DIGITAL CARRIER TRUNK INTERFACE
DESCRIPTION AND MAINTENANCE CONSIDERATIONS
NO. 1 AND NO. 1A
"ESS*" SWITCHES

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1. GENERAL

1.01 This section describes the digital carrier trunk (DCT) frame and its application as used in the No. 1 and No. 1A ESS switches. Maintenance considerations for this frame are also included.

1.02 The reasons for reissuing this section are to add maintenance information contained in Section 231-049-101 and to add information on the circuit switched digital capability (CSDC) feature. Revision arrows are used to emphasize significant changes.

1.03 The DCT frame provides an intelligent interface between the T-carrier transmission lines and switching network of the central office.

1.04 The DCT frame provides an interconnection for processing 1 to 480 one-way or two-way voice frequency circuits between the No. 1/1A office and the far-end office with up to 40-T1, 20-T1C, or 10-T2 digital transmission lines. This is accomplished by a microprocessor controlled interface for signaling and status reporting. Digits are received, converted to digital data, and a channel unit is selected for outpulsing. There may be up to 10 banks contained in one DCT frame. Each bank has two digroups and each digroup contains 24 channels for a total of 480 channels per DCT frame.

1.05 ➧The CSDC feature provides end-to-end circuit-switched transmission interface for 56 kilobit per second digital data signals. To provide the CSDC feature, the DCT bank must be equipped with combined alternate data/voice (CADV) channel units, alarm and digroup control unit (A&DCU, List 2) and an office interface unit (OIU-4). See Section 231-390-380 for feature description. Refer to Part 4 for additional DCT-CSDC description.

1.06 The DCT frame common equipment and test equipment are listed in Table A.◆

2. DIGITAL CARRIER TRUNK FRAME DESCRIPTION

2.01 The DCT frame consists of a peripheral unit controller (PUC), ten DCT banks, and an optional maintenance bank mounted in a 7 foot high (2133 mm), 6 foot 6 inch wide (1981 mm) 3-bay frame. The PUC, two banks, and the optional maintenance bank are placed in the center bay and four banks are placed in each of the side bays (Fig. 1).

PERIPHERAL UNIT CONTROLLER

2.02 The PUC is a microprocessor duplex controller located in the top portion of the center DCT bay. With the BELLMAC*-8 microprocessor as the heart of the processing unit, the PUC is self-contained with memory and power supplies. Refer to Section 231-037-020 for a description of the PUC.

2.03 The function of the PUC may be defined as call processing, and it is located between the No. 1/1A central control (CC) and the digital carrier systems. Although the PUC handles signaling, channel assignment, bit formatting, error checking and diagnostics, the CC commands and externally controls the call processing functions. A hierarchical command structure controls data flow to and from the combined channel units (CCU) (Fig. 2).

2.04 The PUC receives instructions from the CC over the peripheral unit address bus (PUAB). The PUC reports back to the CC over the peripheral unit reply bus (PURB). These instructions include those to be executed within the PUC as well as those to be passed on to the individual digroups.

2.05 For outgoing trunk (or channel) selection, the PUC receives a command from the CC over the PUAB and selects an idle circuit to handle the call. Signaling is also provided by the PUC. One PUC is required for each DCT frame.

2.06 The information returned to the CC consists of PUC and digroup status. This information is returned to the CC over the PURB when the CC periodically interrogates the PUC.

2.07 ◆The PUC contains its own diagnostic tests and will report failures to the CC. Upon request, the status of the DCT is printed out on the maintenance teletypewriter (TTY) for use by maintenance personnel.

2.08 A DCT application program resides in the erasable programmable read only memory (EPROM) within the PUC. This program is the DCT application firmware. This firmware (identified as MC1A000) is used by the PUC to detect changes in trunk signaling, detect and report changes in trunk supervisory states, automatically detect and report transmission facility maintenance information, and receive or generate revertive and dial pulse digits.◆

DIGITAL CARRIER TRUNK CHANNEL BANK

2.09 The DCT channel bank is a 48-channel pulse code modulated (PCM) terminal which serves as the transmission interface between T-carrier lines and the No. 1 or 1A trunk distributing frame. The bank is compatible with other D-type channel banks and digital multiplexers over T1, T1C, or T2 digital carrier systems. The DCT bank layout is shown in Fig. 3.

