SB940A
DIGITAL SUBSCRIBER CARRIER
DESCRIPTION

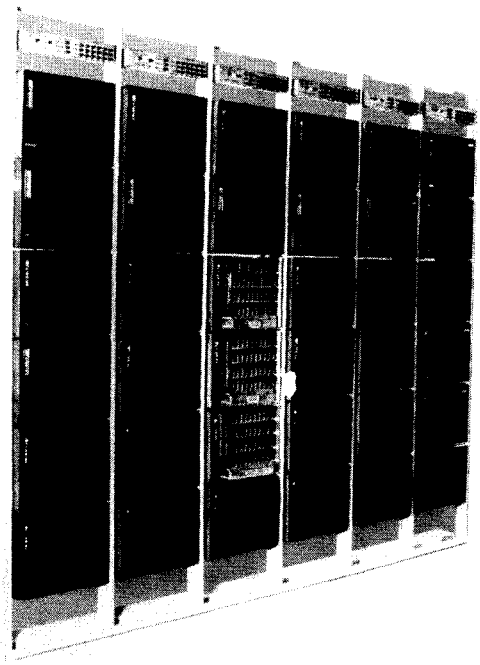

Figure 1
1440 Channel Terminal Installation in 11'6" Racks

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1. DOCUMENTATION ORGANIZATION

1.1 All practices concerning the SAN/BAR SB940A Digital Subscriber Carrier System are prefixed SNBR. Following the prefix is the product class identifier. For the SB940A the identifier is -36.

2. GENERAL DESCRIPTION

2.01 The SB940A Carrier System uses the latest state-of-the-art integrated circuit and digital transmission technology to provide high quality voice or data service where cable plant expansion by conventional means is either economically or time prohibitive.

The system uses continuously variable slope delta modulation (CVSD) and digital multiplexing to convert up to 40 analog channels and signaling information into a single high speed data stream of 1.544 mb/s (T-1) for transmission on two cable pair between two terminals. The SB940A system is configured to permit operation between a central office terminal (COT) and a single remote terminal (RT) or between two central office terminals.

The dynamic range of the system allows it to operate unrepeatered on 26 gauge exchange cable over distances up to 5,000 feet. Operation at distances up to 20-25 miles is accomplished by use of standard T-1 repeaters.

2.02 Typical applications include use to expand existing cable plant; as an alternative to new cable or building expenditures; and for consolidation of wire centers and central offices.

2.03 Specific applications include use for multi-line business or residential service to high rise complexes, mobile home parks, industrial parks, shopping centers, etc.

2.04 Its inherent flexibility, small size and ease of installation also makes it attractive for use in providing temporary service and use in emergencies to provide circuit restoration.

2.1 Services Provided

2.11 The 40 Subscriber Channels are capable of bridged ringing i.e. between tip and ring. They therefore may be used to serve residential or business single party customers. Channels may be used for wired as well as switched services. FEX, Key System Lines, Data, Centrex, etc. may also be served from SB940A derived lines.

2.12 Except for channel assignment the SB940A COT (Central Office Terminal) and RT (Remote Terminal) are identical. COT and Subscriber channel units may therefore be mixed within the same terminal thus extending application flexibility.

2.13 SB940A is fully compatible with tone dialing. No restrictions apply for manual or automatic dialers.

2.14 COT Channel Units are compatible with step, crossbar and electronic switch equipment. Channels permit customer loop control from the CO for Key Line disconnect. Assigned channels are dedicated lines. No concentration is employed. No traffic impairment or service denial will be experienced during peak traffic periods.

2.15 The backplane of the SB945B-100 shelf is universally wired to permit use of optional 2-wire and 4-wire E&M or ground start units in place of loop originating channel units. All types of channel units can be intermixed in a system.

2.2 System Configuration

2.21 A system is structured of five sections as shown in Fig. 2 As compared to physical service the two terminals and DLF (Digital line facility) replace cable pairs. "Services are assigned on a per channel basis as would be the case with physical pairs".

2.22 The two blocks identified as COT and RT comprise the SB940A. The terminals are identical except for channel modems used. They differ by system use only.

2.23 The RT for urban applications will normally be located in customer premises or another CO (wire center relief applications).

