Section 11

4-wire E&M/TO Configuration

About This Section

This section describes how to configure the *4-wire E&M/Transmission Only* (**E&M/TO**) 12-channel voice card for connecting the Access Bank II to T1 private line services that support E&M signaling types I, II, IV and V. Instructions are also provided for optioning the card to function in the *Transmission Only* (TO) operating mode.

4-Wire E&M/TO Voice Card

Functional Description

The *4-wire E&M/Transmission Only* (**E&M/TO**) voice card delivers 12 analog channels for connecting to private line circuits, such as carrier PBX tie lines and 4-wire modems often found in utility, cellular, and metropolitan area networks (MANs). Each of the twelve E&M channels can be individually programmed to support Signaling Types I, II, IV or V, using up to 4 signaling and transmission pairs per channel (E/M, SG/SB, T/R, and T1/R1). This card can be configured to function as Channel Equipment (normal multiplexer mode) or as Switching Equipment for back-to-back Tandem applications sometimes referred to as Reverse E&M or Pulse Link Repeater (PLR). The Transmission Only (TO) operating mode provides dedicated 4-wire transmit and receive paths to radio and modem equipment uncorrupted by the insertion of A/B robbed bit signaling. Transmission Only (TO) uses the identical 4-wire E&M physical interface, but suppresses the A/B bit-robbed signaling, thereby maximizing the transmission capacity per channel for dedicated operations.

Physical Description

Like the FXS and FXO/DPT voice cards, the 4-wire E&M/TO is a 7.8” by 13.16” daughter card designed to slide into the back of the Access Bank II along rails that guide a 64-pin DIN connector to mate with a matched connector on the internal ABII Controller. The E&M/TO card receives T1 signaling, control logic, and -48 Vdc power through this connector from the Controller card. Because the RJ-21X Amphenol™ telco connector on the ABII front Control Panel fails to provide enough wiring leads, it is bypassed through a 96-pin E&M signaling line connector attached on the opposite end of the card. The E&M signaling lines (E, SG, M, SB, T, R, T1 and R1) are

connected to this high-density 96-pin DIN connector. A bank of 12 channel status LEDs are located next to the E&M signaling line connector on the ABII back plate. Each channel has two programming jumpers that allow the channel to be configured for E&M Types I, II, IV and V signaling. Each channel also has a 10-position DIP switch that allows the receive and transmit attenuation to be individually set from -22 dB to +10 dB. There is also a 4-position DIP switch located next to the processor for setting regular or clear channel E&M signaling types and selecting busy or idle during carrier failure.

Typical Applications

The major applications for the 4-wire E&M/TO voice card are E&M Tie Lines operating in either Normal or Tandem mode, and dedicated Transmission Only (TO) operation for audio paging, mobile radio, or modem transmission. Additionally, this interface also supports two-way Direct Inward Dial (DID) applications. Refer to **Figure 11-1** and **Figure 11-2** below for pictorial representations of these typical applications.