2.10 ◆The function of the DCT bank is to translate analog voice frequency (VF) signals to and from PCM signals for transmission over digital line facilities. An exception to this is the digital data use by CSDC as explained in Part 4. The DCT channel units convert the VF signals to pulse amplitude modulation (PAM) samples. The PAM pulses from the 24 channel units are encoded in the transmit unit (TU) to form the PCM signal. The PCM signal is processed in the line interface unit for application to the digital T-line. The receiving unit (RU) performs the complementary decoding function.

2.11 In addition to VF processing, circuits are provided for the transmission of per-channel signaling and supervisory information.◆

2.12 The principle difference between the DCT bank and other channel banks is that the DCT bank is a 3-port device. The third port permits a direct exchange of signaling, supervisory and maintenance information in a digital format with the No. 1/1A ESS switch.

2.13 High-frequency line connections to the DCT bank are in the standard DS1/DS1C and DS2 formats.

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TABLE A

LIST OF DCT COMMON EQUIPMENT AND TEST EQUIPMENT

UNIT	EQUIPMENT CODE	SD/CD
660 Communication Panel	—	292
Alarm and Digroup Control Unit	J98732AA-1	3C298-01
Combined Channel Unit	J98732BA-1	3C329-01
D3/D4 Portable Test Set	J98718AL-1	3C113
DCT Channel Bank	J98732A	3C315-01
DCT Frame Application	J98732A	3C316-01
DCT Maintenance Bank Test Set	J98732MJ-1	3C401-01
DCT Maintenance Bank	ED-98732M	3C400-01
Digroup Control Unit	J98732AB-1	3C298-01
Line Interface Unit (LIU-1D)	J98732AC-1	3C300-01
Line Interface Unit (LIU-2)	J98726AF-1	3C301-01
Line Interface Unit (LIU-3)	J98726AH-1	3C302-01
Line Interface Unit (LIU-4R)	J98726AP-1	3C314-01
Line Interface Unit (LIU-4RA)	J98726AS-1	3C314-01
Line Interface Unit (LIU-4T)	J98726AN-1	3C313-01
Line Interface Unit (LIU-4TA)	J98726AR-1	3C313-01
Office Interface Unit (OIU-1)	J98726AJ-1	3C308-01
PUC/DCT Bus Control and Interface Unit	JA098AA-1	1A477-01
PUC/Digital Carrier Trunk Unit	J1A098A	1A477-01
Power Alarm and Control Circuit	J1A099AC	1A479-01
Power Converter Unit	J87380C-1	82371-01
Power Distribution Unit	J98726AK-1	3C312-01
Receive Unit	J98726AB-4	3C306-03
Shelf Assembly (DCT Bank)	—	3C315-01
Signaling Path Test Set (DCT)	J98732MH-1	3C294
Syndes Unit	J98726AG-1	3C303-01
Transmit Unit	J98726AA-1	3C305-01
Trunk Processing Unit	J98726AD-1	3C311-01
CSDC USE ONLY		
Alarm and Digroup Control Unit	J98732AA-2	3C298
Combined Alternate Data-Voice Channel Unit	J98732PA	7C300
Digroup Control Unit	J98732AB-2	3C298
Office Interface Unit (OIU-4)	J98726AY-1	3C470