2.24 The block identified as DLF is the Telco provided Digital Line Facility which may or may not include repeaters.

2.3 Digital Line Facilities (DLF)

2.31 The SB940A in some applications may not require a repeatered line. The system is capable of operating up to 5 kf of 26 gauge unbridged non-loaded cable without repeaters. The employment of 24 or 22 gauge cable will permit greater separation between terminals. These extended lengths are achieved through the use of the HL option but are limited by other factors.

2.32 Standard T1 levels and bit stream rate permit operation over any T1 conditioned facility. No special repeaters, Span Lines and/or external transfer equipment is required. Using existing or Telco standard T1 line equipment therefore permits mechanical as well as electrical compatibility.

2.33 There is no need to segregate SB940A from other PCM Systems (for coordination or crosstalk purposes) whether trunk, toll or subscriber. Local practices however may differ for administration or maintenance purposes.

2.34 SB940A is compatible with analog carrier systems that do not exceed 150KHZ. They may co-exist under the same sheath.

2.35 In all cases the DLF should meet generally accepted or local practices for T1 line facilities

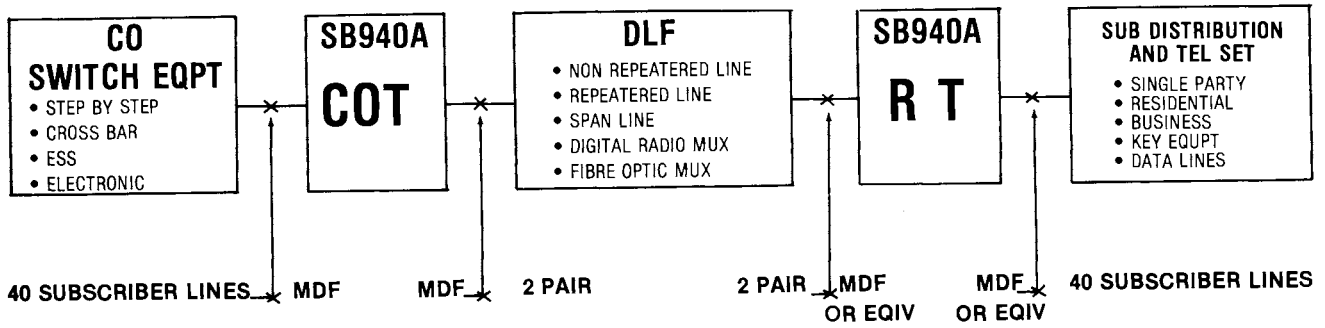

FIG. 2 SB940A SYSTEM CONFIGURATION

2.36 The SB940A includes a built-in Nx1 spare line transfer feature. It may be arranged for 1x1 through 24x1 standby protection. This feature is applicable only when the system is used without span line termination and automatic protection equipment. When the latter equipment is added to the system, this feature is disabled and transfer is accomplished via those equipments.

2.4 Voice Frequency Facilities

2.41 The line distribution arrangement at the RT is served by two 25 pair connectorized cables, which may be terminated on standard terminal blocks. The RT will serve subscriber loops up to 1300 ohms (supervision limits) with a loss of up to 6 db at 1 KHZ. No other special considerations are required.

2.42 The COT VF lines, likewise, are accessed on the terminal by two 25 pair connectorized cables. The VF cables will normally terminate on the MDF.

2.5 System Power Arrangements

2.51 The Central Office Terminal (COT) is powered from central office battery of -48V. The COT requires 1 amp of current.

2.52 The remote terminal requires -48V DC and draws 3.5 amperes with all channels active (including talk battery). Ringing may be applied from an external source or internally from the power supply pack supplied with the RT unit.

2.53 Externally provided + and - current for repeater powering may be applied to the terminals through the SX leads. Power, current limiting and fusing are external to the basic system, and are Telco provided.

2.6 Protection

2.61 VF and HF interfaces are protected by gas tubes and/or solid state devices.

2.62 The power supply primary source is protected by self resetting circuit breakers.

2.63 Heat coils and carbon blocks on the MDF, serving the digital line, should be replaced by dummies. Local practices will dicatate.