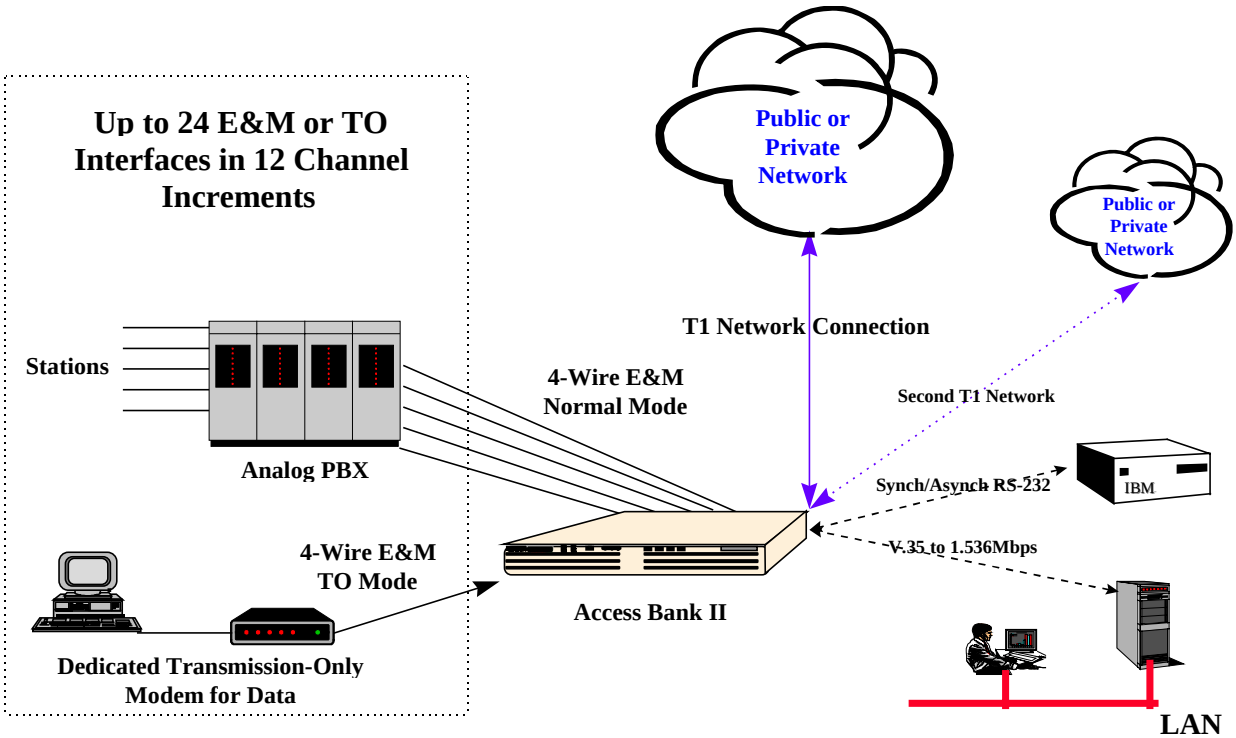

Figure 11-1. Normal Mode E&M and TO Termination

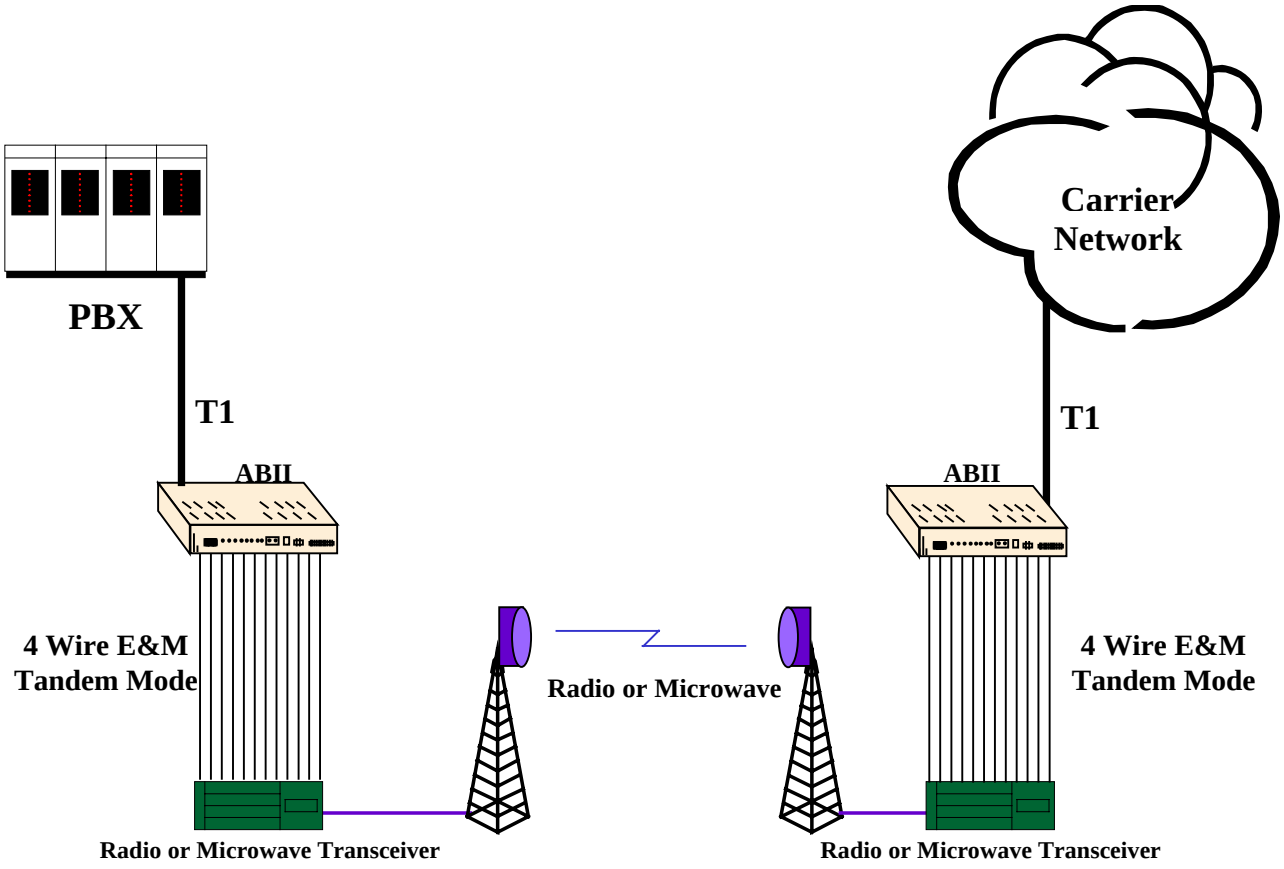

Figure 11-2. Tandem Mode E&M and TO Access to Leased Lines or Carriers

E&M Signaling Conventions

According E&M signaling conventions, Switching Equipment always originates signaling on the M-lead (the "mouth" sending toward the transmission line). The E-lead of the switching equipment interface incorporates a signaling current detector (the "ear" listening to the line). The multiplexed or carrier Channel Equipment always originates signaling on the E-lead coming from the transmission line. The signaling current detector is found on the M-lead going toward the transmission line.

The 4-wire E&M/TO voice card can be optioned to operate either as Channel Equipment or Switching Equipment. Since the Access Bank II typically operates as a voice and data multiplexer, the card is usually configured as Channel Equipment. However, the card can also be configured as Switching Equipment. This is referred to as Tandem operation because the card operates in "tandem" (i.e. back-to-back) with another transmission device.

The following table lists the generic functions performed by the Detector/Detector Return and Driver/Driver Return when the 4-wire E&M card is configured to operate as Channel Equipment or Switching Equipment.

Table 11-1. Detector-Driver Functions

Channel Equipment	Detector is on M-lead function Driver is on E-lead function
Switching Equipment	Detector is the E-lead function Driver is the M-lead function

The Transmission Only (TO) function of the 4-wire E&M/TO card provides 4-wire transmit and receive path uncorrupted by A/B robbed bit signaling insertion. In the TO mode, the outgoing driver signaling lead is held idle and the incoming detector signaling lead is ignored by the ABII software. No A/B bits are inserted in the outgoing T1 span for any of the 12 channels when the card is set to the TO mode of operation. Transmission Only operation is commonly used for dedicated transmission paths to radio and modem equipment. Turning A/B bit signaling insertion "off" provides the highest possible transmission capacity in each channel.