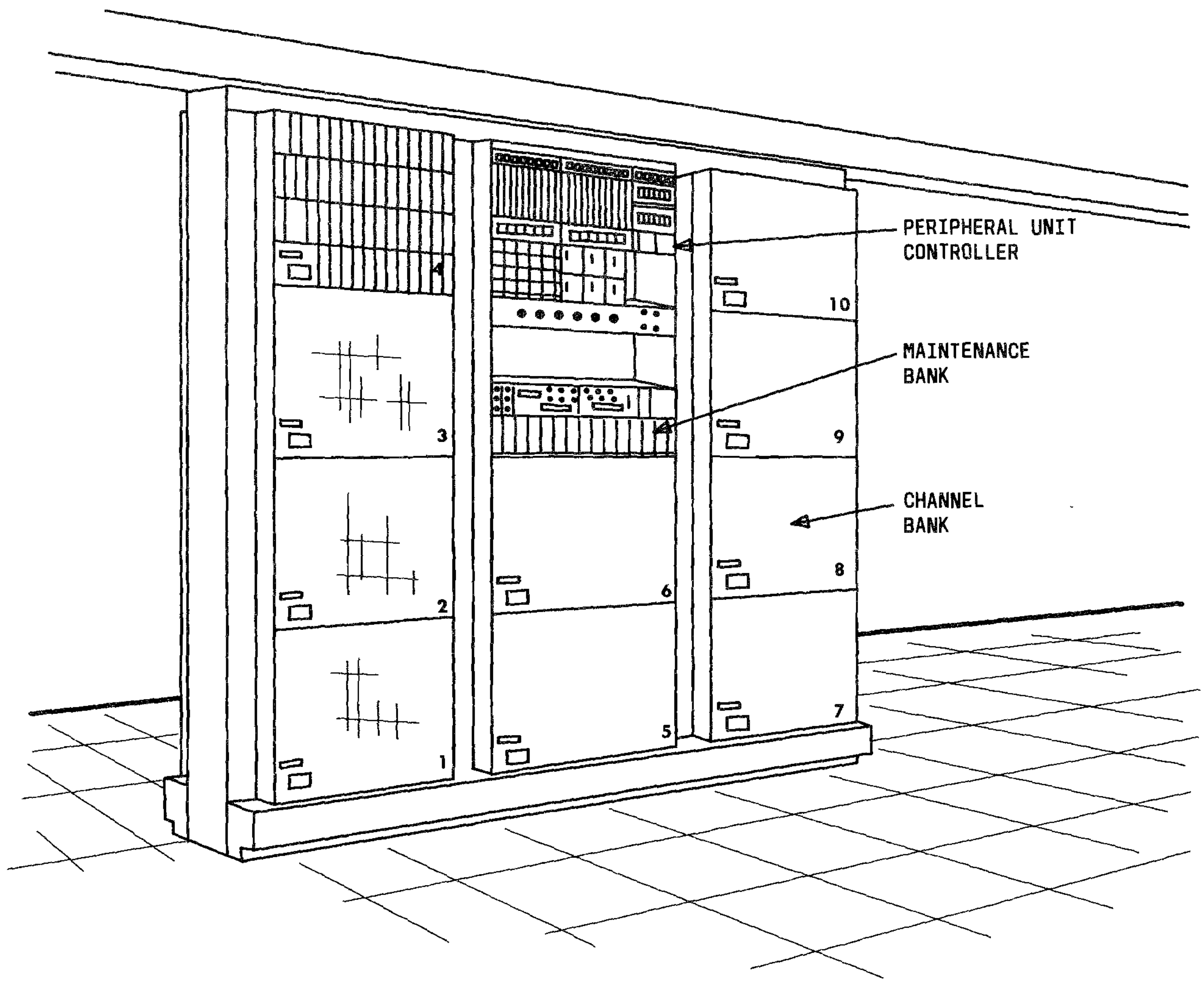


Fig. 1—Digital Carrier Trunk Frame

2.14 ♦The DCT channels are formatted into two 24-channel digroups to make DCT compatible with D1D/D2, D2/D1D, D3, and D4 types of far-end terminal equipment. Each digroup contains an individual transmit unit and receive unit. These units connect to other common equipment as designated by the operational mode.

2.15 Four operating modes are provided to interface with the T1, T1C, or T2 digital carrier systems (Fig. 4). Selection among the modes depend upon the line facility and the far-end terminal equipment. The T1 (24 two-way channels), T1C (48 two-way channels), and T2 (96 two-way channels) lines are used with line interface units to configure the four operating modes.

(a) Mode 1 multiplexes up to 48 VF trunk circuits (channels) into a single 3.152 megabit per second bit stream for application to a T1C line where D4 or DCT banks terminate at the far-end of the system.

(b) Mode 2 multiplexes up to 48 VF trunk circuits into a single 3.152 megabit per second bit stream for application to a T1C line which terminates in an M1C multiplexer at the far-end of the system.

(c) Mode 3 multiplexes up to 48 VF trunk circuits into two digroups of 24 channels each for application to two T1 lines, each with a 1.544 megabit

