AHG37 LINE INTERFACE UNIT (LIU)-3E3
DATA SHEET
D4 CHANNEL BANK

DESCRIPTION

The AHG37 LIU-3E3 line interface unit contains the clock and transmit-receive converters needed to interface the D4 channel bank or digital carrier trunk (DCT) to two bidirectional DS1 (D4 mode 3) facilities. The LIU-3E3 unit supports superframe (SF) and extended superframe (ESF) framing formats for each digroup. Line coding options available independently for each digroup are bipolar eight zero substitution (B8ZS) and alternate mark inversion (AMI). Zero-byte time slot interchange (ZBTSI) formatting is provided as an option with the ESF format. When the LIU-3E3 is optioned for ESF and used in conjunction with the AHG34 receive unit-2 (RU2), the D4 digroup provides true ESF data link yellow alarm processing and supports unrestricted clear-channel capability. The LIU-3E3, optioned for ESF framing format, supports American National Standards Institute (ANSI) T1.403-1989 performance report message generation and payload loopback capabilities. Figure 1 shows the LIU-3E3 circuit board faceplate.

When this data sheet is reissued, the reason for reissue will be given in this paragraph.

The COMCODE and *CLEI** codes assigned to AHG37 LIU-3E3 are as follows:

- COMCODE -- 104391503
- *CLEI* -- D4LIS05NAA.

FEATURES

The features of the AHG37 LIU-3E3 are as follows:

- Provides optional SF or ESF framing formats selectable at the faceplate. Optional ZBTSI coding is available with ESF format.
- Provides optional AMI or B8ZS line coding selectable at the faceplate
- Provides performance-monitoring message generation and payload loopback in the ESF framing mode compatible with ANSI T1.403-1989
- Supports unrestricted clear-channel capability when used in conjunction with the AHG34 RU2.

OPTIONS

Framing

SF: The SF format is the standard D4 framing format containing 12 frames. It uses a bit position (framing bit) to synchronize the equipment and to identify the boundaries of the frames and signaling information. The framing bit occurs before every 192 information bits in the bit stream. Within the 12 frames the 6th and 12th frames contain A and B signaling frame bits that can be used to convey signaling.

The superframe format is selected on a per digroup basis at the faceplate (Figure 1) by setting the designated **ESF/SF** switch to the **SF** position.

ESF: The ESF format extends the D4 framing structure from 12 frames to 24 frames and uses the 6th, 12th, 18th, and 24th frames to convey signaling information. The framing bit sequence is divided into 2 kb/s for main frame and robbed-bit signaling synchronization, 2 kb/s for transmission of a CRC-6 (cyclic redundancy check-6) code, and 4 kb/s for a data link. ESF provides real-time and in-service maintenance capability through the CRC-6 code and ANSI standard T1.403-1989 performance report message generation without interrupting the data being transmitted.

The ESF format is selected at the faceplate (Figure 1) on a per digroup basis by setting the designated **ESF/SF** switch to the **ESF** position.

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Line Coding

AMI: AMI is the standard line code that uses sequential logic one pulses with alternating polarities. Bipolar violations are not permitted. It is used in voice, voiceband data, and standard Digital Data System (DDS) applications. AMI satisfies the ones-density requirements of the DS1 line by either substituting a one in bit 7 of an all-zero byte (B7 zero code substitution) for voice channels or by using bit 8 as provided in DDS format. The AMI line code does not support 64-kb/s clear channel data transmission except when alternate channel 64 kb/s clear capability or ZBTSI coding is used.

The AMI line coding is selected at the faceplate on a per digroup basis by setting the designated **B8ZS/AMI** switch to the **AMI** position.

B8ZS: B8ZS is a zero-suppression line coding format used to support 64-kb/s clear channel or clear-channel capability over DS1 facilities. In the transmit direction, the B8ZS encoder substitutes the code 000V10V1 for each consecutive string of eight zeros. The V represents a bipolar violation relative to the polarity (+1 or −1) of the last 1 transmitted. In the receive direction, the B8ZS decoder converts the incoming code 000V10V1 back to eight zeros.

The B8ZS line coding is selected at the faceplate on a per digroup basis by setting the designated **B8ZS/AMI** switch to the **B8ZS** position.