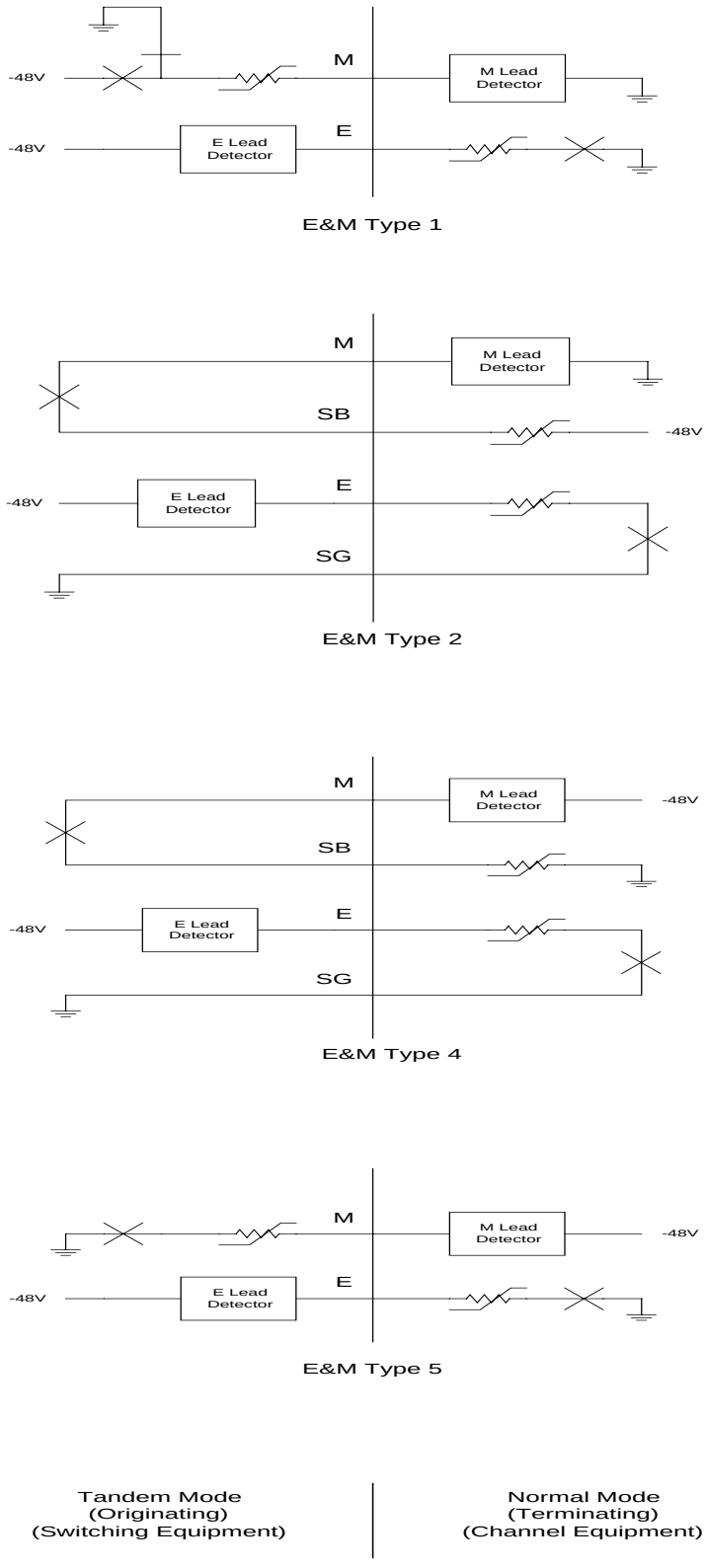

Figure 11-3. E&M Signaling Types 1, 2, 4 and 5

Programming E&M Signaling Types

Jumper Switch Settings

E&M signaling types I, II, IV and V (see **Figure 11-3**) are configured by jumpers J1, J2 and J3 located on each channel. Because the signaling types are configured on an individual channel basis, different E&M types may be mixed on the same card. The entire card, however, must operate in either Normal or Tandem mode, which is determined by the signaling cable used (see the Cabling section below). The following table (which is also printed on the 4-wire E&M back plate) shows the proper jumper connections for each signaling type and mode.

Table 11-2. Jumper Connections By Type and Mode

E&M Type	Mode	Jumper Placement		
		J1	J2	J3
1	Normal	3-4	5	8-9
1	Tandem	1-2	5	10-11
2	Normal	3-4	6	7-8
2	Tandem	1-2	6	7-8
4	Normal	1-2	6	7-8
4	Tandem	1-2	6	7-8
5	Normal	1-2	5	8-9
5	Tandem	1-2	5	8-9

The jumpers are blocks that make several connections simultaneously. The entire block is moved between the positions indicated above. This makes programming easier by changing several connections with one move. The jumper pins are on 0.1”x0.2” centers, making it impossible for the user to accidentally turn the jumper 90° and insert, shorting -48V to ground.