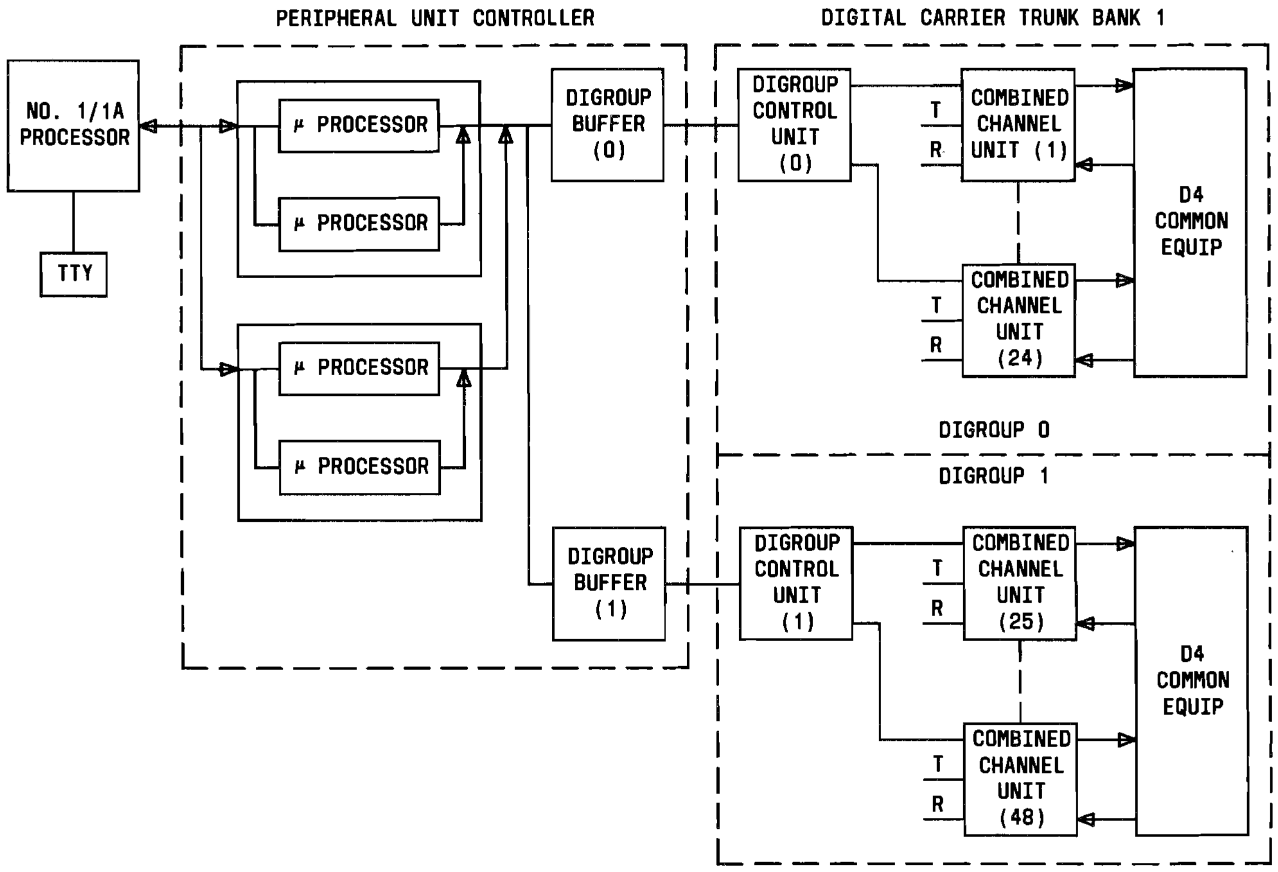


Fig. 2—Digital Carrier Trunk Control Diagram

per second bit stream. The far-end terminates in D1D, D2, D3, D4 or DCT banks.

(d) Mode 4 multiplexes up to 96 VF trunk circuits into a single 6.304 megabit per second bit stream for application to a T2 line, with the far-end terminating in D1D, D2, D3, D4, or DCT banks. Mode 4 operation requires two DCT banks (four digroups) to multiplex 96 lines. One bank is the transmit bank for an output of two digroups. The second bank is the receive bank for the two digroups.

2.16 Depending on the bank mode of operation, either one or two alarm and digroup control units (A&DCU) are provided. Mode 1 requires one such unit plus one digroup control unit. Modes 2, 3, and 4 require two alarm and digroup control units per bank.

DIGITAL CARRIER TRUNK BANK PLUG-IN UNITS

Note: The terms plug-in unit and circuit pack are synonymous when referring to DCT only.

2.17 The DCT bank contains two 24-channel digroups with associated plug-ins for control. The top two shelves are for units dedicated to digroup B and the bottom two shelves contain units for digroup A (Fig. 5).

2.18 In mode 1 both digroups operate synchronously, therefore a full complement of common equipment is required initially. In modes 2, 3, and 4, the two digroups operate independently and may be initially equipped for single digroup operation.

