data), call type (group, emergency group, individual, or system all call), and the individual or group called. The user then pushes the Push-To-Talk (PTT) switch on the radio.

2. The radio transmits a call request message on the Control Channel. The message includes the radio's identification (Logical ID), communication mode, call type, and the identification (Logical ID or Group ID) of the called radio(s).

3. The Control Channel GETC receives the call request from the calling radio, translates it to Controller protocol, and sends a call/channel request message to the Controller.

4. The Controller receives the message and checks with its Active Configuration to see if the request is permitted. (If it isn't permitted, the Controller sends an appropriate system busy or call denied message to the Control Channel GETC which in turn sends a proper indication to the calling radio.)

5. If the call request is permitted, the Controller checks to see if a Working Channel is available. (If a Working Channel is not currently available, the Controller queues the call request and directs the Control Channel GETC to send a queued-call signal to the calling radio. When the call request comes out of queue, continue to next step.) If queuing is disabled or otherwise not possible, the Controller generates a system busy indication.

6. The Controller directs the Control Channel GETC to send the Working Channel assignment to the calling and called radios. This channel assignment includes a hang time value for this call. A hang time of zero indicates Transmission Trunking; non-zero indicates Message Trunking.

7. The calling and called radios receive the Working Channel assignment from the Control Channel GETC and tune to the assigned Working Channel.

8. A high speed handshake on the Working Channel with the calling radio occurs.

9. After confirmation, the caller hears the "ok to transmit" prompt tone alerting the caller to begin talking.

10. Signaling on the assigned Working Channel tells the called radio(s) to unmute their speakers.

11. When the caller finishes talking, the caller releases the PTT switch, sending an unkey message to the assigned Working Channel and all called radio(s). The Controller receives either a call dropped (Transmission Trunked call) or a call unkey (Message Trunked call).

12. With Transmission Trunking, the radios involved in the call return to monitor the Control Channel. With Message Trunking, the radios stay on the Working Channel until hang time expiration or manual drop.

FAILSOFT TRUNKING

If the Controller fails, the site continues to function using Failsoft Trunking. Failsoft Trunking is managed by the Control Channel GETC through the daisy-chained backup serial link to the other Station and Downlink GETCs. See Interconnection Diagrams 4A and 4B.

The sequence of steps for a Failsoft Trunking call is identical to that of a Full-Featured Trunking call except that the Control Channel GETC manages the trunking instead of the Controller. The following features and options are not usable during Failsoft Trunking:

Call Validation

- Activity Logging
- Basic Diagnostics
- Eight Levels of Priority
- Local Telephone Interconnect
- Dynamic Regrouping
- Unit Enable/Disable
- Patch
- Simulselect

MULTISITE TRUNKING AND CONSOLE OPERATION

Multisite Trunking and console operation is not covered in this manual except to mention the function of the Downlink and Redundant Downlink GETCs.

Downlink GETC

The Downlink GETC serves as the interface between the Controller and the Downlink to the multisite/console switch. When managing calls placed between sites (or between a site and a console), the Controller sends messages to and receives messages from the multisite/console switch through the Downlink GETC. The Controller communicates with the Downlink GETC over a 19.2 Kbaud RS-232 data link connecting Port 26 on the back of the Controller to J100 on the back of the Downlink GETC. Message Bytes are made up of 8 data bits, 1 stop bit, and no parity bit. See Interconnect Diagrams 4A and 4B.

If the site is in the Failsoft Trunking mode of operation, the individual Station GETCs send messages to and receive messages from the Multisite Coordinator through the Downlink and the Downlink GETC over the daisy-chained RS-232 Backup Data Link connecting J102 on each Station GETC to J102 on the Downlink GETC.

Redundant Downlink GETC Option

If the Downlink or Uplink GETC, or the physical link between them fails, the Redundant Downlink GETC serves as the data interface between the Controller (or the Station GETCs if the site is in the Trunked Failsoft mode of operation) and the multisite/console switch.

The connections to the Redundant Downlink GETC are identical to those for the Downlink GETC, except for the connection to the Controller. The Controller communicates with each Redundant Downlink GETC on a selectable port (typically ports 21-25), as specified in its Active Configuration.

LOCAL TELEPHONE INTERCONNECT OPTION

Overview

Operation of the Local Telephone Interconnect option (manufactured by IDA) is a cooperative function of the Line Interconnect Controller (LIC) plug-in module of the Local Telephone Interconnect, and Repeater Interconnect Controller (RIC) shelf connected to each repeater configured for telephone interconnect calls. Each operates by following its own software and responding to messages from the Controller.

The System Manager has control over the following Local Telephone Interconnect parameters in the Controller's Active Configuration (Trunking parameters also apply - see Full-Featured Trunking section - default values are customer specific; the values indicated below apply when generic Personality PROMs are installed):

- Which channels are equipped to handle telephone interconnects - default is channels 1-20
- What is the telephone interconnect Hang Time between unkey and channel drop - default is 30 seconds
- What is the maximum number of simultaneous telephone interconnect calls permitted - default is 20
- What is the level of toll call restrictions for each individual radio - default is totally restricted
- What is the queue priority for telephone interconnect calls for each radio - default is lowest priority (zero)
- Which radios are permitted to receive inbound telephone interconnect calls - default is no Group IDs (all are Logical IDs)
- What line number is dedicated to outgoing calls for each individual radio - default is 1
- What is the rotary hunt sequence for each individual radio - default is none - note that a none for both rotary hunt sequence and dedicated line number prevents telephone interconnect calls for that radio

The Controller supervises the Local Telephone Interconnect over two 19.2 Kbaud serial data links: one to the LIC module, and one daisy-chained to all the RIC shelves. Message bytes are made up of 8 data bits, 1 stop bit, and no parity bit. See Interconnect Diagrams 5A and 5B.

Telephone interconnect calls utilizing a Centralized Telephone Interconnect system are managed by the Multisite Coordinator. Their operation is not described here.

Telephone-Originated Call on a Dedicated Line

When a telephone line is dedicated to a Logical (individual) ID or Group ID, telephone-originated calls coming in on this line will only go to the specific radio or group of radios assigned to that line.

The sequence of steps for a telephone-initiated telephone interconnect call coming in on a dedicated line is as follows:

IDENTIFYING LINE TYPE

1. When a call comes in on one of the telephone lines connected to the Local Telephone Interface, the LIC reports to the Controller that a LIX has detected ringing voltage on a calling line.

2. The Controller receives the report from the LIC that ringing voltage has been detected on a calling line and checks to see if it is permitted to add another telephone interconnect call. There may be a limit, imposed by the System Manager, on the number of telephone interconnect calls allowed at any one time. (If the Controller is not permitted to add another telephone interconnect call, the Controller lets the incoming call go unanswered and never reconsiders that incoming call again, even if room for the call is available before the caller hangs up. So if the caller does not get an answer within 3 ringbacks, the caller should hang up and call again. This ends the sequence here.)

3. If the Controller is permitted to add another telephone interconnect call, the Controller checks to see if the incoming call is on a dedicated line or a non-dedicated line. (If it is on a non-dedicated line, see the next sequence of steps, Telephone-Originated Call on a Non-Dedicated Line.)

OBTAINING WORKING CHANNEL

4. If the incoming call is on a dedicated line, the Controller checks to see if a Working Channel with a RIC is available. (If no Working Channel with a RIC is currently available, the Controller lets the incoming call go unanswered. The caller should hang up and call back after 3 ringbacks. This ends the sequence here.)

5. If a Working Channel with a RIC is available, the Controller directs the LIC to have the LIX connect itself to the calling line (to simulate a telephone being taken "off hook"). A LED on the front of the LIX indicates which line is "off hook".

6. The telephone exchange detects that the calling line (actually the called line from the telephone exchange point of view) has come "off hook", and removes the ringing voltage from the calling line.

7. The Controller directs the Control Channel GETC to send the Working Channel assignment to the radio(s) with the Logical (Group) ID assigned to the dedicated line.

8. The Controller directs the assigned Working Channel RIC to connect its associated radio channel for a telephone interconnect call without DTMF regeneration.

9. The Controller directs the LIC to have the LIX connect the assigned Working Channel RIC to the calling line.

10. The Controller directs the assigned Working Channel RIC to send a call-completion tone to the calling line and the called radio(s). The audio path is now connected between the calling line and the called radio(s).

11. The Controller directs the assigned Working Channel RIC to connect its DTMF decoder to the calling line, to be able to detect the end-of-call DTMF digit from the calling line.

ENDING THE CALL

12. To end the telephone interconnect call, the caller presses the # key on the DTMF keypad of the telephone.

13. The assigned Working Channel RIC detects this end-of-call DTMF # digit and reports it to the Controller.

14. The Controller receives the DTMF digit and identifies it as the end-of-call signal.

15. The Controller directs the assigned Working Channel RIC to disconnect audio.

16. The Controller directs the LIC to have the LIX disconnect itself from the assigned Working Channel RIC.

17. The Controller directs the LIC to have the LIX disconnect itself from the calling line (to simulate a telephone being put "on hook").

If at the end of the call the caller forgets to press the # key, the callee can push the EXIT, SPC, or designated button on the radio. See the operator’s manual for the radio. The radio will then transmit the disconnect signal to the Working Channel GETC. If neither the caller nor the callee pushes any button or key, the conversation time interval will time out and terminate the call.

Telephone-Originated Call on a Non-Dedicated Line

When a telephone line isn’t dedicated to a Logical (individual) ID or Group ID, telephone-originated calls coming in on these lines can go to any valid radio or group of radios provided the caller has a DTMF keypad.

The sequence of steps for a telephone-initiated telephone interconnect call coming in on a non-dedicated line is as follows:

IDENTIFYING LINE TYPE

1. When a call comes in on one of the telephone lines connected to the Local Telephone Interface, the LIC reports to the Controller that a LIX has detected ringing voltage on a calling line.

2. The Controller receives the report from the LIC that ringing voltage has been detected on a calling line and checks to see if it is permitted to add another telephone interconnect call. There may be a limit, imposed by the System Manager, on the number of telephone interconnect calls allowed at any one time. (If the Controller is not permitted to add another telephone interconnect call, the Controller lets the incoming call go unanswered and never reconsiders that incoming call again, even if room for the call is available before the caller hangs up. So if the caller does not get an answer within 3 ringbacks, the caller should hang up and call again. This ends the sequence here.)

3. If the Controller is permitted to add another telephone interconnect call, the Controller checks to see if the incoming call is on a dedicated line or a non-dedicated line. (If it is on a dedicated line, see the previous sequence of steps for a telephone-initiated telephone interconnect call coming in on a dedicated line.)

BORROWING A RIC

4. If the incoming call is on a non-dedicated line, the Controller checks to see if a RIC is available just to decode DTMF digits from the calling line. The Controller first checks the availability of the Control Channel RIC, since it is not used for Control Channel operation. If the Control Channel RIC is not currently available, the Controller checks to see if one of the Working Channel RICs is available. (If no RIC is currently available, the Controller lets the incoming call go unanswered. The caller should hang up and call back after 3 ringbacks. This ends the sequence here.)

5. If a RIC is available, the Controller directs the LIC to have a LIX connect itself to the calling line (to simulate a telephone being taken "off hook"). A LED on the front of the LIX indicates which line is "off hook".

6. The telephone exchange detects that the calling line (actually the called line from the telephone exchange point of view) has come "off hook", and removes the ringing voltage from the calling line.

7. The Controller directs the LIC to have the LIX connect itself to the borrowed RIC.

8. The Controller directs the borrowed RIC to start sending a dial tone to the calling line.

9. The Controller directs the borrowed RIC to connect its DTMF decoder towards the calling line.

10. The Controller starts a rapid polling mode of operation to poll the LIC and borrowed RIC more frequently than usual.

11. The caller hears the dial tone from the borrowed RIC, and starts sending DTMF digits indicating whether the call is to an individual or a group, whether the call is conventional or Voiceguard, and the ID of the individual or group.

IDENTIFYING CALLED ID

12. The borrowed RIC detects the first DTMF digit and reports it to the Controller.

13. The Controller directs the borrowed RIC to stop sending a dial tone to the calling line, and sets up a counter to count the received DTMF digits.

14. The Controller receives the report from the borrowed RIC and checks the first DTMF digit to see if it is a *, #, or number from 0 to 9. If the first DTMF digit is a *, the call is identified as a group call and the * is counted as a digit. If the first DTMF digit is a #, the call is identified as a Voiceguard call but the # is not counted as a digit. If the first DTMF digit is a number from 0 to 9, the digit is stored in the ID buffer and is counted as a digit.

15. The borrowed RIC detects the next DTMF digit and reports it to the Controller.

16. The Controller receives the report from the borrowed RIC, stores the digit in its ID buffer, and advances the counter by 1. (If the counter is less than 5, return to step 15.)

17. If the counter equals 5, the Controller has received all 5 digits of the ID, and the Controller directs the LIC to have the LIX disconnect itself from the borrowed RIC.