Optional Zero-Byte (Octet) Coding Technique

ZBTSI: ZBTSI is an optional coding technique applied to a DS1 signal framed with ESF to ensure that the ones-density requirement is met for the DS1 line. Bits 2 through 193 are scrambled to minimize the occurrence of all-zero octets (8-bit bytes). When an all-zero octet is contiguous to another octet with zeros and they would combine to violate the ones-density requirement, an algorithm is invoked where some all-zero octets are replaced by an address chain. The reverse algorithm is performed by the receiving terminal.

ZBTSI is selected at the faceplate on a per digroup basis by setting the designated **ZBTSI/OFF** switch to the **ZBTSI** position. Otherwise the switch should be in the **OFF** position. When ZBTSI is used, the LIU-3E3 meets the ZBTSI requirements of ANSI T1.107-1988.

> ***Note:*** The ESF option must be selected with the ZBTSI option.

APPLICATIONS

Applications of the LIU-3E3 are presented in the following paragraphs.

Clear-Channel Capability

The initial concept of clear-channel capability referred to a single 64 kb/s channel which allowed customer access to all the 8 bits of a byte, commonly called 64 kb/s clear channel. The currently available data services expand the concept to include customer access to multiple contiguous 64 kb/s channels in the DS1 bit stream including up to 24 channels (the last 192 bits of each frame). An application providing full access to the entire DS1 bit stream includes configuring the D4 channel bank with Nx64/56 dataport unit(s). The D4 channel bank supports the clear-channel capability in a number of ways:

- **Alternate channel 64 kb/s clear:** This clear-channel capability is compatible with carrier facilities which support only AMI line-coded DS1 signals. This capability guarantees DS1 line density requirements with AMI line coding by requiring that the preceding and succeeding channel positions of the first 64 kb/s clear channel be unequipped (unequipped channel positions default to a high ones density pulse-coded modulated signal). Additional 64 kb/s clear channels may be added by alternating clear channels with unequipped channel positions. The benefit of this capability is cost avoidance by not having to upgrade existing facilities, terminal equipment, and maintenance plans to support B8ZS line codes. However, it creates inefficient use of bandwidth and necessitates maintaining the channel associations throughout the network or portions of the network which do not support clear channel capability.

- **D4 clear channel:** The D4 channel bank can support up to 23 channels of 64 kb/s clear channel service when equipped with a D4 LIU which supports B8ZS line coding such as the AHG9, S2 LIU-3B and J98726AC-2 alarm control units (ACUs) which use an enhanced yellow alarm detection algorithm. The 23-channel limitation is based on the probability that a full complement of 24 data channels of customer data (or network maintenance codes) could emulate an inband SF yellow alarm code and cause the digroup to be removed from service. The limitation can be eliminated by equipping the D4 channel bank with the AHG37 LIU3E3 and the AHG34 RU2 plug-in units configured for ESF framing format.

- **Unrestricted clear-channel capability:** The D4 channel bank when equipped with the AHG37 LIU and AHG34 RU2 plug-in units per digroup supports true ESF yellow alarm handling. This configuration supports a full complement of 24 data port (including 64 kb/s clear channel) channel units as well as wideband data services such as Nx64 service which allows access to the full information bandwidth of the DS1 bit stream.

Performance Monitoring

The LIU-3E3 supports both ESF cyclic redundancy check (CRC) error detection and ANSI standard T1.403-1989 performance report message generation for enhanced facility and carrier performance-monitoring capabilities.

The embedded ESF CRC error detection feature provides transmit-end to receive-end performance monitoring capability in both standard and complex network configurations where conventional bipolar violation and frame error detection methods are of limited use. It detects 98.6 per cent of all logical errors. With the ESF CRC error detection, a mathematical based algorithm is applied to all the data in an entire superframe of the ESF. The result of the mathematical calculation is a 6-digit binary number (CRC-6 code) which is inserted into the CRC frame bit positions of the next superframe sequence transmitted. CRC errors can be detected by appropriate equipment at any access point [digital signal cross-connect (DSX-1)] or the terminating end. They are detected by duplicating the calculation on the received data and comparing the locally generated result to the result forwarded in the CRC bit position of the next frame sequence to be received.

The ESF CRC error detection feature supports both network monitoring and maintenance sectionalization and can be accomplished on a nonintrusive basis using customer data and is particularly useful in multiplexed and lightwave systems which do not propagate bipolar violations. The CRC error detection feature is useful in systems in which data errors can be introduced as a result of customer dependent data patterns which do not generate frame bit errors due to channel-frame bit orientations. The nonintrusive nature of ESF performance monitoring also allows for sectionalization and trouble identification before a service failure or interruption occurs and can be accomplished without customer service interruption or the need to secure customer access permissions.