A. Trunk Processing Unit

2.19 The trunk processing unit (TPU) provides trunk processing control signals to the chan-

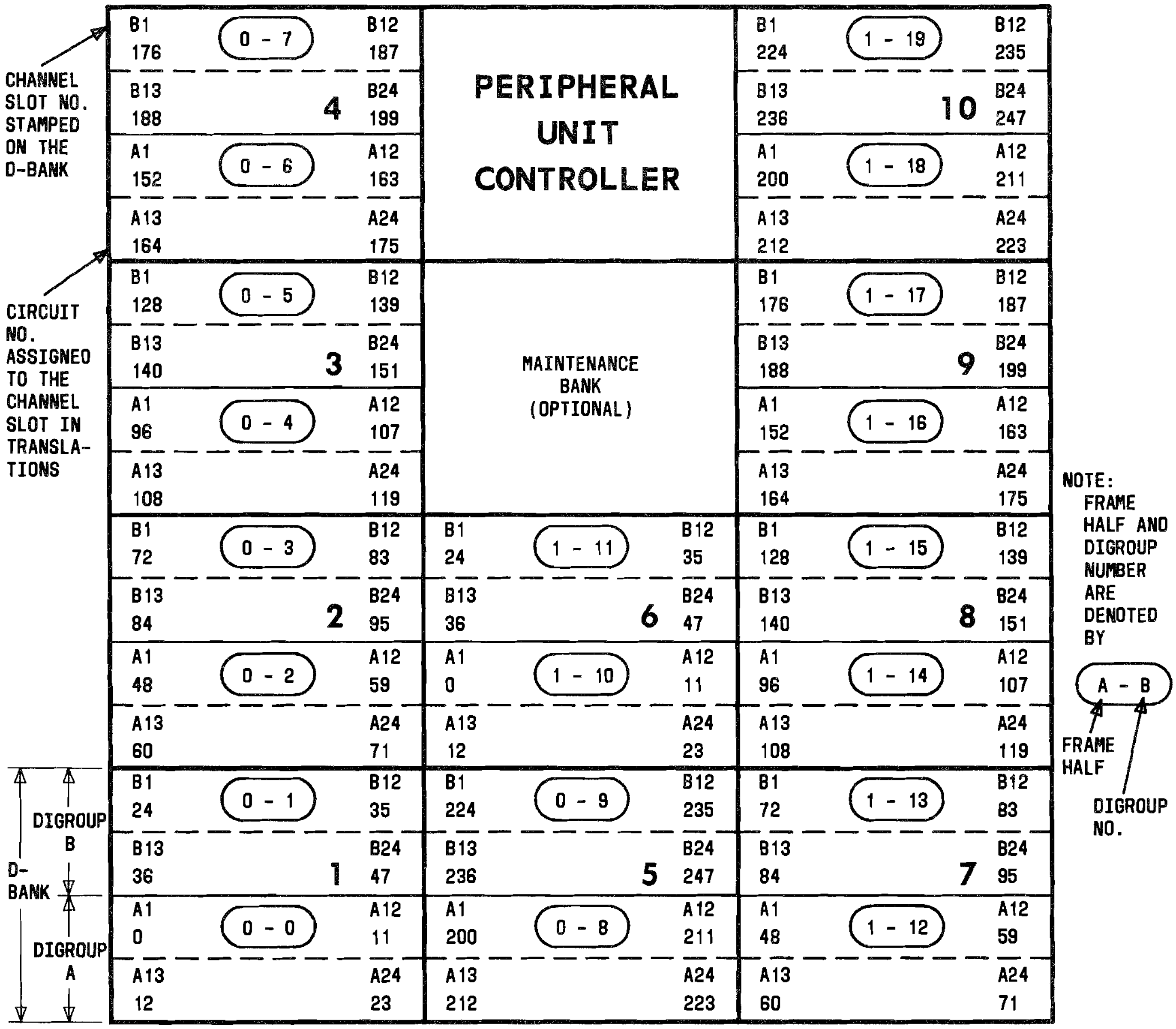


Fig. 3—Channel Bank Layout

nel units during carrier failure, sets the channel counting sequence, and provides equalizers to compensate for cable loss.