Figure 11-4 shows the jumpers as they appear on the 4-wire E&M/TO card. The programming positions listed in the table above are marked in bold for each jumper. In this illustration, the blocks are shown set for “E&M Type 1 Normal” with jumper J1 connected in position 3-4, jumper J2 in position 5, and jumper J3 in position 8-9. Solid lines represent connections made by the jumpers in the positions indicated, while the dashed lines represent open connections.

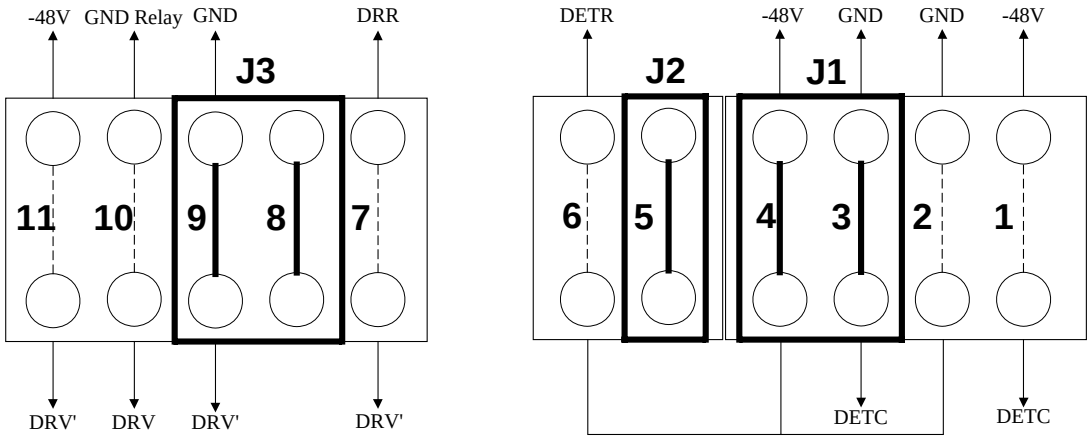

Figure 11-4. Jumper Switch Configuration

NOTE: The jumpers do not change the actual interface pin assignments for the E&M signaling line connector. The detector and driver functions always stay on the same pinouts.

Detector Configuration

Jumper 1 is used to select options for configuring E&M signaling types I, II, IV and V. This jumper connects the detector to -48 Vdc or ground. It is also used to connect the Detector Return to -48 Vdc or ground. An on-hook signal from the far-end equipment does not cause current to flow through the detector. When the far-end equipment applies an off-hook signal, current flows in the detector, causing the detector to be grounded. The processor receives this information and sends E&M signaling bits to the T1 line. The table below summarizes the signaling bits sent for both detector states:

Table 11-3. E&M T1 Signaling

Detector	XMT Signaling Bits		RCV Signaling Bits		Driver
	A	B	A	B	
Off	0	0			
On	1	1			
			0	*	On-Hook
			1	*	Off-Hook

*Don’t care (0 or 1)

Normal, Tandem and TO Cables

Individual E&M/TO voice cards require the purchase of the Normal mode, Tandem mode, or Transmission Only (TO) mode cables listed below in **Table 11-4**. The type of cable used with the signaling line connector determines whether all twelve channels of that card operate only in that mode. Physically, the Normal and Tandem cables have one 96-pin DIN connector that plugs into the E&M card. The 96-pin DIN connector has two 50 conductor, 24 AWG cables leading to two 50-pin Telco connectors. The Telco connectors use standard RJ-2HX pinouts for 4-wire E&M, providing six channels per connector (twelve channels per card). The Transmission Only (TO) cable has the same 96-pin DIN connector but only one 50 conductor cable and one Telco connector. The Transmission Only (TO) cable uses standard RJ-2DX pinouts, allowing 12 channels per cable. **Figure 11-5** and **Figure 11-6** show the 4-wire E&M/TO cables.