2.7 Installation

2.71 Individual terminal installation consists of connection of power, alarms and HF lines on the rear of each respective terminal. Shop wired bays are essentially the same, except that the connections are made at the top of the rack. In either case, VF connection is by means of standard 25 pair connectorized cable to each terminal.

2.72 Plug-in unit option wiring is by means of plug-links requiring no soldering.

2.73 There are no installation adjustments to be made. A terminal loop back switch permits simple terminal and channel functional tests to be made locally before turn up.

2.74 Installation tests (acceptance tasks) are presented in a step by step format.

2.8 Maintenance

2.81 The SB940A is simple to maintain. There are no scheduled or periodic tests required. Maintenance will be the result of an alarm or customer complaint.

2.82 Circuit packs of the SB940A are not field repairable. Substitution is therefore the primary remedy of circuit pack failures.

2.83 Plug-ins common to the 40 channels are identical at each end of the system (COT or RT) thus minimizing the requirement for necessary spares.

2.84 Faults may be localized by use of alarm indications and the loop back feature.

2.85 Individual channel modems likewise are maintained by localization and substitution.

2.86 Trouble analysis and test procedures are presented in step by step format.

2.87 Faults on the Digital Line Facility (DLF) should be cared for in accordance with local practices. Access to the Digital Line for test purposes is provided by means of jacks at the SB940A terminals.

3. EQUIPMENT DESCRIPTION

3.01 The SB940A consists of two SB945B-100 Shelves, one for each end of the system. The shelves mount in standard 23" relay racks or cabinets. Fig. 3.

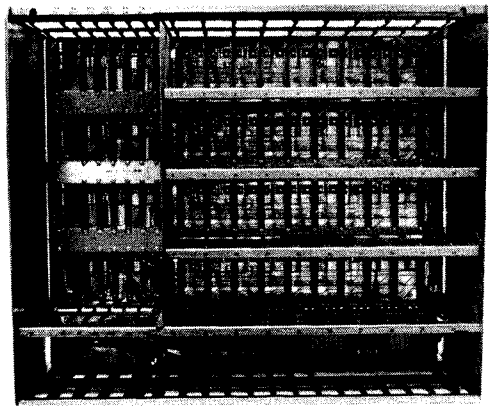

FIG. 3 SB945B-100 Shelf

3.02 The shelves require 17.5 inches of vertical space. No gap or space between terminals is necessary. The shelf extends 4 inches beyond the rack mounting surface.

3.03 All external wiring is made from the rear of the shelf. VF termination connections are by means of two 25 pair connectorized cables; all other connections are made on barrier strip screw terminals, also from the rear of the shelf.

3.04 The front of the shelf is provided with a one piece removable plastic cover for protection. The cover is translucent permitting "channel busy" LED's to be seen without removal of the cover. The cover includes an opening permitting access to operating controls. Controls that may disable service are not accessible with the cover in place.

3.1 Shop Wired Assemblies (option)

3.11 Shop wired assemblies provide inter-terminal wiring which appears at the top of the rack on the rear of the SB947A-100 Fuse and Alarm Panel. In addition the panel provides individual terminal fusing for -48V, and DLF Simplex (SX + and SX -) as required. Fuses are also provided for ringing voltage. Major and Minor and Fuse Alarm Lamps are also included on the panel which are common to all terminals in the bay.

3.12 The fuse and alarm panel is available only on shop wired arrangements.

3.13 The fuse and alarm panel occupies 4 inches of vertical rack space. External connections are by means of wire wrap terminals for alarms, control and digital lines. Power connections are made to stud type terminals.

3.2 RT (Remote Terminal) Considerations

3.21 Although the RT shelf, wiring, etc. is identical to the COT, special consideration regarding mounting must be made.

3.22 The RT more often than not will be located on customer premises in the urban area. Where a telephone equipment room is not provided, provisions must be made to locate and protect the equipment from unauthorized access and extremes of environment.

3.23 Lockable PBX type cabinets with front and rear access are preferred, however rear access is only necessary at the time of installation.

3.24 Wall mount hinged racks are an acceptable alternative.

3.25 Environmental considerations should include temperature and humidity extremes. Electrical noise also must be considered. Mounting near items such as large control relays and circuit breakers should be avoided. Likewise wiring should be run to avoid electrical interference.