OBTAINING WORKING CHANNEL

18. The Controller checks to see if a Working Channel with a RIC is available. (If no Working Channel with a RIC is currently available, the Controller queues the call. When the call comes out of queue, continue to the next step.)

19. If a Working Channel with a RIC is available, the Controller directs the Control Channel GETC to send the Working Channel assignment to the radio(s) with the Logical (Group) ID called.

20. The Controller directs the assigned Working Channel RIC to connect its associated radio channel for a telephone interconnect call without DTMF regeneration.

21. The Controller directs the LIC to have the LIX connect itself to the assigned Working Channel RIC.

22. The Controller directs the assigned Working Channel RIC to send a call-completion tone to the calling line and the called radio(s). The audio path is now connected between the calling line and the called radio(s).

23. The Controller directs the assigned Working Channel RIC to connect its DTMF decoder to the calling line, to be able to detect the end-of-call DTMF digit from the calling line.

ENDING THE CALL

24. To end the telephone interconnect call, the caller presses the # key on the DTMF keypad of the telephone.

25. The assigned Working Channel RIC detects this end-of-call DTMF # digit and reports it to the Controller.

26. The Controller receives the DTMF digit and identifies it as the end-of-call signal.

27. The Controller directs the assigned Working Channel RIC to disconnect audio.

28. The Controller directs the LIC to have the LIX disconnect itself from the assigned Working Channel RIC.

29. The Controller directs the LIC to have the LIX disconnect itself from the calling line (to simulate a telephone being put "on hook").

If at the end of the call the caller forgets to press the # key, the callee can push the EXIT, SPC, or designated button on the radio. See the operator's manual for the radio. The radio will then transmit the disconnect signal to the Working Channel GETC. If neither the caller nor the callee pushes any button or key, the conversation time interval will time out and terminate the call

Radio-Originated Call

A request for a telephone interconnect call can be made from any radio that is equipped to place telephone interconnect calls, but will only be connected if the Controller's Active Configuration permits that specific radio to place that specific type of call. Of those radios so equipped, some may not be permitted to place any type of telephone interconnect call, some may only be permitted to place a local call, and some may be permitted to place some toll calls in addition to a local calls. The System Manager manages and modifies these call restrictions as needed.

To place a telephone interconnect call, the radio must send telephone number digits to the Controller. There are 3 sources of telephone number digits:

- Telephone number digits may be prestored in the radio when the radio is programmed.
- Telephone number digits may be temporarily stored at the time of the call by entering the telephone number digits using the keypad on the radio.
- Telephone number digits may be sent without being stored, as DTMF digits directly from the keypad on the radio.

A telephone number can be made up entirely from any one of the three sources of telephone number digits, from a combination of one or more prestored digits followed by the remaining DTMF digits, or from a combination of one or more temporarily stored digits followed by the remaining DTMF digits.

Both prestored and temporarily stored telephone number digits are digitally transmitted to the Control Channel GETC where they are translated to Controller protocol and sent to the Controller. DTMF digits are transmitted as audio tones to the assigned Working Channel RIC where they are decoded and sent to the Controller.

The end of a group of prestored or temporarily stored digits, whether or not it is the end of the telephone number, is marked with a digit stream terminator automatically by the calling radio. The end of the telephone number, when the last digit is a DTMF digit, whether or not it is added to the end of a group of prestored or temporarily stored digits, must be marked manually by the caller by pressing the * key following the last digit of the telephone number. Failure to do so will cause the call to be dropped at the end of a timed interval.

All telephone number digits are intercepted, checked for all applicable toll call restrictions, and logged before a telephone line is actually connected and the regenerated DTMF or pulsed digits are sent to the telephone line. Any DTMF overdialed digits, sent by the calling radio after the called telephone answers, are also logged by the Controller but are allowed to pass directly to the telephone line without interception and regeneration.

The sequence of steps for a radio-initiated telephone interconnect call is as follows:

OBTAINING WORKING CHANNEL

1. The radio user sets the radio to the mode of operation that allows an interconnect call, and selects a prestored telephone number or manually enters a temporarily-stored telephone number.

2. he radio user keys the radio, which sends a request on the Control Channel for a telephone interconnect call.

3. The Control Channel GETC receives the request, translates it to Controller protocol, and sends a call request message to the Controller.

4. The Controller receives the call request message from the Control Channel GETC and checks to see if it is permitted to add another telephone interconnect call. There may be a limit, imposed by the System Manager, on the number of telephone interconnect calls allowed at any one time. (If the Controller is not permitted to add another telephone interconnect call, the Controller directs the Control Channel GETC to send a busy signal to the calling radio. This ends the sequence here.)

5. If the Controller is permitted to add another telephone interconnect call, the Controller checks to see if the caller is allowed to place some type of telephone interconnect call. (If the caller is not allowed to place some type of telephone interconnect call, the Controller directs the Control Channel GETC to send a call-denied signal to the calling radio. This ends the sequence here.)

6. If the caller is allowed to place some type of telephone interconnect call, the Controller checks to see if the LIC appears to be working. (If the LIC appears to have failed, the Controller directs the Control

Channel GETC to send a call-denied signal to the calling radio. This ends the sequence here.)

7. If the LIC appears to be working, the Controller checks to see if a telephone line is available. (If a telephone line is not available, the Controller directs the Control Channel GETC to send a busy signal to the calling radio. This ends the sequence here.)

8. If a telephone line is available, the Controller allocates a telephone line for the telephone interconnect call and checks to see if a Working Channel with a RIC is available. (If a Working Channel with a RIC is not available, the Controller queues the call request and directs the Control Channel GETC to send a cueued-call signal to the calling radio. When the call request comes out of queue, continue to next step.)

9. The Controller directs the Control Channel GETC to send the Working Channel assignment to the calling radio and directs the assigned Working Channel GETC to establish contact with the calling radio.

10. The calling radio receives the Working Channel assignment from the Control Channel GETC and tunes to the assigned Working Channel.

DIGITALLY-TRANSMITTED DIGITS

11. The calling radio confirms the connection with the assigned Working Channel GETC, and digitally transmits all of the prestored or temporarily stored telephone number digits and the digital stream terminator to the Working Channel GETC. The assigned Working Channel GETC and the calling radio handshake until the digital stream terminator is received. (If the digital stream terminator is not received by the assigned Working Channel GETC within the allowed time interval, the Controller directs the assigned Working Channel GETC to terminate the call and deallocate the telephone line. This ends the sequence here.)

12. he assigned Working Channel GETC receives all of the prestored or temporarily stored telephone number digits and the digital stream terminator from the calling radio, translates them to Controller protocol, and sends them in a message to the Controller. More than one message may be sent, depending on the length of the telephone number.

13. The Controller receives the message(s) containing the telephone number digits and the digital stream terminator from the Working Channel GETC, translates the message(s) into telephone number digits and stores them, and counts how many telephone number digits were received before the digital stream terminator was received.

14. If 4 or more telephone number digits were received before receiving the digital stream terminator, the Controller checks the first 4 telephone number digits for all applicable toll call restrictions for that radio. Go to step 32. (If the Controller determines that the 4 telephone number digits fail any applicable toll call restriction, the Controller directs the assigned Working Channel GETC to terminate the call and deallocate the telephone line. This ends the sequence here.)

15. If less than 4 telephone number digits were received before receiving the digital stream terminator, the Controller assumes that the digits received (if any) are the very first digits of the telephone number and checks for all applicable toll call restrictions for that radio, using all possible values for any of the 4 digits that are missing. (If the Controller determines that the telephone number digits (or the lack of them) fails any applicable toll call restrictions for that radio, the Controller directs the assigned Working Channel GETC to terminate the call, and deallocates the telephone line. This ends the sequence here.)

DTMF CODED DIGITS

16. The Controller directs the assigned Working Channel RIC to connect its DTMF decoder to intercept DTMF digits from the calling radio.

17. The Controller directs the assigned Working Channel RIC to generate and send a psuedo dial-tone to the calling radio.

18. The Controller starts a timer. (If the Controller does not receive a message from the assigned Working Channel RIC containing the first DTMF digit within the time allowed, the Controller directs the assigned Working Channel GETC to terminate the call, directs the assigned Working Channel RIC to stop generating and sending a psuedo dial-tone to the calling radio, and deallocates the telephone line. This ends the sequence here.)

19. The Calling radio receives the psuedo dial-tone and the caller proceeds to send DTMF digits using the DTMF keypad on the radio.

20. The assigned Working Channel RIC receives the first DTMF digit from the calling radio, translates it to Controller protocol, and sends a message containing the first DTMF digit to the Controller.

21. The Controller receives a message from the assigned Working Channel RIC containing the first DTMF digit, directs the assigned Working Channel RIC to stop generating and sending a psuedo dial-tone to the calling radio, stores this DTMF digit with any previously received digitally-transmitted telephone number digit(s) if there were any, and counts the total number of telephone number digits accumulated so far.

22. If the number of accumulated telephone number digits is now 4, go to step 26.

23. If the number of accumulated telephone number digits is still less than 4, the Controller starts a timer. (If the Controller does not receive a message containing the next DTMF digit within the time allowed, the Controller directs the assigned Working Channel GETC to terminate the call, and deallocates the telephone line. This ends the sequence here.)

24. The assigned Working Channel RIC receives the next DTMF digit from the calling radio, translates it to Controller protocol, and sends a message containing the next DTMF overdialed digit to the Controller.

25. The Controller receives a message containing the next DTMF digit, stores the digit. with the previously received telephone number digits, and counts the number of telephone number digits accumulated. (If less than 4 telephone number digits have been accumulated, return to step 23.)

26. If 4 telephone number digits have been accumulated, the Controller checks these 4 accumulated telephone number digits for all applicable toll call restrictions for that radio. (If the Controller determines that these 4 telephone number digits do not pass all applicable toll call restrictions for that radio, the Controller directs the assigned Working Channel GETC to terminate the call, and deallocates the telephone line. This ends the sequence here.)

27. If the Controller determines that these 4 telephone number digits do pass all applicable toll call restrictions for that radio, the Controller starts a timer. (If the Controller does not receive a message containing the next DTMF digit within the time allowed, the Controller directs the assigned Working Channel GETC to terminate the call, and deallocates the telephone line. This ends the sequence here.)

28. The assigned Working Channel RIC receives the next DTMF digit from the calling radio, translates it to Controller protocol, and sends a message containing the next DTMF digit to the Controller.

29. The Controller receives a message containing the next DTMF digit and checks to see if it is the * key indicating the end of the telephone number. (If the DTMF digit is the * key, go to step 32.)

30. If the DTMF digit is not the * key, the Controller checks to see if it has room to store any more digits. A maximum of 32 digits can be stored for a telephone number. (If the Controller has already stored 32 digits, the Controller directs the assigned Working Channel GETC to terminate the call, and deallocates the telephone line. This ends the sequence here.)

31. If the Controller has not already stored 32 digits, the Controller stores this DTMF digit with the previously stored digits. Return to step 27.

DIALING TO TELEPHONE LINE

32. The Controller directs the assigned Working Channel RIC to look for dial tone from the telephone line.

33. The Controller directs the LIC to have the LIX connect itself to the allocated telephone line (to simulate a telephone being taken "off hook").

34. The Controller directs the LIC to have the LIX connect itself to the assigned Working Channel RIC.

35. The Controller starts a timer for the dial tone

36. The telephone exchange detects that the allocated line is "off hook", and applies dial tone to the allocated line.

37. If the assigned Working Channel RIC detects dial tone, go ahead to step 43.

38. If the assigned Working Channel RIC does not report to the Controller that it has detected dial tone within the time allowed by the Controller, the Controller directs the RIC to send a momentary tone to both the radio and the telephone line to indicate that a problem has been encountered.

39. The Controller directs the LIC to have the LIX disconnect itself from the assigned Working Channel RIC.

40 The Controller directs the LIC to have the LIX disconnect itself from the allocated line.

41. The Controller checks to see if a telephone line is available. (If a telephone line is not available, the Controller directs the Control Channel GETC to send a busy signal to the calling radio.

42. If a telephone line is available, the Controller allocates that line for the telephone interconnect call. Return to step 32.

43. The assigned Working Channel RIC reports to the Controller that it has detected dial tone.

44. The Controller receives the report from the assigned Working Channel RIC and checks to see if the allocated telephone line requires pulsed or DTMF dialing.

45. If pulsed dialing is required, the Controller directs the LIC to apply dial pulses on the allocated telephone line corresponding to each digit of the telephone number called. The caller will hear the dial pulsed digits as they are sent.

46. If DTMF dialing is required, the Controller directs the assigned Working Channel RIC to generate and send the DTMF digits to the allocated telephone line. The caller will hear the DTMF digits as they are sent.

47. The Controller directs the assigned Working Channel RIC to connect its DTMF decoder to the assigned Working Channel to detect any DTMF overdialed digits that might come from the radio.