Table 11-4. Normal, Tandem, and TO Mode Cables for 4-wire E&M/TO Card

CAC Part Number	Cable Length	Application	Connectors and Wiring
005-0004-10’	10ft (3.05m)	**Normal Mode Cable** supporting E&M Types I, II, IV, and V in Normal (Non-Tandem) Operation. Normal operation is typical of channel equipment such as phones, and modems, which are viewed as terminating equipment.	C-Type 96-Pin Male to Dual 50 Pin Telco Male Connectors, 24AWG
005-0005-10’	10ft (3.05m)	**Tandem Mode Cable** supporting E&M Types I, II, IV, and V in Tandem Operation. Tandem operation is typical of switching equipment such as PBXs and CO switches which can be said to originate traffic.	C-Type 96-Pin Male to Dual 50 Pin Telco Male Connectors, 24AWG
005-0006-10’	10ft (3.05m)	**Transmission Only (TO) Mode Cable** for use in radio or modems assigned to dedicated transmission operation.	C-Type 96-Pin Male to Single 50 Pin Telco Male Connector, 24 AWG

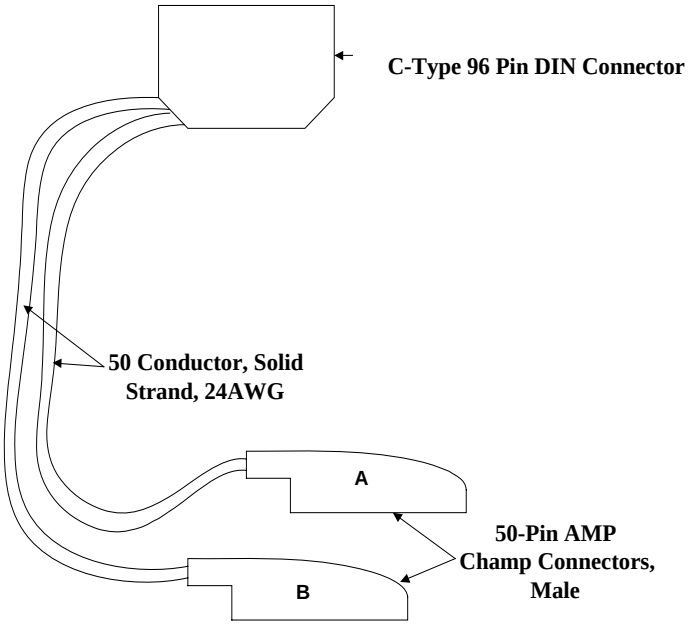

Figure 11-5. Cable for Normal or Tandem Modes

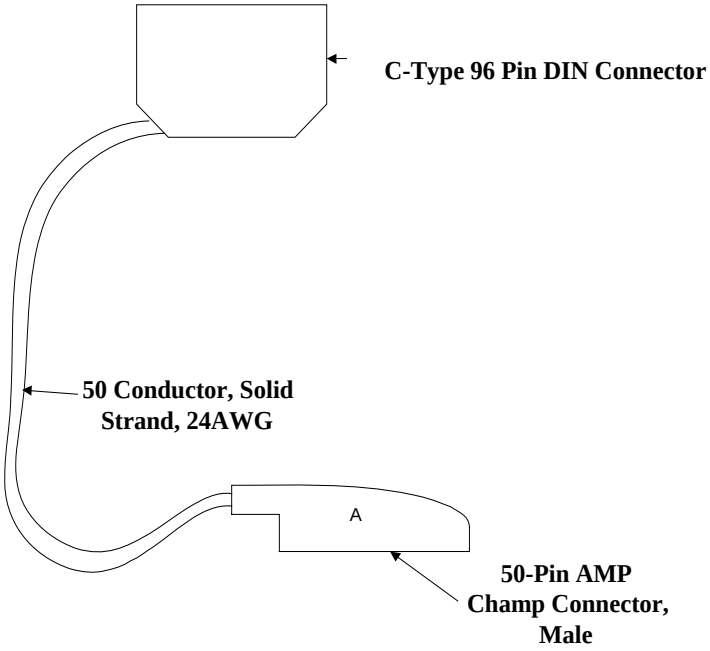

Figure 11-6. Cable for Transmission Only (TO) Mode

Configuring Signaling Types and Trunk Processing

The 4-wire E&M/TO card is also equipped with a 4-position DIP switch for selecting between regular or clear channel E&M signaling types and setting busy or idle during trunk processing. This switch is located at the front of the circuit board next to the 64-pin DIN connector.