4. FUNCTIONAL DESCRIPTION

4.01 This section describes the system operation and function of the respective plug in units and operational options.

4.1 Terminal Shelf (SB945B-100) Fig. 3,4

4.11 The terminal shelf provides frame work and mounting hardware for the 40 Channel Modems and five common equipments PCB's (printed circuit boards) and power supply which comprise the SB940A terminals.

4.12 The shelf includes HF isolation transformers providing SX access to the digital line. Three terminal gas tube protectors are included for PCB protection.

4.13 Plug-in relays on the shelf provide the Spare Line transfer function.

4.14 External Voice Frequency connections are made from two, 25 pair, male Amphenol type connectors on the rear of the shelf.(Fig. 4)

4.15 Power, alarm, control and digital line wiring is made from screw terminal barrier strips.

4.16 All other intra-terminal wiring is factory provided by PCB back planes. Plug-in unit connectors are part of the back plane. Plug-in units are keyed to prevent wrong slot insertion.

4.17 In addition to the power unit (discussed later) there are five plug-in

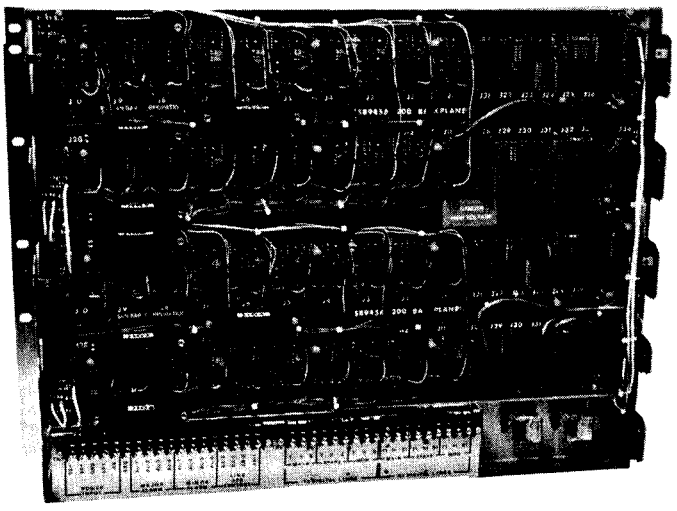

FIG. 4 SB945B-100 Rear View

PCB's in the common equipment group. These five are identical at both COT and RT Terminals differing only in position of option "Plug-Links". Two of the five PCB's relate to the transmit (TX) functions while three apply to receive (RX) functions and alarms. PCB plug-ins are arranged functionally which permits not only simplified explanation but easy maintenance as well.

4.2 Line Driver (SB941A-100) Fig. 5 Position 46

Includes two major functional blocks (a) TX time base and (b) digital line conditioning and coupling.

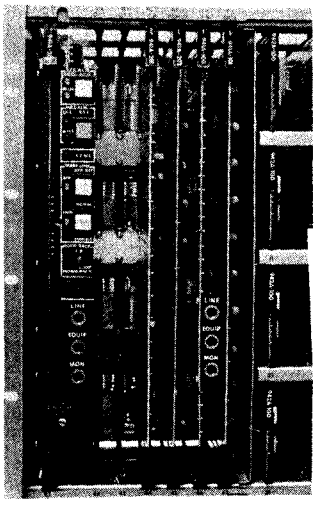

FIGURE 5

POS. 41 44 45 46 47

4.21 The time base consists of a 6.176 crystal oscillator from which all timing is derived. When divided by 4 the line bit rate of 1.544 mhz is obtained. Simply stated, one bit per cycle results in 1.544 mbs (mega bits per second). Since all timing is derived from this clock absolute synchronization of relative information is assured. All timing signals are forwarded to the TX MUX unit for control of the MUC (multiplexing) functions.

4.22 The multiplexed signals are returned to the Line Driver unit where they are conditioned for application to the DLF. Conditioning includes conversion of the unipolar signal to bipolar and providing level control and pre-equalization.