48. The Controller starts a timer for the telephone interconnect call.

49. When the called telephone answers, the audio path is connected between the calling radio and the called telephone.

ENDING THE CALL

50 If the caller terminates the call before the time allowed by the Controller, go to step 51. If the timer times out first, go to step 54.

51. The telephone interconnect call can be terminated by pressing the EXIT button on the front of the radio, to cause the radio to transmit a digitally transmitted end-of-call signal to the assigned Working Channel GETC.

52. The assigned Working Channel GETC or RIC receives the end-of-call signal from the calling radio, and sends it in a message to the Controller.

53. The Controller receives the message from the assigned Working Channel GETC or RIC and determines that it is the end-of-call signal.

54. The Controller directs the assigned Working Channel RIC to disconnect audio.

55. The Controller directs the LIC to have the LIX disconnect itself from the assigned Working Channel RIC.

56. The Controller directs the LIC to have the LIX disconnect itself from the allocated telephone line.

57. The Controller directs the assigned Working Channel GETC to terminate the call.

POWER MONITOR UNIT OPTION

The Power Monitor Unit (PMU) operates by following its own custom PMU software and responding to messages from the Controller. The System Manager has control over the following PMU parameters in the Controller's Active Configuration:

- PMU Enabled (default is enabled)
- PMU Power Level (alarm threshold of the output power level - default is 30 watts)

The Controller communicates with the PMU through a 2400 baud serial data link. Message bytes are made up of 8 data bits, 1 stop bit, and no parity bit. See Interconnection Diagrams 6A and 6B.

The Controller uses the following 6 messages to supervise the operation of the PMU:

- Clear Alarms
- Poll
- Enable Mask
- Program Threshold
- Power Request
- On Channel

The PMU uses the following 2 messages to report the results of its activities to the Controller:

- Status
- Channel Power

When the PMU powers-up or the Controller is reset, the Controller sends a Clear Alarm message to the PMU which causes the PMU to clear all 22 alarm circuits.

The PMU enables or disables each individual alarm circuit using information from the Enable Mask message received from the Controller.

The PMU sends a Status message to the Controller each time it receives a Poll message from the Controller. The Status message contains the current state of all 22 alarm circuits. Only enabled alarm circuits report alarm conditions.

The PMU determines if an alarm condition has been met by comparing the measurements and calculations to the threshold values programmed through the front keypad. The minimum transmit power threshold values can also be adjusted by the System Manager, by having the Controller send a Program Threshold message to the PMU.

The PMU only makes measurements for a specific channel's transmitter when that transmitter is in use under the direction of the Controller. As the Controller directs a Working Channel, it also sends a Channel Assignment message and a Channel Drop message to the PMU, so the PMU knows when to start and stop the measurements, and which channel's RF sensors to measure. (Which antenna is used with which transmitter must be programmed into the PMU at installation time using the front keypad.)

When the PMU determines that an alarm condition has been met and the alarm circuit is enabled, the PMU immediately sends a Status message to the Controller without waiting to receive a Poll message.

TEST AND ALARM UNIT OPTION

The Test and Alarm Unit (TAU) option is made up of the Alarm and Control Unit (ACU), and the Test Unit (TU). The ACU can also be operated without the TU, but the TU can't be operated without the ACU (because the TU depends upon interface circuitry in the ACU to communicate with the Controller).

Alarm and Control Unit

The Alarm and Control Unit (ACU) operates by following its own ACU software and responding to messages from the Controller. The System Manager has control over the following ACU parameters in the Controller's Active Configuration:

- Enabled (which alarm circuits are enabled - default is disabled)
- Active High (which alarm circuits are considered active or alarmed for a logic high input)
- Major (which alarm circuits are considered major alarms)
- Relay On (which relays are set - default is reset)

The Controller communicates with the ACU through a 19.2 Kbaud asynchronous serial data link. Message bytes are made up of 8 data bits, 1 stop bit, and no parity bit. See Interconnection Diagram 7.

The Controller uses the following 4 messages to supervise the operation of the ACU:

- Poll
- Set Relays
- Alarm Mask
- Reset

The ACU uses the following message to report the results of its activities to the Controller:

- Status

All 4 messages from the Controller give the latest status of the 8 system status parameters listed on the front of the ACU. The ACU responds by turning LEDs on and off as needed.

The Status message from the ACU gives the latest status of 32 alarm inputs, 8 control outputs, and 8 alarm unit status parameters. This status information is also displayed on the front of the ACU.

The Controller sends a Poll message at regular intervals. The ACU responds each time with a Status message.

The Alarm Mask message from the Controller contains three 32-bit masks. The Enable/Disable mask contains a 1 in the bit locations representing each alarm input to be enabled. The ACU responds by reporting a disabled alarm input as normal (not in the alarm state), whether the actual alarm input is in the normal or the alarm state. The Active Hi/Low mask contains a 1 in the bit locations representing each alarm input where the alarm state is a logic high. The ACU uses this mask to determine the alarm state for each alarm input. The Major/Minor Alarm mask contains a 1 in the bit locations representing each alarm point designated as a major alarm. The ACU uses this mask to determine if an alarm is a major alarm or a minor alarm.

The ACU continually scans the 32 alarm inputs, looking for changes from user-supplied alarm-sensing devices. The

ACU uses the Active Hi/Low mask to determine an alarm state and the Enable/Disable mask to determine whether to ignore it or report it. Whenever the ACU detects a change in an enabled alarm input, the ACU sends a status message to the Controller. If the detected change is to an alarm condition, the ACU uses the Major/Minor Alarm mask to determine which alarm unit status LED to turn on.

The ACU also continually scans the 8 control output relay positions using the Set Relays message mask. If a discrepancy is detected, the ACU turns on the "RELAY ERROR" LED in the "ALARM UNIT STATUS" display group and tries to set (or reset) the appropriate relay. If the relay is successfully set (or reset), the discrepancy disappears and the "RELAY ERROR" LED is turned off.

The Set Relays message from the Controller contains an 8-bit mask containing a 1 in the bit locations representing each control output relay that should be set (N.O. contacts closed). The ACU responds by setting (or resetting) each control relay to agree with the mask.

The Reset message from the Controller causes the ACU to initiate a reset cycle, during which time the ACU performs a diagnostic self test. During this self test, the ACU disables all 32 alarm inputs, leaves all 8 control output relays in their existing positions, and turns on all front panel LEDs. If a problem is detected, the ACU sends a message to the Controller identifying the problem.

Test Unit

The Test Unit (TU) operates by following its own TU software and responding to messages from the Controller. The System Manager has control over the following TU parameters in the Controller’s Active Configuration:

- TU Enabled (default is enabled)
- Testcall Enabled (default is enabled)
- Background Testcall Interval (the time interval between test calls - default is 5 minutes - note that an interval of 0 inhibits test calls)

The Controller communicates with the TU through a 19.2 Kbaud asynchronous serial data link. Message bytes are made up of 8 data bits, 1 stop bit, and no parity bit. See Interconnection Diagram 7.

The Controller uses the following 4 messages to supervise the operation of the TU:

- Reset
- Status Request
- Monitor Control Channel
- Testcall State

The TU uses the following 3 messages to report the results of its activities to the Controller:

- Status Response
- CC Fail
- Call Results

During normal operation, the TU operates in one of the following states:

- Power-Up
- Initialization
- Set-Up
- Monitor
- Test Call

Power-Up

The TU is in the Power-Up state when power is first applied or after receiving the Reset message from the Controller. In the Power-Up state the Test Unit sets all switching circuits to a predetermined known state and performs self-diagnostic checks. When these tasks are finished, the TU sends a Status Response message to the Controller and waits for a Status Request message from the Controller. Individual bits within the Status Response message tell the Controller

- Presence of Personality
- Presence of Error in Memory
- Synthesizer Locked
- Operational State

If a Status Request message is not received within 10 seconds, the TU again sends a Status Response message and again waits for a Status Request message. This continues until a Status Request message is received from the Controller.

Initialization

The TU enters the Initialization state after it has received the first Status Request message from the Controller. Upon entering this state, the TU sends another Status Response message to the Controller and proceeds to the Set-Up state.

Set-Up

The TU is in the Set-Up state when it has finished its last task and is waiting for a new task.

Monitor

The TU enters the Monitor state when it receives the Monitor Control Channel message from the Controller. Upon entering this state, the TU sets its receiver to the frequency of the current Control Channel number (given in the Monitor Control Channel message) and begins monitoring the outbound Control Channel.

Monitoring the Control Channel is the primary function of the TU. Control Channel monitoring consists of the following chores:

1. Obtaining synchronization with the outbound Control Channel data frames.
2. Decoding the outbound Control Channel data.
3. Verifying the site ID from the outbound Control Channel data.

If the TU is unable to do any one or more of these chores, the TU sends the CC Fail message to the Controller and returns to the Set-Up state. When the Controller receives the CC Fail message, it logs the failure and sends a CC Monitor message with a new Control Channel number to the TU. When the TU receives the new CC Monitor message, it returns to the Monitor state and begins monitoring the new Control Channel.

If the number of failed channels, as a percentage of the total channels at the site, reaches 50%, the Controller searches its activity log to find and disable the piece of equipment responsible for identifying most of the failures under the assumption that it is falsely failing channels. If, in such a case, the TU is the suspect piece of equipment, the Controller effectively disables the TU by sending the Reset message and no more messages.

Test Call

The TU enters the Test Call state when it receives the Testcall State message from the Controller. Upon entering this state, the TU initiates a simulated mobile-originated, channel-request sequence. A normal (successful) sequence contains the following major steps (a failure at any step in the sequence causes a jump to step 13):

1. The TU receives the Testcall State message from the Controller.
2. The TU sets itself to the frequency of the Control Channel and obtains synchronization with the outbound Control Channel data frames.
3. The TU sends a request for an individual call and waits to receive a Working Channel assignment. (For call requests, the TU uses a Logical ID of 0 for both the caller and callee.)
4. The TU receives the Working Channel assignment and sets itself to the frequency of the assigned Working Channel.
5. The TU receives the high-speed-data channel confirmation from the Working Channel.
6. The TU sends the high-speed-data key message followed by low-speed data to the Working Channel.
7. The Working Channel detects the high-speed-data key message followed by low-speed data from the TU.
8. The TU stops sending low-speed data to the Working Channel.
9. When the Working Channel stops receiving the low-speed data from the TU, it starts a 2-second hang time interval. During this interval, the Working Channel transmitts low-speed data, if in a wide-band system. (For 900 MHz systems, the Working Channel transmitts pre-drop alert dotting for the first 0.7 second, followed by low-speed data for the remaining 1.3 second.)
10. The TU detects and checks the low-speed data in a wide-band system; pre-drop alert dotting in a 900 MHz system.
11. Approximately 2 seconds after the Working Channel stops receiving the low-speed data from the TU, the Working Channel transmits the drop-channel message.
12. The TU receives the drop-channel message.
13. The TU sends the Call Results message to the Controller, and returns to the Set-Up state to wait for further instructions.

If the Working Channel fails the test, the Controller removes it from service and logs the failure. If the number of failed channels, as a percentage of the total channels at the site, reaches the number specified in the Personality PROM (default is 50%), the Controller disables the piece of equipment responsible for identifying most of the failures under the assumption that it is falsely failing channels. If, in such a case, the TU is the suspect piece of equipment, the Controller effectively disables the TU by sending the Reset message and no more messages.

TROUBLESHOOTING

This section will be expanded in future revisions. However, for now the following three techniques are especially useful for troubleshooting EDACS Site Controllers:

1. Comparison - Compare all of the readily measurable parameters of a suspect assembly with an identical, known-to-be-good assembly. If a significant difference is found, then the problem may have been located.