ANSI T1.403-1989 performance report message generation provides access to performance information for the DS1 signal received by the LIU-3E3 unit. The performance parameters reported by the LIU-3E3 include the following:

- No events (no bipolar violations, no CRC errors, or framing errors).
- CRC errors detected (6 threshold limits are reported to indicate the performance level of the network).
- Severely errored (SE) frame event (2 or more frame errors detected in 3 milliseconds).
- Frame error (FE) event - synchronization error or frame bit error.
- Line code violation (LV) - bipolar violation.
- Slip (SL) - the slip indication provided by the LIU-3E3 unit indicates a comparison of the transmit and receive clock rates based on a frame length interval. Hence, the parameter in the LIU-3E3 indicates bank synchronization and not a true controlled frame slip as defined in ANSI T1.403-1989.

The information collected in the LIU-3E3 unit receive circuitry is transmitted as a formatted message through the outgoing (transmit) ESF data link once each second. Therefore, the transmit signal generated by the LIU-3E3 unit contains both the CRC error detection capability as well as the performance information for the DS1 signal received.

The combination of the CRC error detection and the performance report message generation provides and supports many of the network monitoring features available in DSX and multiplex equipment designs. Such equipment includes Digital Access Cross-Connect System (DACS) IV and DDM 2000 which provide operations systems (OS) interfaces. These features also facilitate remote end-office maintenance and troubleshooting from a central office location with DSX access and are supported by a number of commercially available portable DS1 test sets.

ENGINEERING CONSIDERATIONS

The AHG37 LIU-3E3 line interface unit is backward compatible with all D4 and DCT applications using earlier receive units (RUs) but with the following functional limitations:

- The J98726AB-4, L4 A, B RU and earlier RUs do not support the ESF data link yellow alarm and the more robust SF reframe algorithm for protection

against data patterns that emulate alarm codes and framing patterns.

- The J98726AB-5, L6 RU incorporates the more robust SF reframe algorithm, but does not support the ESF data link yellow alarm capability.

- The AHG34 RU2 incorporates both the more robust SF reframe algorithm for false framing protection and the enhanced ESF yellow alarm handling capabilities of the LIU-3E3 for unrestricted clear-channel capability.

Unrestricted clear-channel capability is supported when the LIU-3E3 and AHG34 RU2 are used in conjunction in the ESF framing mode. If other combinations of LIUs and RUs are used with B8ZS line coding (excluding AHG35 LIU-3E2), each digroup of the D4 channel bank will accommodate a maximum number of DS0 signals with each bit 2 equal to 0 from DS1 signal sources as follows:

- 23 when the D4 channel bank is equipped with a J98726AC-2 ACU (a voice channel unit should occupy channel slot 24 whether it is in service or not).

- 15 when it is equipped with a J98726AC-1 ACU.

The LIU-3E3 requires a conventional D4 passive equalizer card per digroup to compensate for office cabling. The equalizer(s), mounted inside the trunk processing unit (TPU), is selected on an application basis and ordered per cable type and length. See Table A for typical cable types and lengths with corresponding equalizer cards to be ordered.

> ***Note:*** If only one digroup in the D4 channel bank is in service and growth is expected requiring a second digroup, it is recommended that the second equalizer card be ordered and installed at the initial installation. This will prevent service interruption in the first digroup when the second digroup is placed into service.

MAINTENANCE

Local Loopback

Local terminal loopback is provided on a digroup basis by looping the transmit data back to the receive converter. The manual connection bypasses the external DS1 line. During a local loopback, an unframed all ones alarm indication signal (AIS) is transmitted on the DS1 line toward the far end.

Local loopback is activated by inserting a pin plug into either **LP-A** jack or **LP-B** jack depending upon which digroup is to be tested. These jacks are located on the faceplate (Figure 1).

The local loopback can also be activated at the **LL LT NORM** switch located on the faceplate of the ACU. Activation of this switch creates the loopback in the LIU-3E3. Refer to AT&T 365-170-607.

Payload Loopback

The LIU-3E3 provides payload loopback capability for each DS1 digroup in the ESF framing mode. Activating the payload loopback causes the digroup to trunk process and triggers an office alarm. When a payload loopback is in progress, the received data is transmitted back to the far-end channel bank through the DS1 line. The LIU-3E3 reports the payload loopback status by making the loopback (LB) bit a 1 in the outgoing performance report message.