4.23 For proper operation of T1 type repeaters and general T1 compatibility, a bipolar TX signal is necessary. The bit stream from the TX MUX unit is unipolar ("1" or "0") in other words an "0" is at ground potential while a "1" is at some negative potential. Bipolar conversion does not alter the "0"s but changes every odd (or even) "1" to the opposite polarity. This does not alter the information since the "1"s are not "0" regardless of polarity.

4.24 The line coupling function includes four option jacks. These must be properly "Plug Linked" per application.

Option A (HL Option) Provides a 6 DB higher than normal level for application to the digital line. Use of this option is restricted to applications not requiring coordination with other PCM Systems and not requiring repeaters. The option will allow greater non-repeatered span line length.

Option B Standard option for repeatered DLF or non-repeatered LDF requiring PCM coordination. Span Line equipment or MDF must be less than 55 feet from the SB940A terminal.

Option C Same as B except span equipment or MDF may be 55 feet to 355 feet from terminal.

Option D Same as B except span equipment or MDF may be 355 to 655 feet to terminal.

4.25 The Line Driver includes 310 type Jacks for access to the working line or equipment (EQ). A third Jack (MON) permits bridging a working line. Regardless of powering arrangement no voltage appears on any of the jacks. Accessing of the LINE or EQ jack will interrupt service.

4.3 TX MUX (SB941A-101) Fig. 5 Position 47

4.31 Function of the unit is to assemble all bits of information into logical sequential order, or format. This is accomplished by momentarily storing all sampled or programmed bits in registers. The registers are then scanned for their stored bits at a line rate.

4.32 A bit stream is monitored for "Excess 0"s. This is a condition where if too many consecutive "0"s occur, repeaters and far terminal synchronization may be lost.

4.4 RX Line Couplers (SB941B-200 Fig. 5 Position 41

4.41 The RX digital line first appears at the Line Coupler. Here the signal is equalized and amplified. The recovered signal is fed both to the TX Time Base and RX Demux units for further action.

4.42 The Line Coupler includes 310 type jacks for LINE and EQ ("In and Out"). Access to either will interrupt the Digital Line Signal. A third jack (MON) is provided for bridging "in service" tests as required.

4.43 Alarm circuitry and associated lamps and switches are located on the Line Coupler. Alarm operation and automatic Nxl Spare Line Transfer are discussed separately, for clarity.

4.44 RX digital line equalization is accomplished by a two position switch on the face of the Line Coupler card. Settings are used as follows: "Out" for loops greater than 12db loss, "In" for loops having less than 12db loss or when interfacing with span line termination equipment including office repeaters.

4.45 The reconditioned digital signal is converted from bipolar to unipolar. The RX clock signal is recovered from the bit stream and furnished to the RX TIME BASE unit.

4.46 Bit errors are monitored at this point. A bit error is detected as being successive positive or negative bits. Since special circuitry at the transmit end of the system assured that "1" bits would be transmitted alternately as positive and negative, any violation is an error (bipolar violation) and can be detected. False bits can be the result of noise or interference on the digital line. Errors can also result from a faulty repeater failing to properly regenerate the signal. Occasional errors are of little consequence. Continuous errors are stored in a counter, and when they exceed a predetermined number per second, will cause a MIN (minor) alarm and cause the system to switch to the Spare Line. (DLF)

4.47 Acceptable error rate may vary between applications. A Plug-Link option is provided to permit selection of an error rate of 10^{-5} or one in 10^{-6}. Normally the option will be set for 10^{-6} on non-repeatered applications and 10^{-5} for repeatered DLF's.

4.48 Synchronization (monitored on the RX TIME BASE UNIT) status is returned to coupler unit. Momentary loss of SYNC will cause the SYNC lamp to wink. Repetitive loss of SYNC will cause the SYNC lamp to flash. In the case of loss of SYNC, the SYNC lamp will be on. Loss of SYNC will initiate a MIN (minor) alarm and cause transfer to the Spare Line. (DLF)

4.49 Failure to complete a line transfer or to reestablish SYNC, at the pre-set error rate, will result in a MAJ (major alarm). The major alarm will disable Channel Supervision and ringing to prevent customer annoyance and false rings. A timing option is provided so that proper sequence of disabling will occur. Line Couplers at the RT should be set (Plug-Link J1A) for "0 seconds" delay, while Line Couplers at the COT are set for "3 second delay" (Plug-Link J1-B),

4.49.1 The major alarm circuitry of the unit monitors the ringing battery source. Failure or absence of the voltage will result in a Major Alarm. In some applications a ringing source is not needed or provided. In such cases the monitor may be disabled. A Plug Link in J2-B disables the monitor. The monitor is active when the Plug-In is in position J2-B.