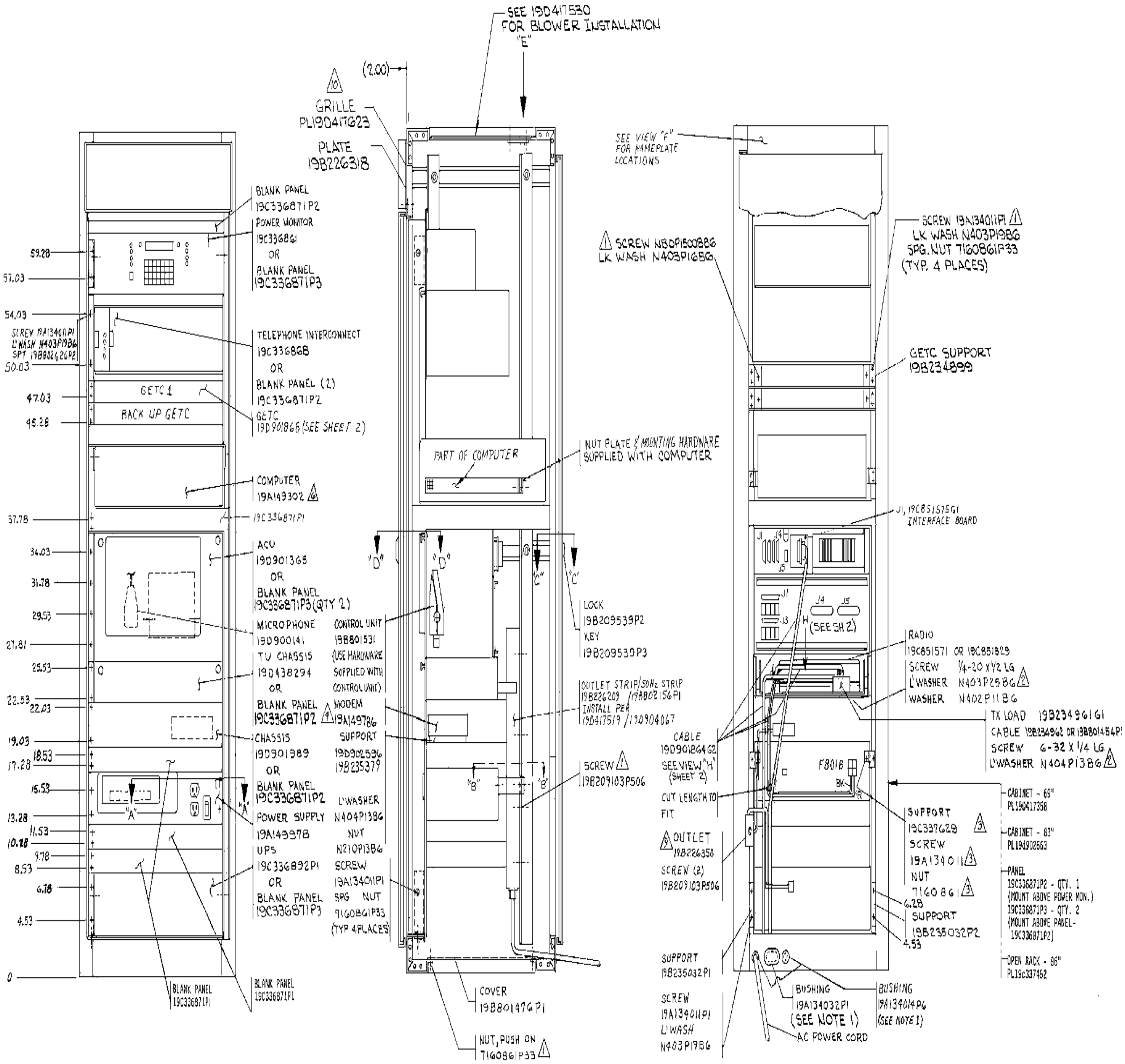
2. Substitution - Exchange the suspect assembly with an identical, known-to-be-good assembly. If the problem moves, then the defective component must have moved also.

3. Divide and Conquer - Divide the equipment in half and find a symptom of the problem that appears in one half only. Then divide that half in half and repeat until you come to a point where the problem exists on one side of a replaceable component and not on the other.

GLOSSARY

Control Channel GETC	A Control Channel GETC is a Station GETC that is at the moment connected to a Control Channel.
Controller	The 32-port computer housed in the EDACS Site Controller cabinet and responsible for directing the Full Featured Trunking at the site.
Controller's Active Configuration	The Controller's Active Configuration is the Controller's Initial Configuration modified by the current Site Database from the System Manager.
Controller Application Software	The Controller Application Software is the programming instructions read from the Controller's 12 Application Software PROMs. It is used by the Controller to control the operation of the site.
Controller's Initial Configuration	The Controller's Initial Configuration is the data read from the Controller's 2 Personality PROMs. It is usually only present at power up or reset, but will remain the Controller's Active Configuration until System Manager communication is established (if ever).
Controller's Personality PROMs	The Controller's Personality PROMs contain certain information about the specific site where the Controller is located, such as Site ID, equipment available at the site, validation tables by feature and priority for each Logical (individual) ID and Group ID, etc.
Downlink GETC	A Downlink GETC is the GETC that is connected to the Downlink to the multisite/console switch. The Downlink GETC provides the communications interface between the Downlink and the Controller (or between the Downlink and the Failsoft Data Link to the Station GETCs in the event of a Controller failure).
EDACS	EDACS is the acronym for Enhanced Digital Access Communications System.
EDACS Site Controller	The EDACS Site Controller is all that standard and optional equipment housed in the single cabinet that houses the Controller (computer).
Failsoft Data Link	The Failsoft Data Link is a daisy-chained data link connecting all the Station GETCs to the Downlink and Redundant Downlink GETCs. The Failsoft Data Link provides the communications path needed for Failsoft Trunking in the event of a Controller failure, or a combination Controller and Downlink GETC failure.
Failsoft Trunking	Failsoft Trunking is an EDACS design feature that puts the Control Channel GETC in charge of basic trunking in the event of a Controller failure.

Full Featured Trunking	Full Featured Trunking is any trunking under the direction of the Controller utilizing all features of its customer specific configuration (however many or few features they are).
GETC	A GETC is a communications interface with various hardware and software configurations. For specific configurations, see: Station GETC Control Channel GETC Working Channel GETCDownlink GETC Redundant Downlink GETC
Redundant Downlink GETC	A Redundant Downlink GETC is the GETC that is connected to the Redundant Downlink to the multisite/console switch. The Redundant Downlink GETC provides the communications interface between the Redundant Downlink and the Controller (or between the Redundant Downlink and the Failsoft Data Link to the Station GETCs in the event of a Controller failure).
Site Database	The Site Database is the specific information about the site, such as equipment available at the site, validation tables by feature and priority for each Logical (individual) ID and Group ID, etc. maintained by the System Manager.
Station GETC	A Station GETC is the GETC that is connected to a MASTR II, IIe, or III repeater station to make it an EDACS trunk. The Station GETC provides the communications interface between the repeater station and the Controller (or between the repeater station and other Station GETCs in the event of a Controller failure). A Station GETC can more specifically be called a Control Channel GETC or a Working Channel GETC depending upon how it is being used at that moment.
System Manager Modem	The System Manager Modem is a telephone channel modem serving as the data interface between the Controller and the telephone line used as the data link to the System Manager (through a second modem at the far end).
Working Channel GETC	A Working Channel GETC is a Station GETC that is at the moment connected to a Working Channel.



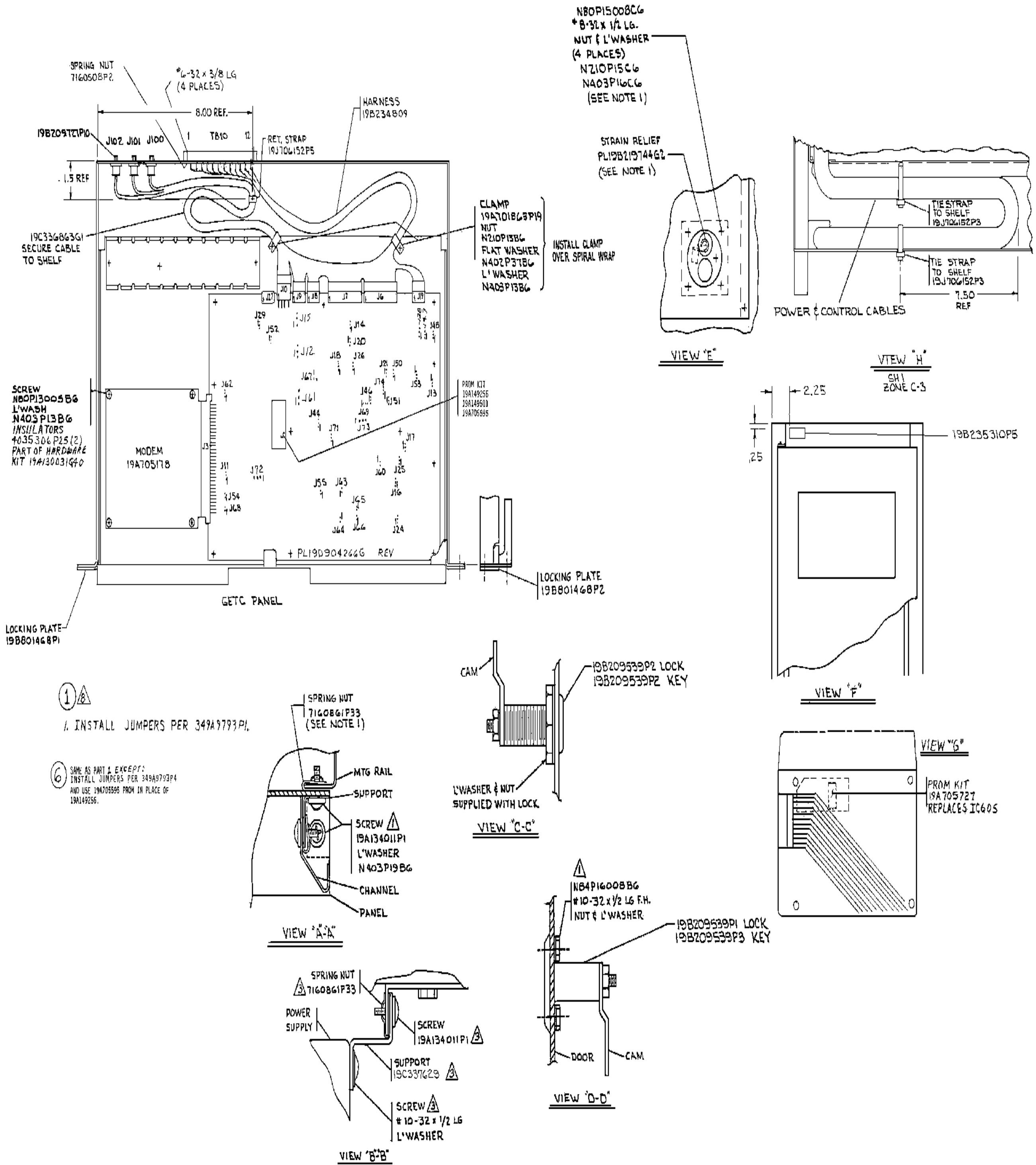
NOTES: (CONT ON SH.3)

1. PART OF HARDWARE KIT 19A130031G12 (STD. CABINET)
3. PART OF HARDWARE KIT 19A149326G8 (POWER SUPPLY)
4. TIE-STRAP MODEM POWER SUPPLY TO SHELF FOR SHIPPING.
5. INTERCONNECT DIAG 19B234964 AND 344A4663.
6. PLACE DEC LICENSE WITH THE MATCHING SERIAL NUMBER IN ENVELOPE PROVIDED AND TAPE TO THE INSIDE OF THE BACK DOOR OF THE CABINET.
8. DO NOT CONNECT P2, P8 AND P19 OF 19B234809G4 FOR OPTION PSCPIK
9. PLUG MODEM, 19A149786 AND COMPUTER 19A149302 INTO OUTLET STRIP AND OUTLET STRIP INTO ...
10. IF ERICSSON NAMEPLATE IS SUPPLIED, RETURN GE NAMEPLATE TO STOCK OR DISCARD.

(1) SITE CONTROLLER
(2) TEST & ALARM UNIT
(3) TSIN GETC OPTION PSCPIK

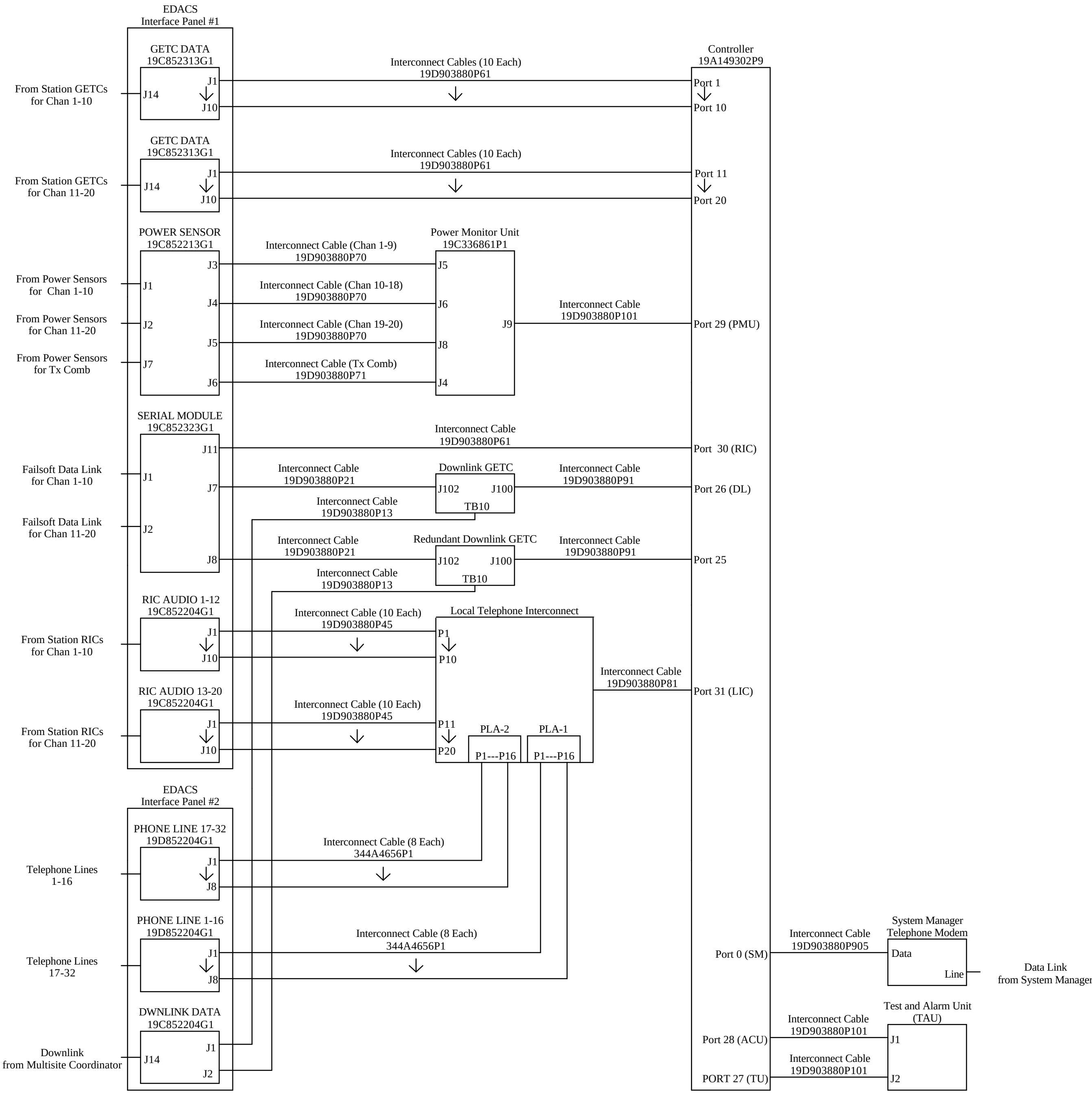
Application Assembly

(19D438315, Sh. 1, Rev. 18)