The payload loopback is activated by applying a loop-up code (00010100 11111111) on the ESF data link. It remains active until any one of the following occurs:

- A payload loop-down code (00110010 11111111) or universal loop-down code (00100100 11111111) is received

- Two performance report messages separated by idle code are received

- An unframed all ones (AIS) is received from the far end.

Performance Monitoring

When a digroup is optioned for the ESF format, the LIU-3E3 transmits the ESF data link performance report messages (one every second) as specified by ANSI T1.403-1989. These messages report CRC error events, severely errored framing events, frame-synchronization bit error events, and line-code violation events. In addition, the messages report a "slip" when there has been a 193-bit differential between the timing for the transmit and receive directions of the digroup. Note that this treatment of the "slip" parameters does not meet the definitions of ANSI T1.403-1989.

SPECIFICATIONS

Total power dissipation: 2.3 Watts (typical).

Ambient Operating Temperature: 4°C to 38°C (40°F to 100°F).

Relative Humidity: 20 per cent to 55 per cent (non-condensing).

Transmit Clock (Master): 6.176 MHz ±32 ppm (free running) - Stratum 4.

REFERENCES

The following publications contain description, engineering, and maintenance information on the D4 channel bank and can be ordered from the AT&T Customer Information Center by calling 1-800-432-6600:

PRACTICE	TITLE
365-170-000	D4 Channel Bank - (TOP)
365-170-100	D4 Channel Bank - Description
365-170-101	D4 Channel Bank - General Channel Unit Description
365-170-607	D4 Channel Bank - J98726AC, L2, A Alarm Control Unit (ACU) - Data Sheet
365-170-608	D4 Channel Bank - AHG34 Receive Unit (RU2) - Data Sheet
801-505-155	D4 Channel Bank Equipment - for Use With Digital Transmission Systems - Equipment Design Requirements - Common Systems
855-351-103	D1, D2, D3, and D4 Digital Channel Banks and D5 Digital Terminal System - Application Engineering - Carrier Engineering
855-351-105	D4 Channel Bank - Channel Units - Application Engineering.

DRAWING	TITLE
SD-3C304-02	D4 Channel Bank - Application Schematic
SD-3C316-01	Digital Carrier Trunk/Universal Trunk (DCT/UT) Frame Application Schematic

PRECAUTIONS

The **LIU-3E3** unit contains devices that are subject to damage or decreased reliability from static discharges. When handling either unit, proper antistatic measures should be taken, such as wearing grounding bracelets and handling by the faceplate only.

REGIONAL TECHNICAL ASSISTANCE

Technical assistance for the D4 channel bank can be obtained by calling the Regional Technical Assistance Center at **1-800-225-RTAC**. This telephone number is staffed 24 hours per day.

WARRANTY

The terms and conditions of sale will include a five year warranty.

ISSUING ORGANIZATION

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TABLE A

LINE EQUALIZER CARDS TO BE USED WITH LIU-3E3

CABLE TYPE AND DISTANCE TO CROSS-CONNECT (FEET)		EQUALIZER CARD TO BE USED PER DIGROUP		
750/1249 CABLE	ABAM/TYPE 600 CABLE	DRAWING NO.	GROUP NO.	COMCODE
0 to 90	0 to 133	ED-3C655-31	G6	600225262
90 to 180	133 to 267	ED-3C655-31	G8	601156904
180 to 270	267 to 400	ED-3C655-30	G3	600185151
270 to 360	400 to 533	ED-3C655-30	G4	600185169
360 to 450	533 to 655	ED-3C655-30	G5	600185177

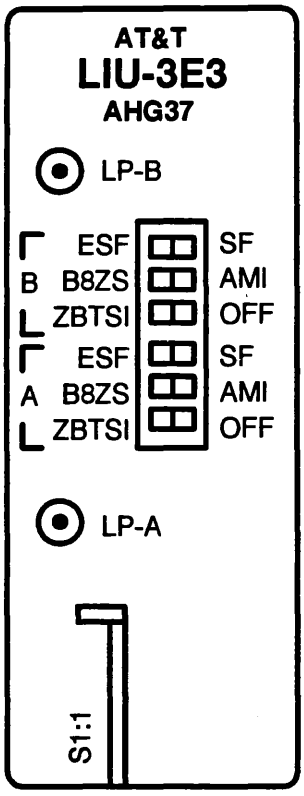

Figure 1—AHG37 LIU-3E3 Faceplate