4.5 TX Time Base (SB941A-201) Fig.5 , Position 44

4.51 The received and conditioned clock signal from the line coupler is used to derive all necessary timing and control pulses which are fed to the RX DEMUX unit. Framing pulses are recovered and monitored. Loss of synchronization (framing pulses) is monitored and furnished to the alarm circuits of the Line Coupler.

4.6 RX DEMUX (SB941A-202) Fig. 5, Position 45

4.61 The reconditioned digital bit stream from the Line Coupler and timing pulses from the REC Time Base Unit are used to distribute all bits to their proper slot. The operation is used to distribute all bits to their proper time slot. The operation is the reverse of the transmit end i.e. the digital stream is momentarily stored and "read out" by the respective time slot.

4.7 Channel Unit-COT, Loop Start (SB942-100)
Fig. 6 Pos. 1-40

4.71 Voice frequency signals entering the two-wire hybrid are conditioned and fed directly to a "Delta Mod" chip. The Chip is also fed a timing signal from the time base unit which controls sampling rate. The sampled bits are in turn fed to the TX MUX unit.

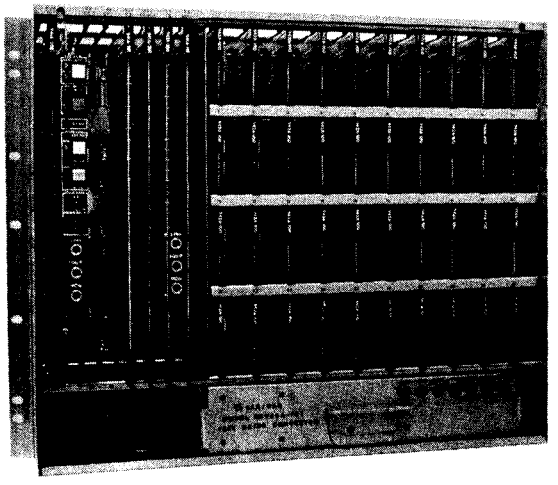

FIGURE 6

4.72 Ringing signals, between VF drop tip and ring, are monitored. When a ring signal is present a relay is operated which in turn furnished "ON" information to the Supervision register on the TX MUX Unit.

4.73 For various reasons it is sometimes necessary for the COT end to be able to control the RT loop. Should the CO loop momentarily be opened, such information will be forwarded to the RT end. The same time slot as used for ringing is used for loop Control. Signals are not misinterpreted since a ring signal can only occur in the COT "ON HOOK" condition.

4.74 Central Office loop seizure and loop dial pulsing information are forwarded to the modem from the RX DEMUX supervision register. Bits from the time slot are conditioned and relay control the Central office loop.

4.75 Received supervision pulses from the RT also turn power on to both TX and RX Delta Mod Chips. Therefore in the Channel idle condition (on hook) power is conserved and possible singing conditions avoided.

4.76 Channel Modems SB942A-300 4-wire E&M, SB942A-301 2-wire E&M, and SB942A-110 CO ground-start (described later) are available as options to provide those types of service. These modems and the loop-start modems can be intermixed in the SB940B-100 shelf by plugging into the card slots for the channels to be dedicated for those types of service.

4.8 Channel Unit-RT Loop Start (SB942A-200) Fig. 6, Pos. 1-40

4.81 VF Transmission and Delta Modulation function and identical to that of the COT Modem.

4.82 In the RT on hook condition, bits received at the modem from its supervision time slot operate a transfer relay in the VF Drop Leads. The operated contacts cut through the ring generator to the customer line. Ringing Voltage is applied to the ring side while the tip side is returned to ground within the channel unit.

4.83 In the RT off hook condition, bits received at the modem from its supervision time slot "enables" talk battery and opens the loop to the customer. The "Loop Control" is under control of the CO switching equipment or test board.