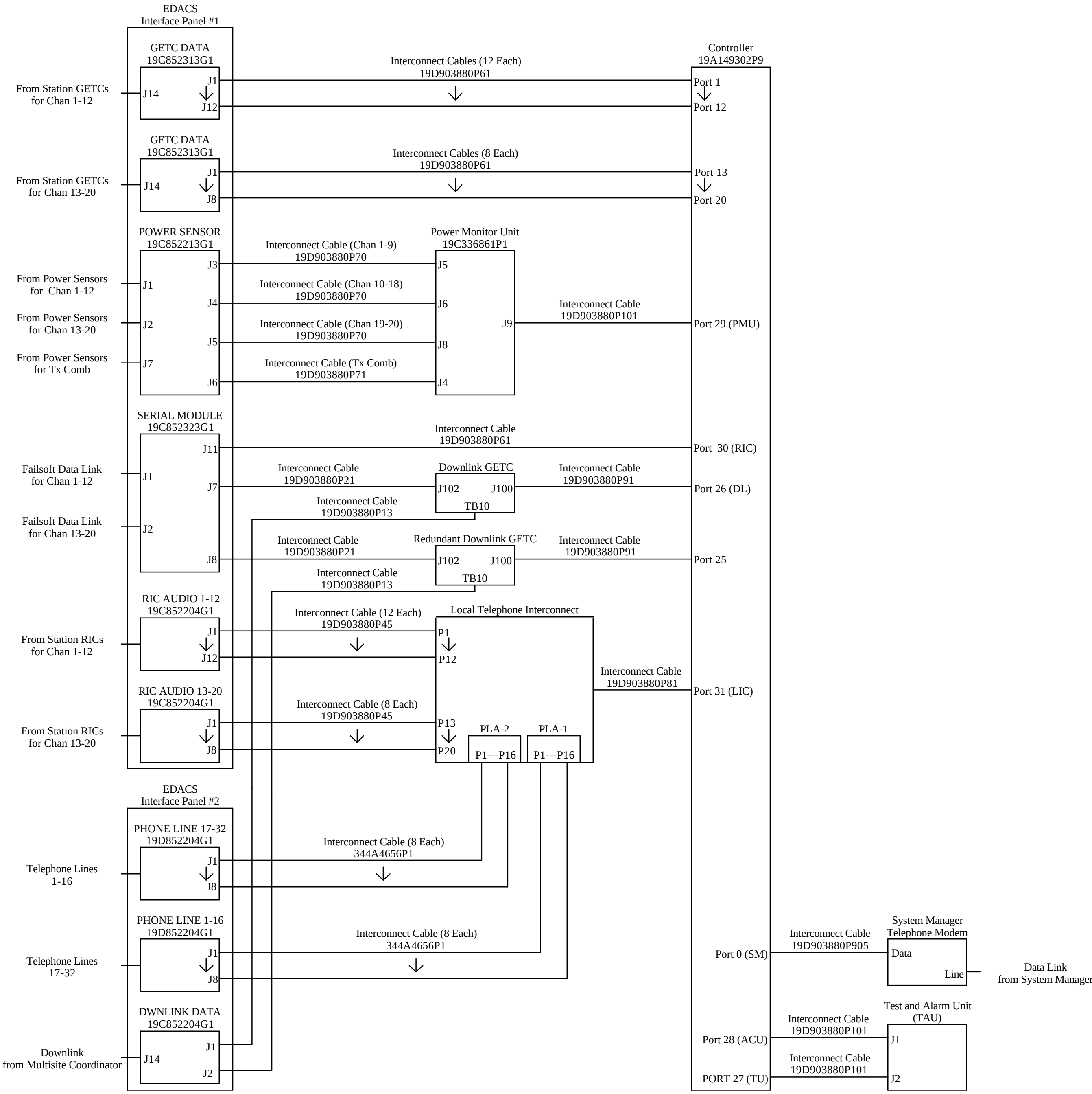


Application Assembly

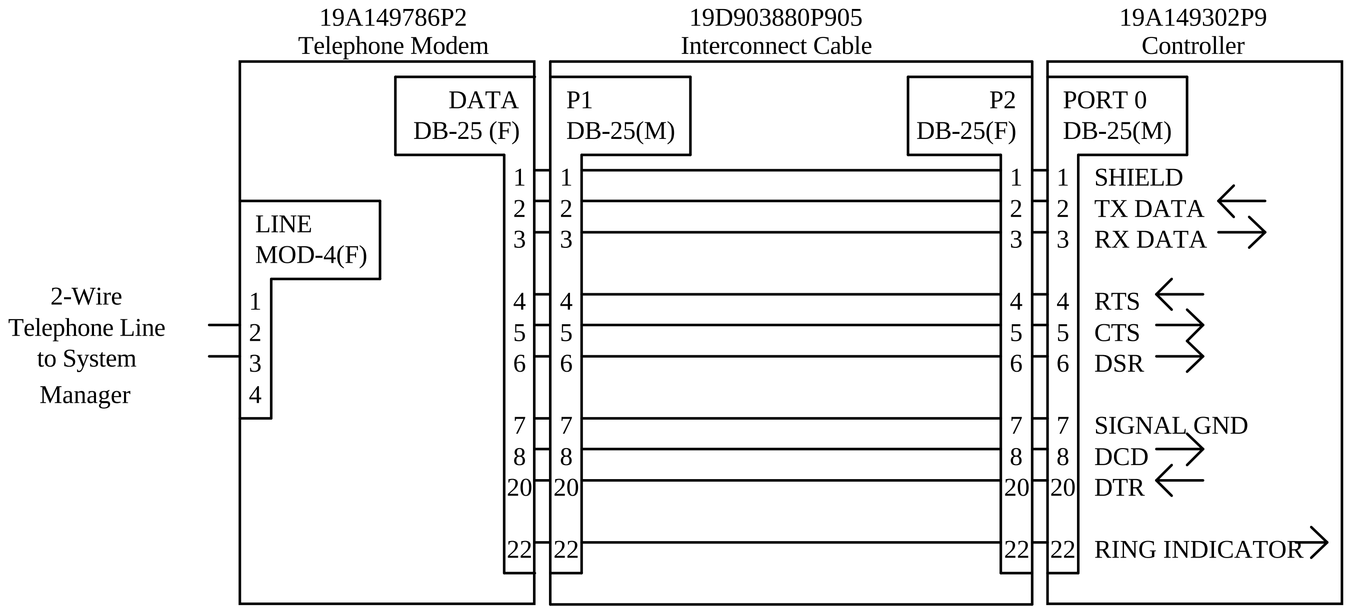
(19D438315, Sh. 2, Rev. 14)



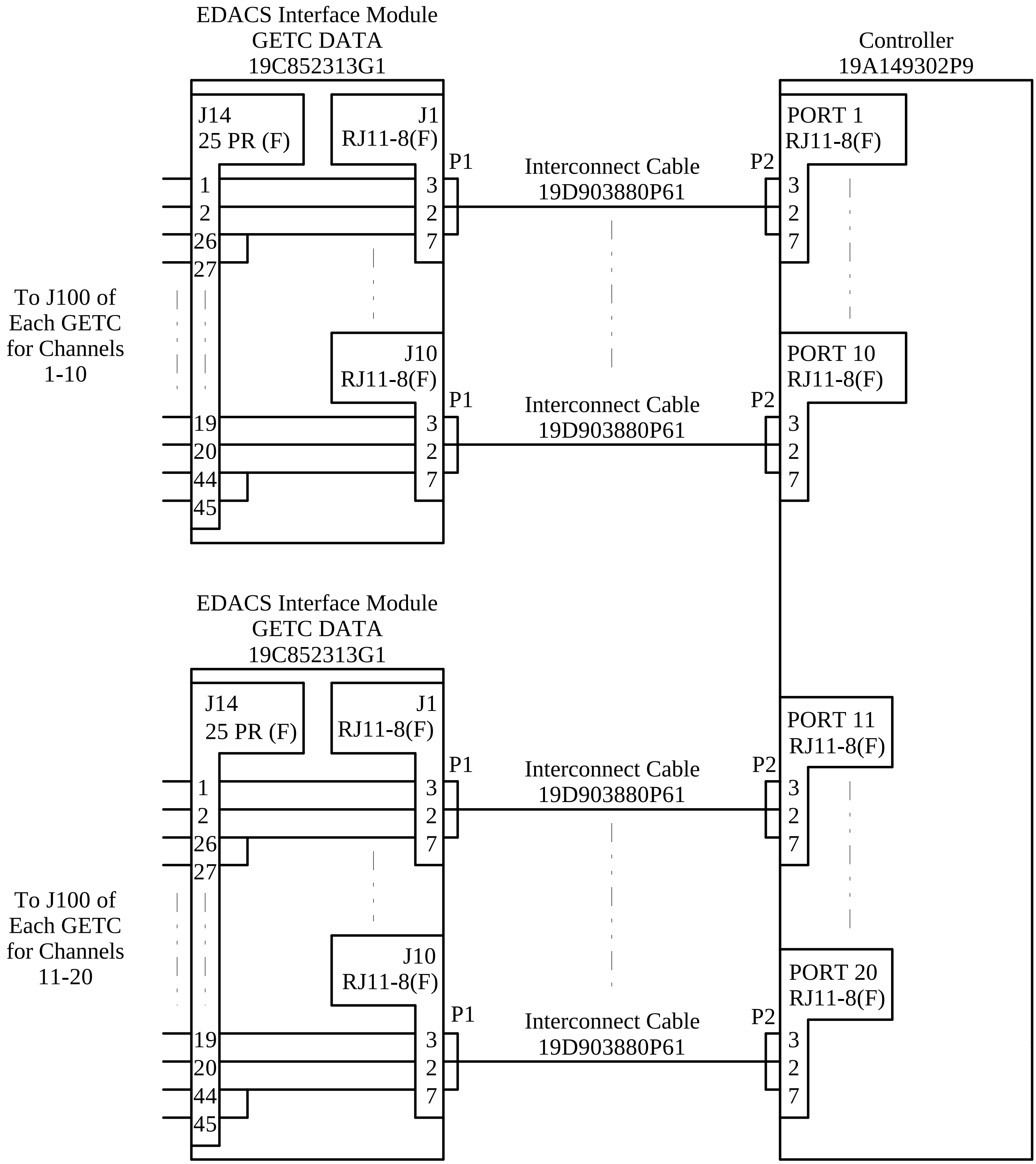
Interconnection Diagram #1A
EDACS Site Controller (For Sites with 2 Repeaters Per Cabinet)