Table 11-5. 4-Position DIP Switch Settings

Switch Number	ON	OFF
1	TO Clear Channel	Normal E&M
2	N/A	N/A
3	N/A	N/A
4	TP Idle	TP Busy

Clear Channel or Normal E&M Signaling

Use switch 1 to configure the 4-wire E&M/TO for clear channel operation when the card is operating in the Transmission Only (TO) mode or normal E&M when the card is to be operated in Normal or Tandem modes.

TP Busy/Idle Switch

Use switch 4 to select whether the tip-ground relays are closed (busy) or open (idle) during trunk processing. (Trunk processing occurs when the T1 line is in an alarm or reset state.) The Busy position (OFF) causes the tip-ground relays to be closed during a T1 alarm or reset period. The Idle position (ON) causes the tip-ground relays to be open during a T1 alarm or reset period.

Setting Transmit and Receive Gain

The transmit (analog-to-digital) and the receive (digital-to-analog) gain for each voice channel can be set independently using twelve 10-position DIP switches on top of the 4-wire E&M card circuit board. Each analog channel uses a bank of ten DIP switches, with five for transmit and five for receive. The gain from each switch is additive, with switches 1-5 providing transmit (analog-to-digital) gain of 1, 2, 4, 8 and 16 dB, respectively. Switches 6-10 set receive (digital-to-analog) gains of 1, 2, 4, 8, and 16 dB, respectively. With all five switches off, the gain is -21dB. Because the gain from the each switch is additive, any gain level between -21dB and 10dB is possible.

The digital transmission level is limited by the codec to a maximum of 3.17dBm0. The gain stages may be set to apply up to 10dB of gain; however, the maximum level of the codec must not be exceeded or distortion will result.

The analog transmission level may be set to a maximum 9.5dBm before distortion begins to occur.

Transmit (Analog-to-Digital) Gain

A transformer provides the analog input (T,R) from the 4-wire voice connections to the Access Bank II. The gain from each switch on the 10-position DIP switch is additive, with switches 1-5 providing gain of 1, 2, 4, 8 and 16 dB, respectively. To calculate the T1 transmit level, use the following formula:

$$T1\ level = Analog\ Input\ level + \sum Gain\ Switches - 21$$

The following is an example of setting transmit gain:

Example: Suppose the analog input level is at +3dBm. With all switches off, the level at the T1 line is +3dBm -21db = -18dBm0. To set a 0dBm0 level at the T1 line, switches 2 and 5 (gains 2dB, and 16dB) must be turned on. The level at the T1 line is then:

T1 level = 3dBm + 16dB + 2dB - 21dB = 0dBm0

Receive (Digital-to-Analog) Gain

To calculate the transmission level on the T1, R1 pair, use the following formula:

$$T1/R1\ level = T1\ level + \sum Gain\ Switches - 21dB$$

The following is an example of setting receive gain:

Example: Suppose the T1 input level to codec is at -1dBm0. With all switches off, the output at the T1, R1 pair is -1dBm -21db = -22dBm. To set a 4-wire transmission level of 0dBm, switches 7, 9 and 10 (gains 2dB, 8dB, and 16dB) must be turned on. The level at the T1, R1 pair is then:

T1/R1 level = -1dBm0 + 2dB + 8dB +16dB -21dB = 0dBm.

E&M Voice Channel Monitoring

Call Progress LED Indicators

A bank of LEDs on the ABII back plate are used to monitor the status of incoming or outgoing calls on each of the twelve voice channels. When viewing the LED bank, channel 1 corresponds to the LED in the top left hand corner. Other channels are arranged left to right, row by row (like reading a book), so channel 12 is in the bottom right corner. The meaning of the states of these 12 LEDs are summarized below in **Table 11-6**.

Table 11-6. E&M Channel Status LEDs

LED State	Meaning
Off	Idle state
Green	Analog side is Off Hook
Red	Digital side is Off Hook
Yellow	Analog and Digital sides are both Off Hook