4.84 Subscriber "Off Hook" is sensed by a relay in the drop loop. An off hook between or during ringing results in ring trip. An "On Hook" condition sends an "ON" status to its respective supervision time slot. Supervision will respond to open and closure of the loop permitting loop dial pulsing or customer switch hook functions.

4.85 Talk battery is furnished on a constant current basis. Talk battery is furnished in the ring side of the line while the regulator and ground return is in the tip side. A Plug-Link option permits selection of 23ms or 40ma loop current. Unless locally required for special services the 23ma option should be used.

4.86 Channel modems SB942A-300 4-wire E&M, SB942A-301 2-wire E&M and SB942A-210 SUB ground-start (described below) are available as options to provide those types of service. These modems can be intermixed in the SB940B-100 by plugging into the card slots for the channels to be dedicated for those types of service.

4.8.1 CHANNEL UNIT COT & RT, (SB942A-300) 4-WIRE E&M OPTION

4.8.1.1 This type channel unit is used in both the COT and RT when 4-wire E&M compatibility is to be provided in the system. The SB942A-300 card is directly interchangeable with the SB942A-100 and -200 channel units and no additional wiring is required. SB942A-300 channel units must be installed for the appropriate channel in both the COT and RT terminals.

4.8.1.2 The SB942A-300 converts the M-lead signaling input into digital form for transmission and converts the receive supervision into E-lead condition reflecting the signaling slate of the M-lead at the remote terminal. Strapping options for the M-lead include normal and repeat operation, and type I, II and III interfaces.

4.8.1.3 The unit provides a balanced 600 ohm impedance for the transmit voice frequency and receive voice frequency.

4.8.1.4 The unit filters transmit audio signal and amplifies/attenuates this signal to the optimum level required for delta modulation. At the receive end, the unit recovers the receiver audio signal and filters and amplifies it to a level suitable for transmission to trunk circuits.

4.8.1.5 The unit has test points for monitoring E&M leads; has a busy switch for maintenance; provides test points for monitoring T&R and T1 and R1; and provides CGA function.

4.8.2 Channel Unit, (SB942A-110 CO and SB942A-210 RT) Ground Start Option

4.8.2.1 These cards are directly interchangeable with the SB942A-100 and -200 respectively in the SB945B-100 shelves, no wiring changes are required.

4.8.2.2 When ground is placed on "ring" side of subscriber channel unit a 500 resistive ground will be placed on the "ring" side of the Central Office channel unit until ground is returned from the Central Office switching equipment. The unit will then behave as a loop start unit.

4.8.2.3 When ground is placed on the "tip" side of Central Office channel unit a ground will be placed upon the "tip" side of the Subscriber Channel Unit such that as long as the ground remains on the Central Office channel unit, the channel unit will then behave the same as a loop start unit.

4.8.2.4 Removal of the "tip" ground from the Central Office Channel Unit will cause the "tip" ground from the subscriber channel unit tip to be removed (forced disconnect).

4.8.2.5 Unit has all of the other features of the loop start channel unit.

4.8.2.6 Reverse battery supervision is not provided.

4.9 POWER UNIT (SB946B-100, SB946B-101) (Fig. 6 lower)

4.91 When supplied with -48V DC the power unit provides all necessary terminal power required for operation of COT or RT terminal. At the COT ring generator and talk battery are normally not used but are available permitting either terminal to accept CO or Sub Channel Units.

4.92 The Power unit is protected on the primary (-48V DC) side by a 5A circuit breaker. The breaker will auto-reset when fault is cleared.

4.93 To minimize noise, impulse noise etc. talk battery is derived in the power unit by a DC to DC Converter providing a regulated -54V.

4.94 The standard configuration of the SB940A system provides a SB946B-100 -48VDC plug-in DC/DC converter with ringing generator for the remote terminal and a SB946B-101 -48VDC DC/DC converter, no ringing generator for the CO terminal. Except for the ringing generator, these units are identical and interchangeable. The SB946B-101 can be converted in the field to a SB946B-100 by addition of the ringing generator assembly.

4.95 For bidirectional applications of the SB940A system (see paragraphs 2.11 and 2.12) both the CO and RT should be equipped with the SB946B-100 (DC/DC converter with ringing generator).