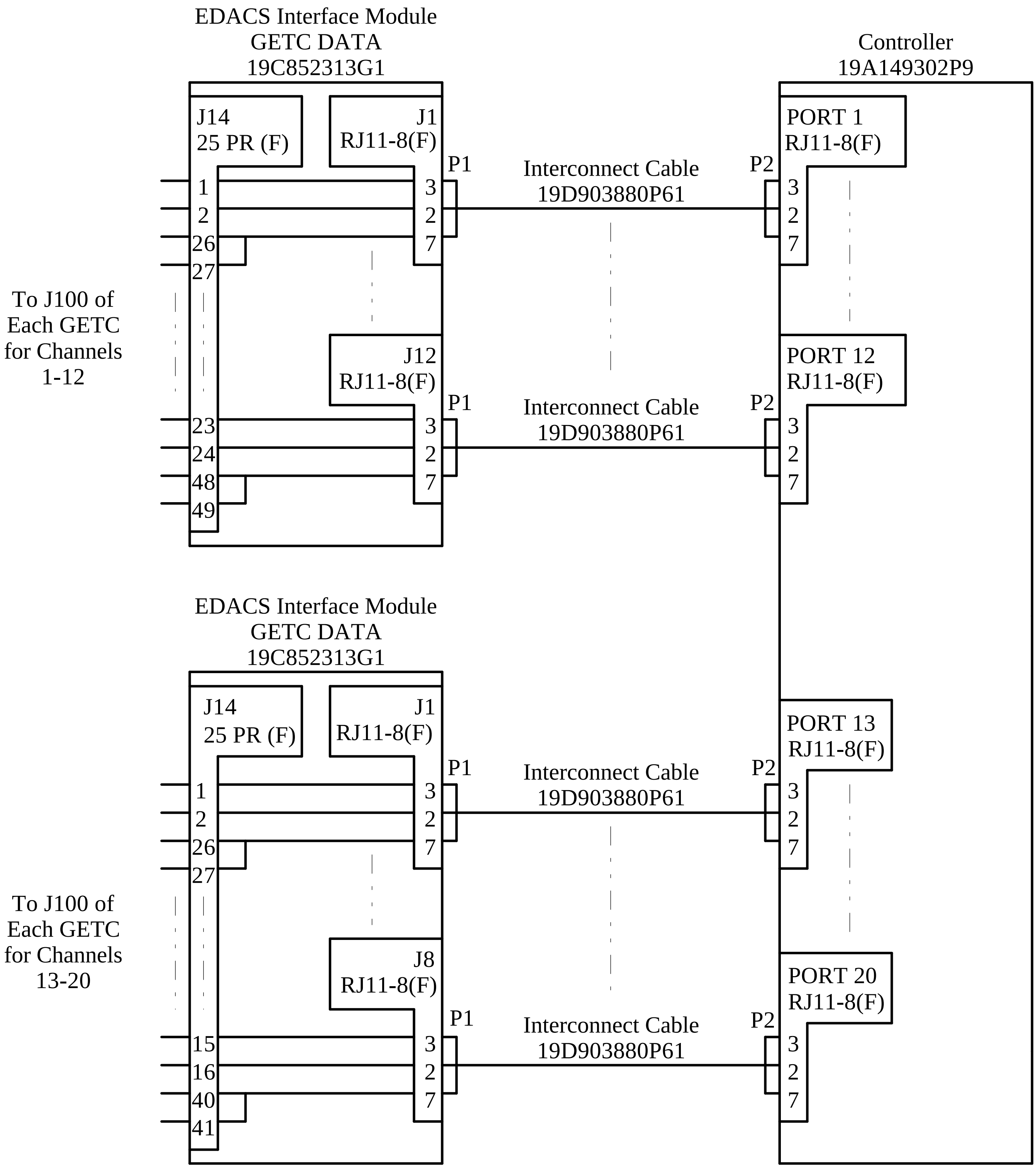
Interconnection Diagram #1B
EDACS Site Controller (For sites With 3 Repeaters Per Cabinet)



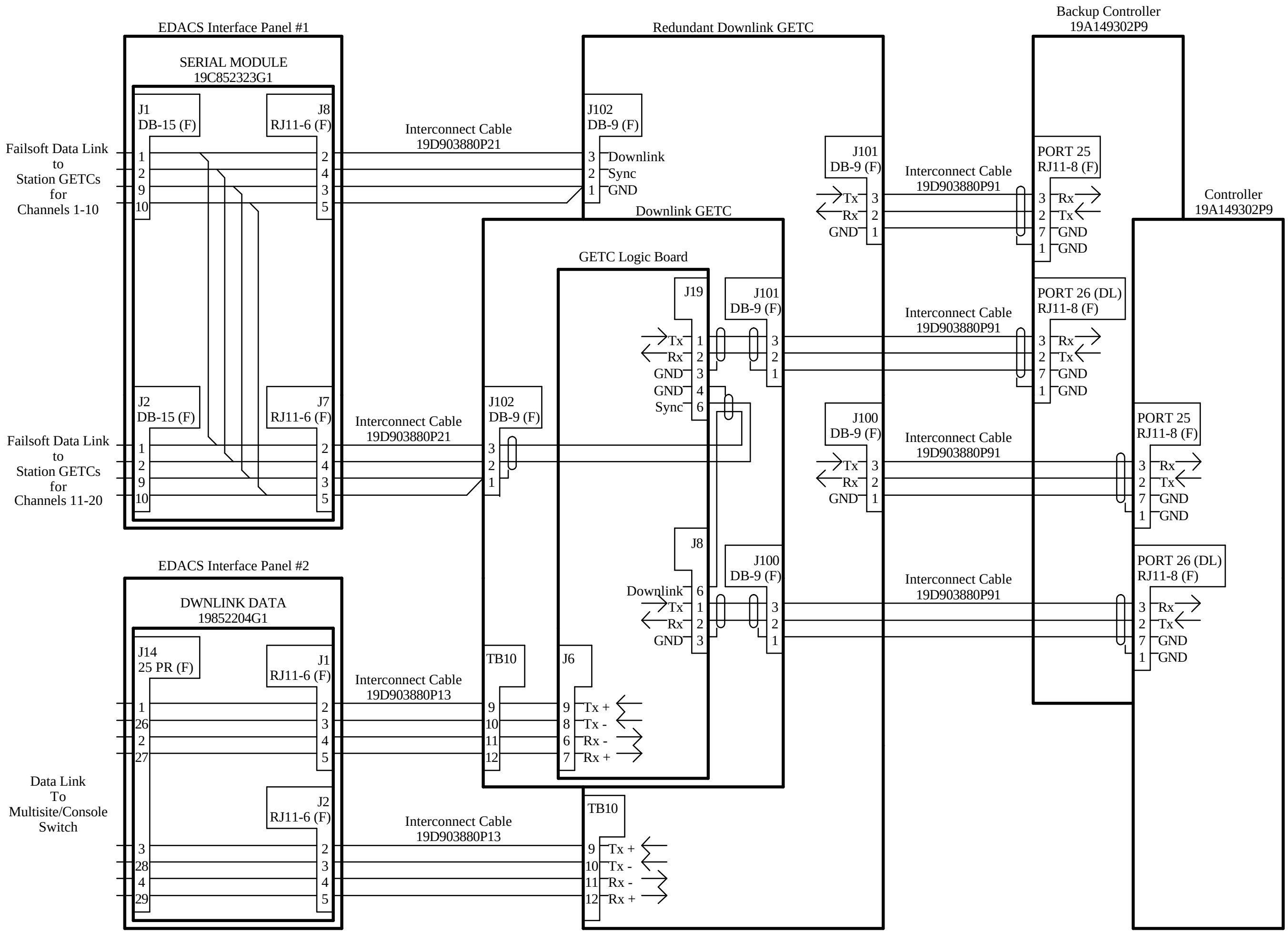
Interconnection Diagram #2
System Manager Data Link



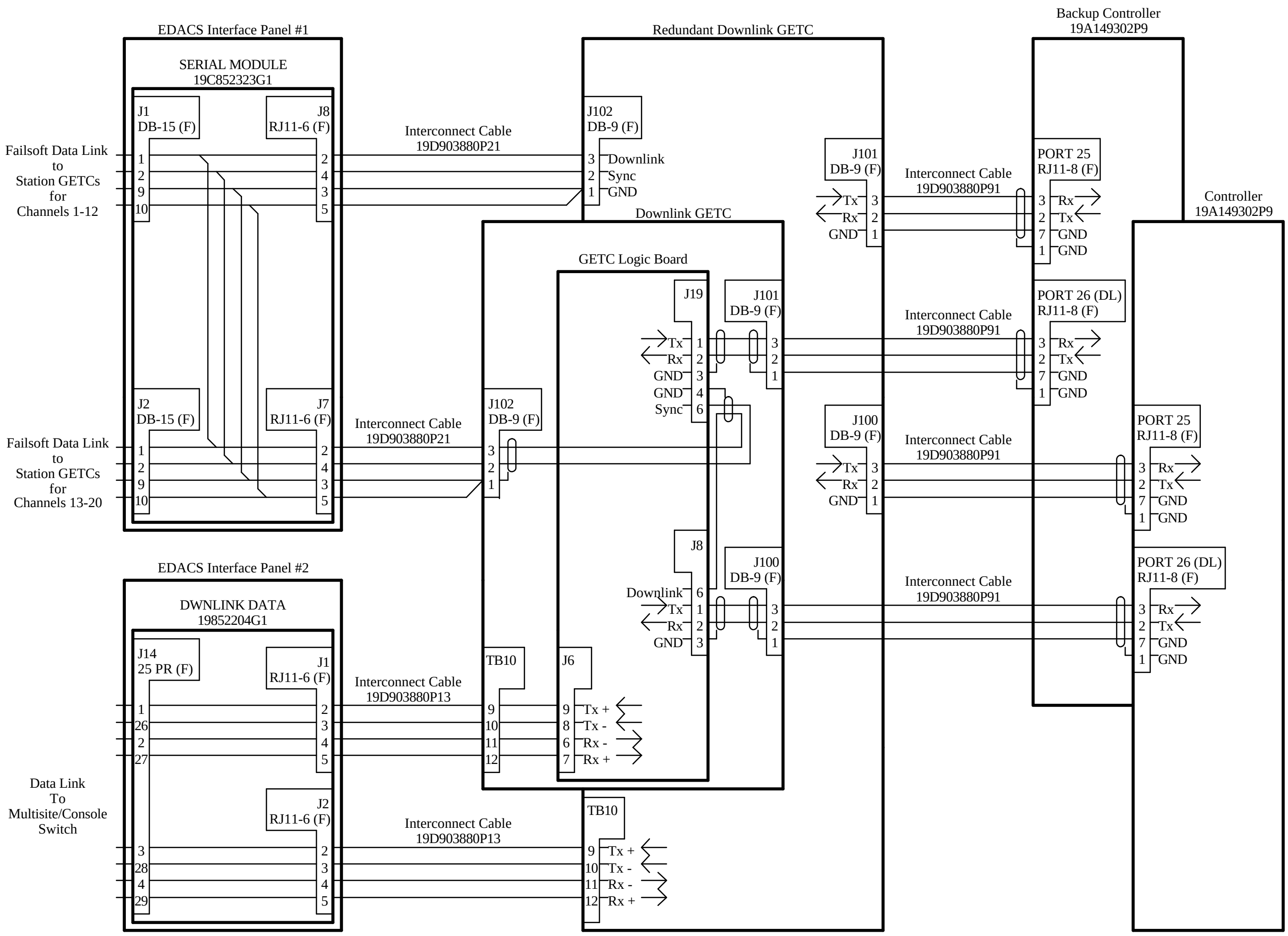
Interconnection Diagram
Station GETC Data Links (For Sites With 2 Repeaters Per Cabinet)



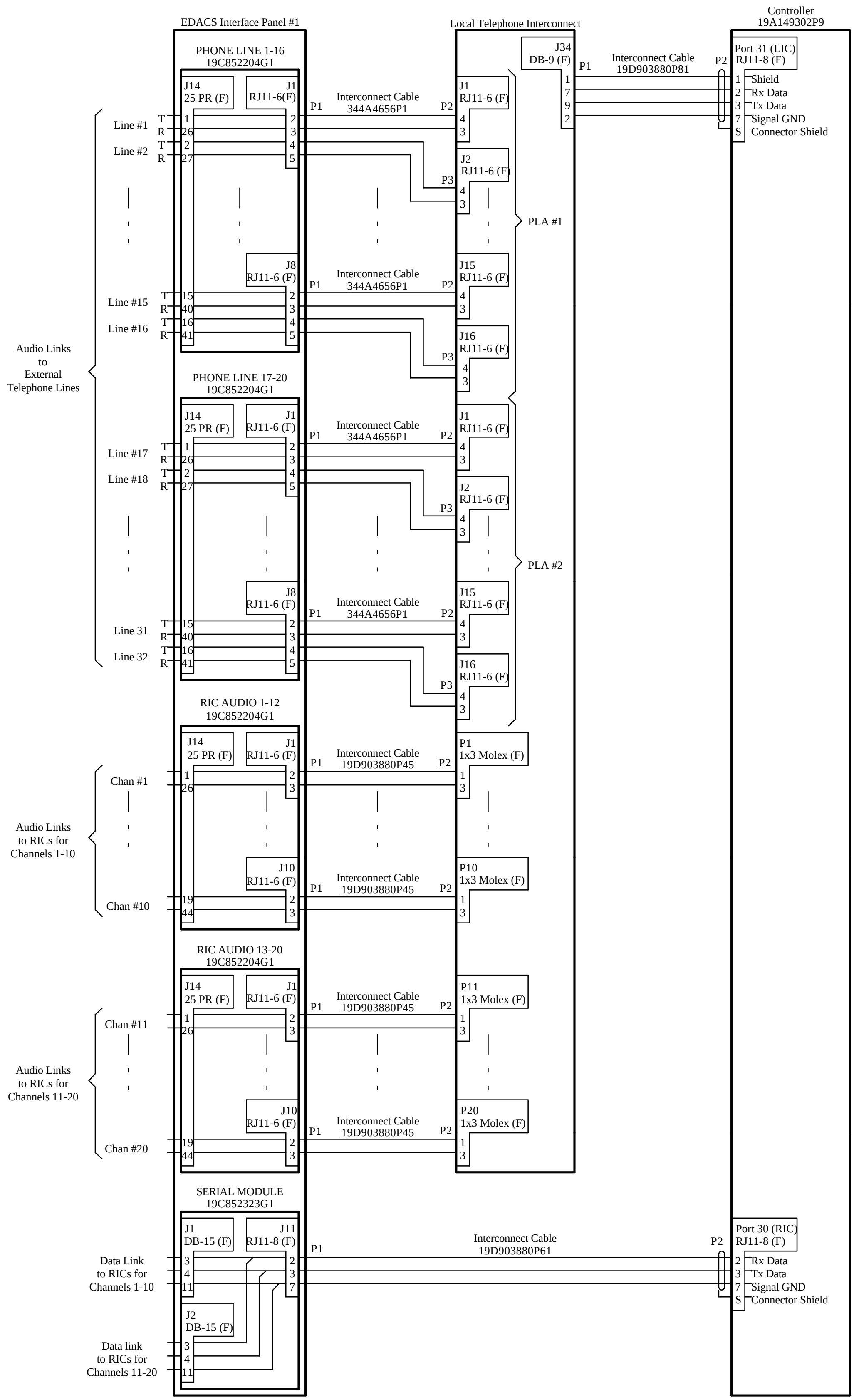
Interconnection Diagram #3B
Station GETC Data Links (For Sites With 3 Repeaters Per Cabinet)



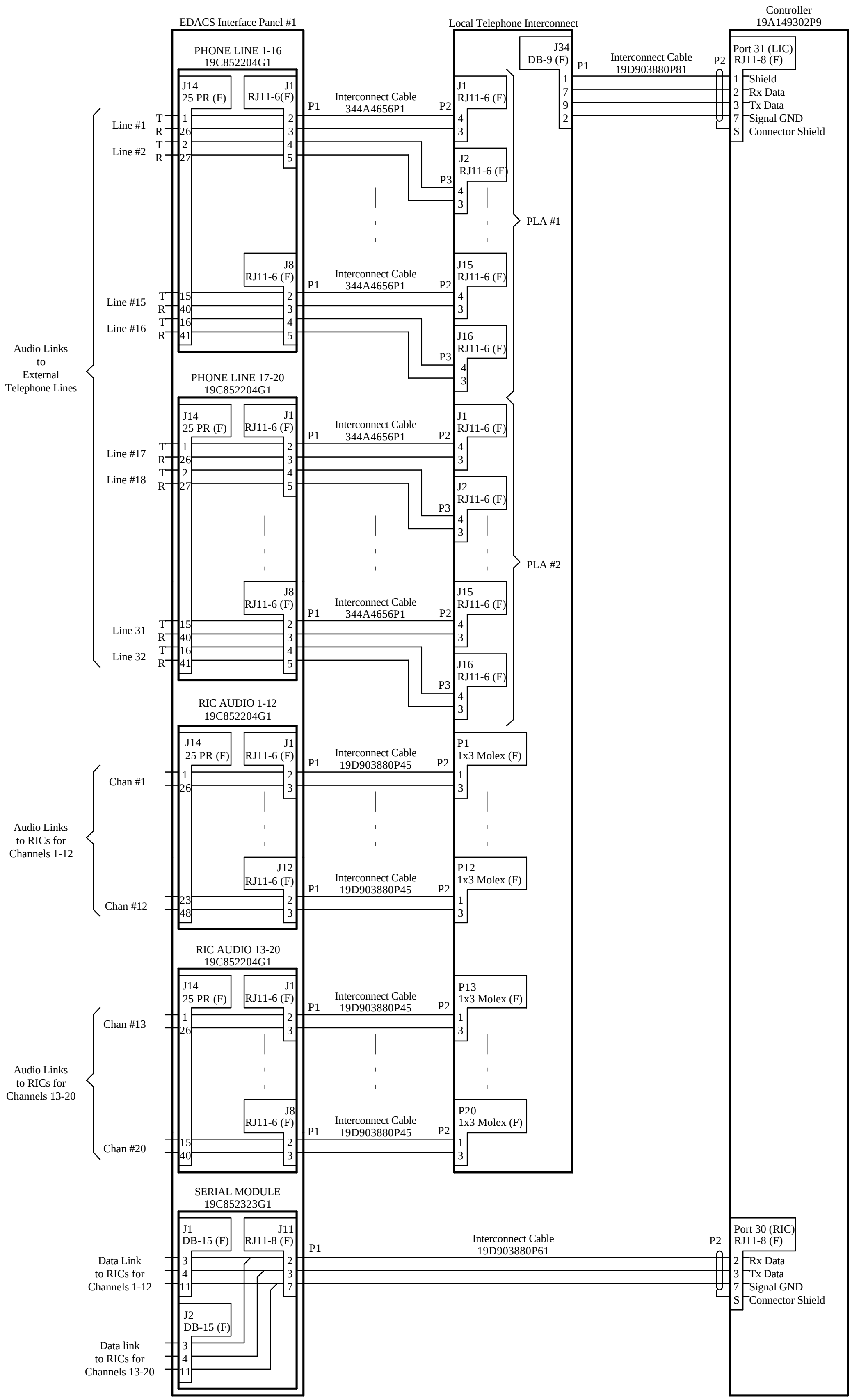
Interconnection Diagram #4A
Downlink And Redundant Downlink Option (For Sites With 2 Repeaters Per Cabinet)



Interconnection Diagram #4B
Downlink And Redundant Downlink Option (For Sites With 3 Repeaters Per Cabinet)

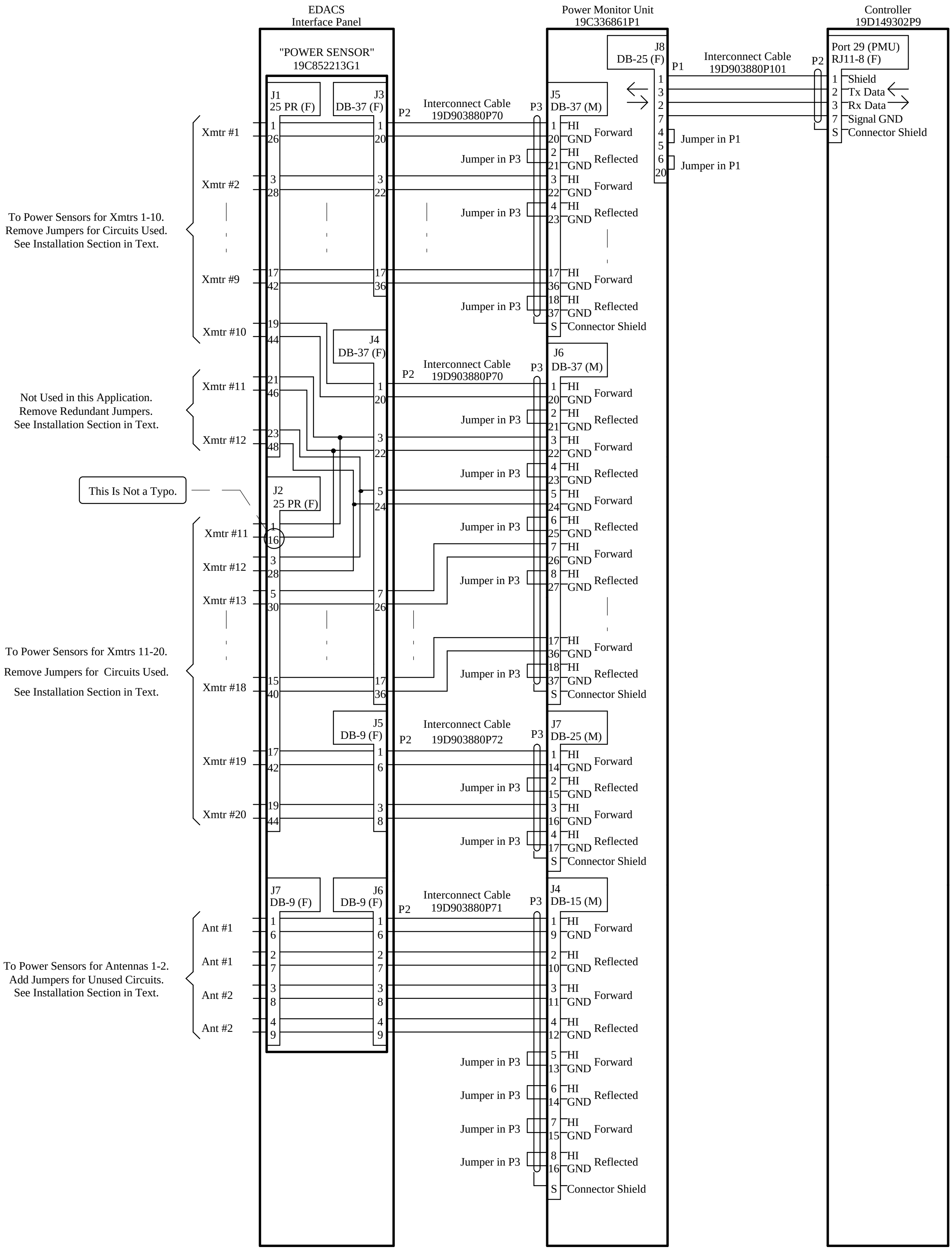


Interconnection Diagram #5A
Local Telephone Interconnect Option (For Sites With 2 Repeaters Per Cabinet)

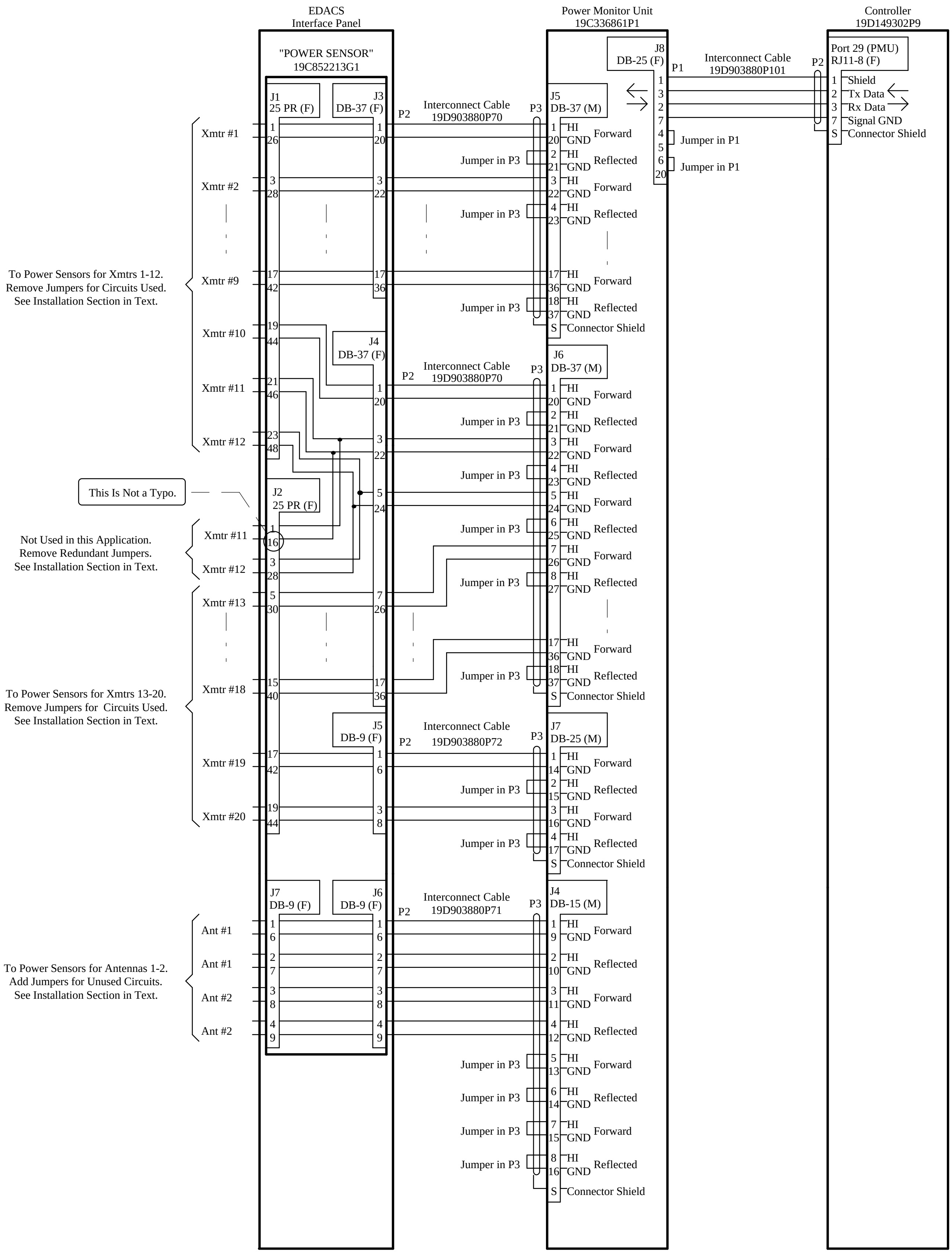


Interconnection Diagram #5B

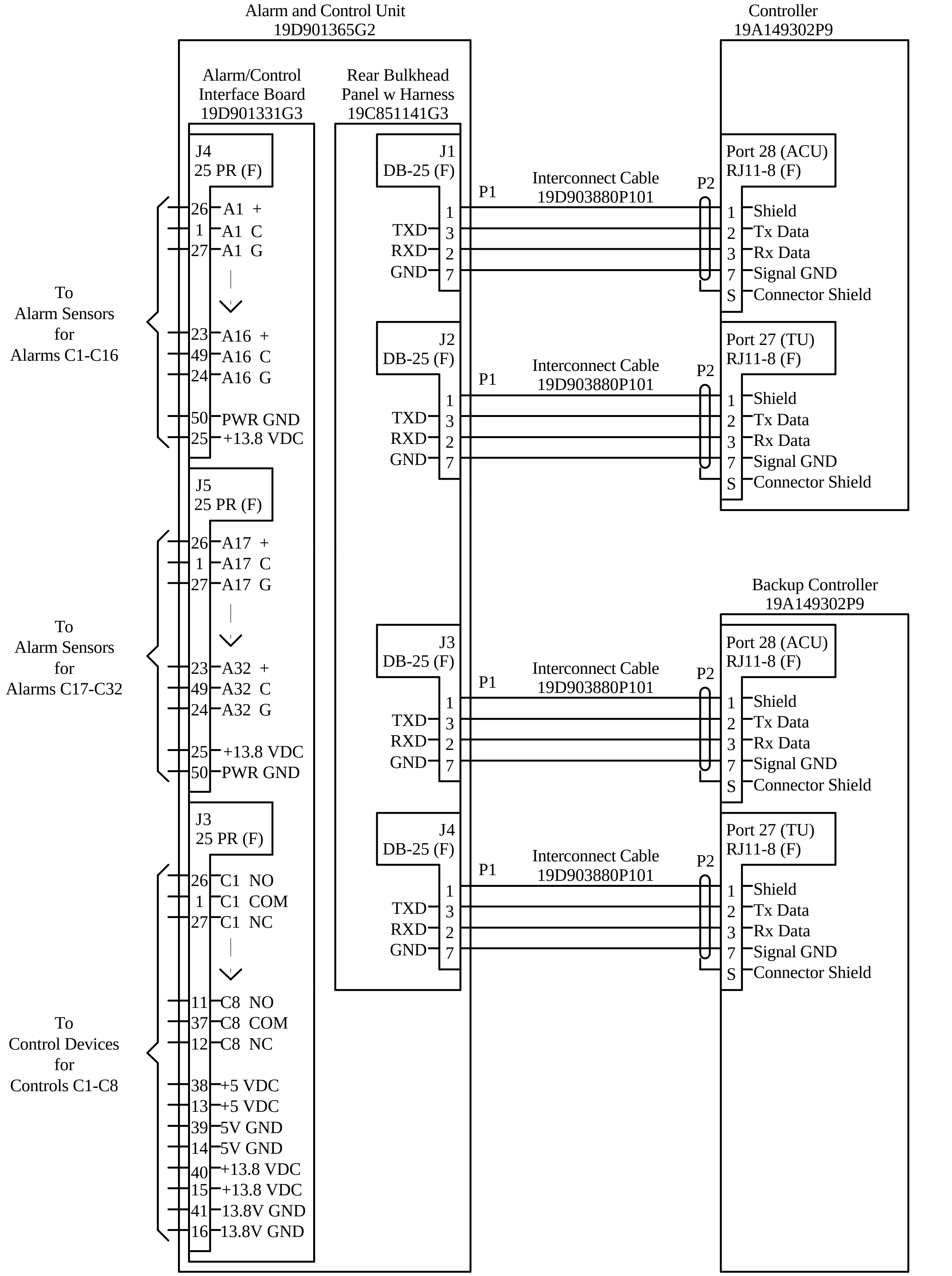
Local Telephone Interconnect Option (For Sites With 3 Repeaters Per Cabinet)



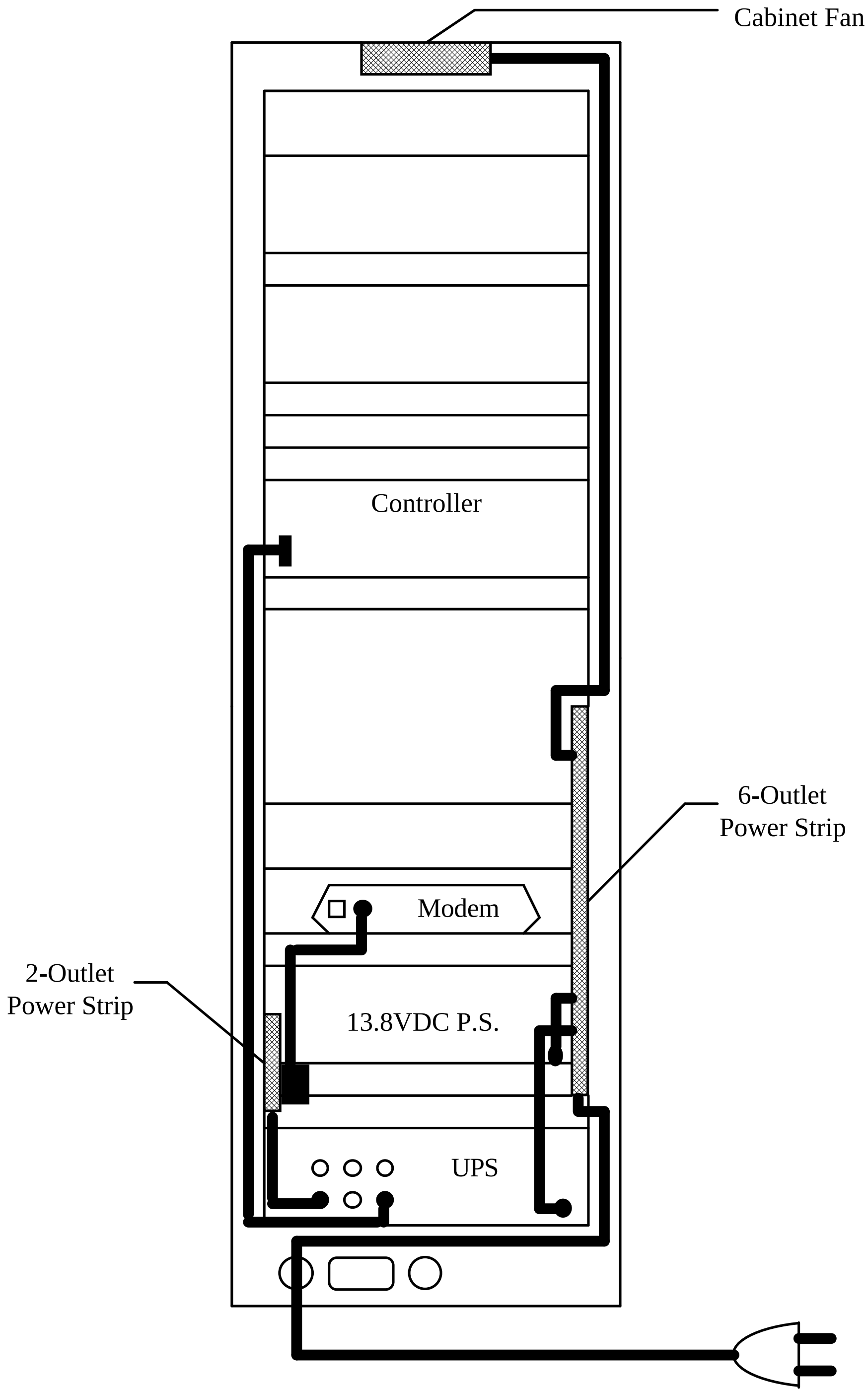
Interconnection Diagram #6A
Power Monitor Option (For Sites With 2 Repeaters Per Cabinet)



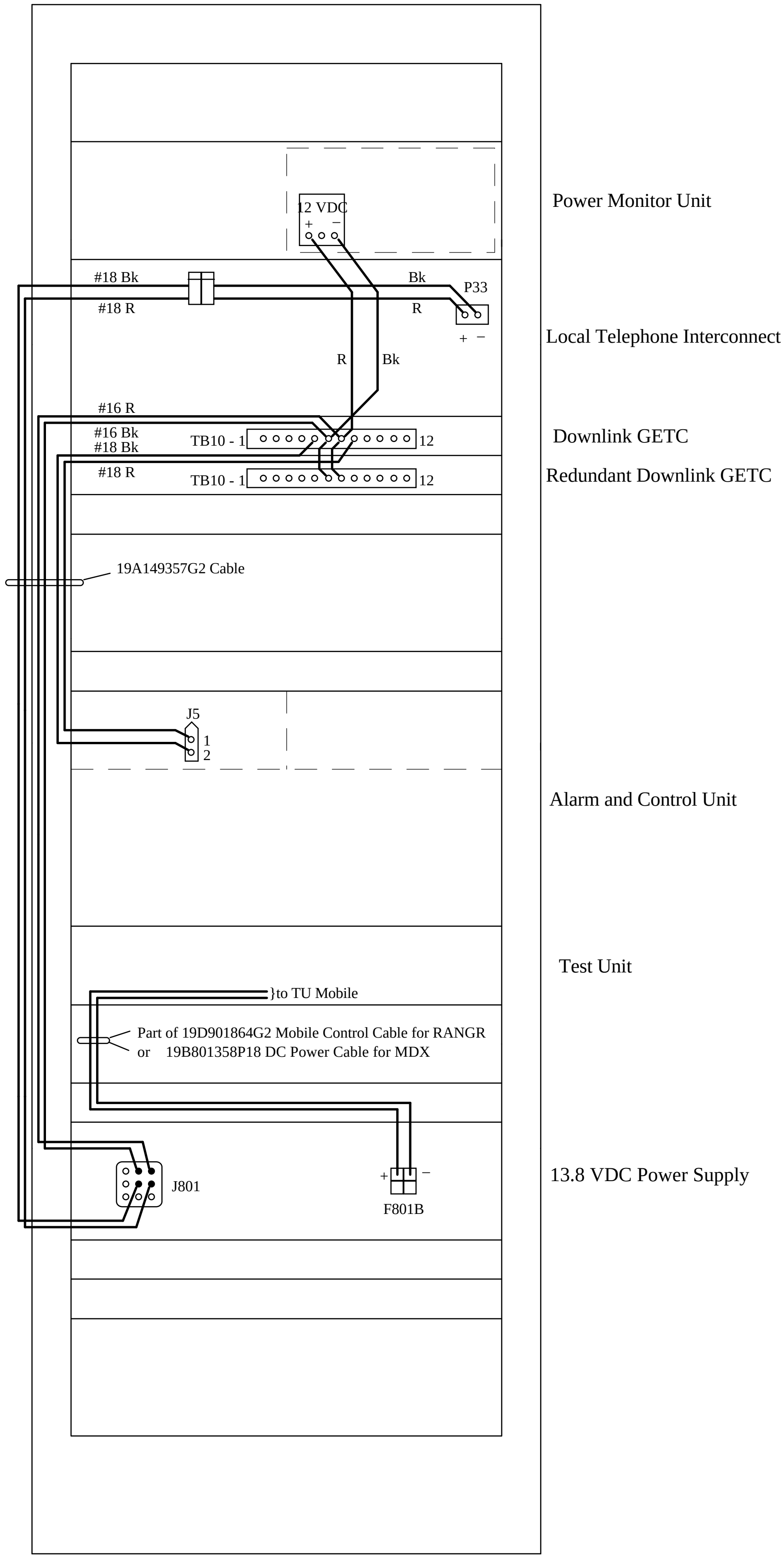
Interconnection Diagram #6B
Power Monitor Option (For Sites With 3 Repeaters Per Cabinet)



Interconnection Diagram #7
Test And Alarm Unit Option



Interconnection Diagram #8
AC Power (Rear View)



Interconnection Diagram #9
DC Power (Rear View)