B. Combined Channel Unit

2.20 The combined channel unit (CCU) is used in the DCT banks to perform voice channel and trunk circuit functions. The CCU is designed to replace most of the standard 2-wire No. 1/1A ESS switch trunk circuit design functions. Refer to Section 231-090-152 for a listing of trunk circuit types replaced by DCT-CCUs.◀

2.21 The CCU provides the interface between the office VF trunk link frames and the common equipment units. Each channel unit includes transmitting and receiving circuits plus signaling and supervisory circuits. In the transmitting circuit, outgoing VF information is sampled at an 8-kilohertz rate, providing PAM signals which are fed to the transmit unit. Also, outgoing per-channel signaling

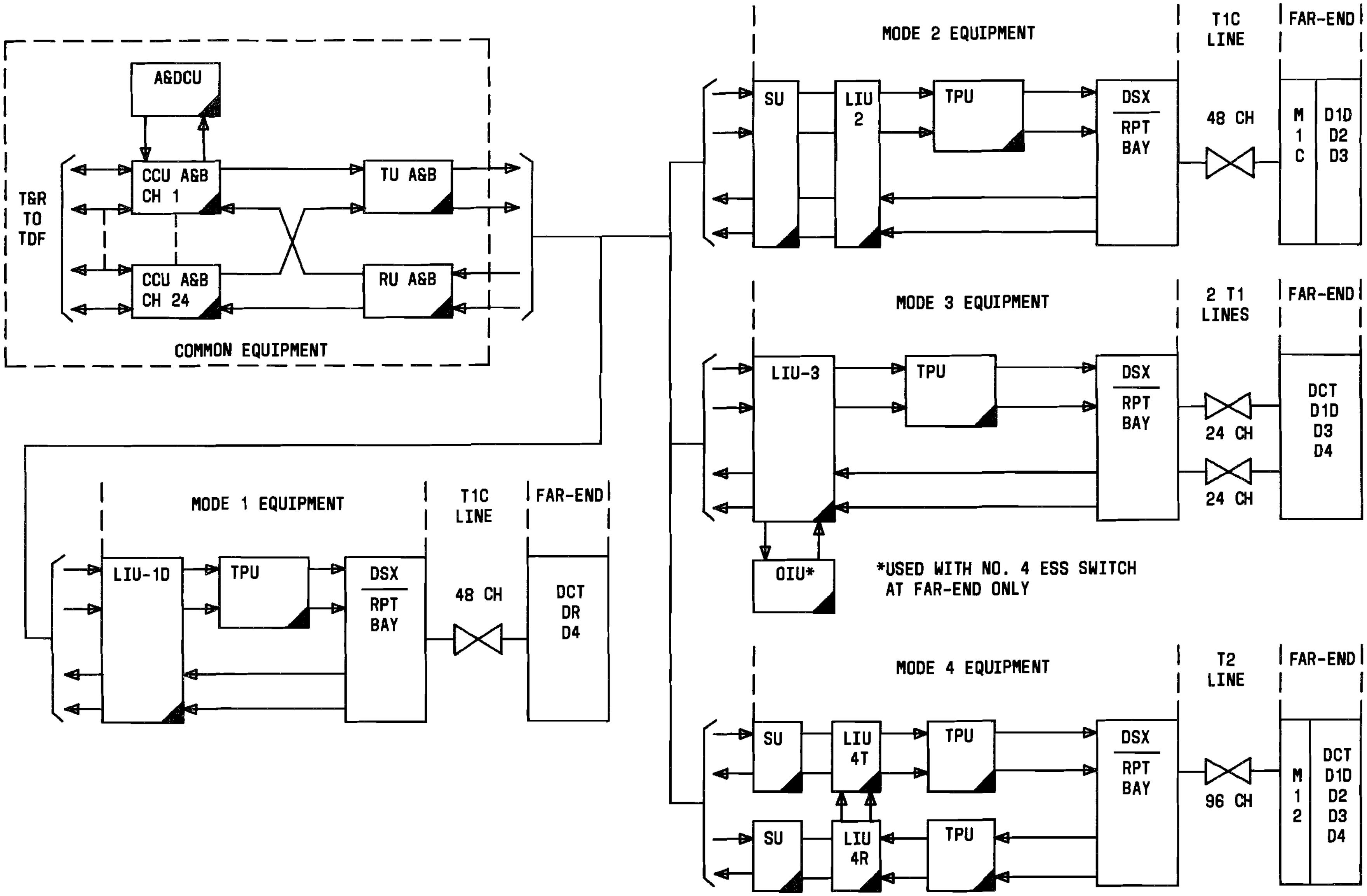


Fig. 4—Mode Dependent Equipment Configuration

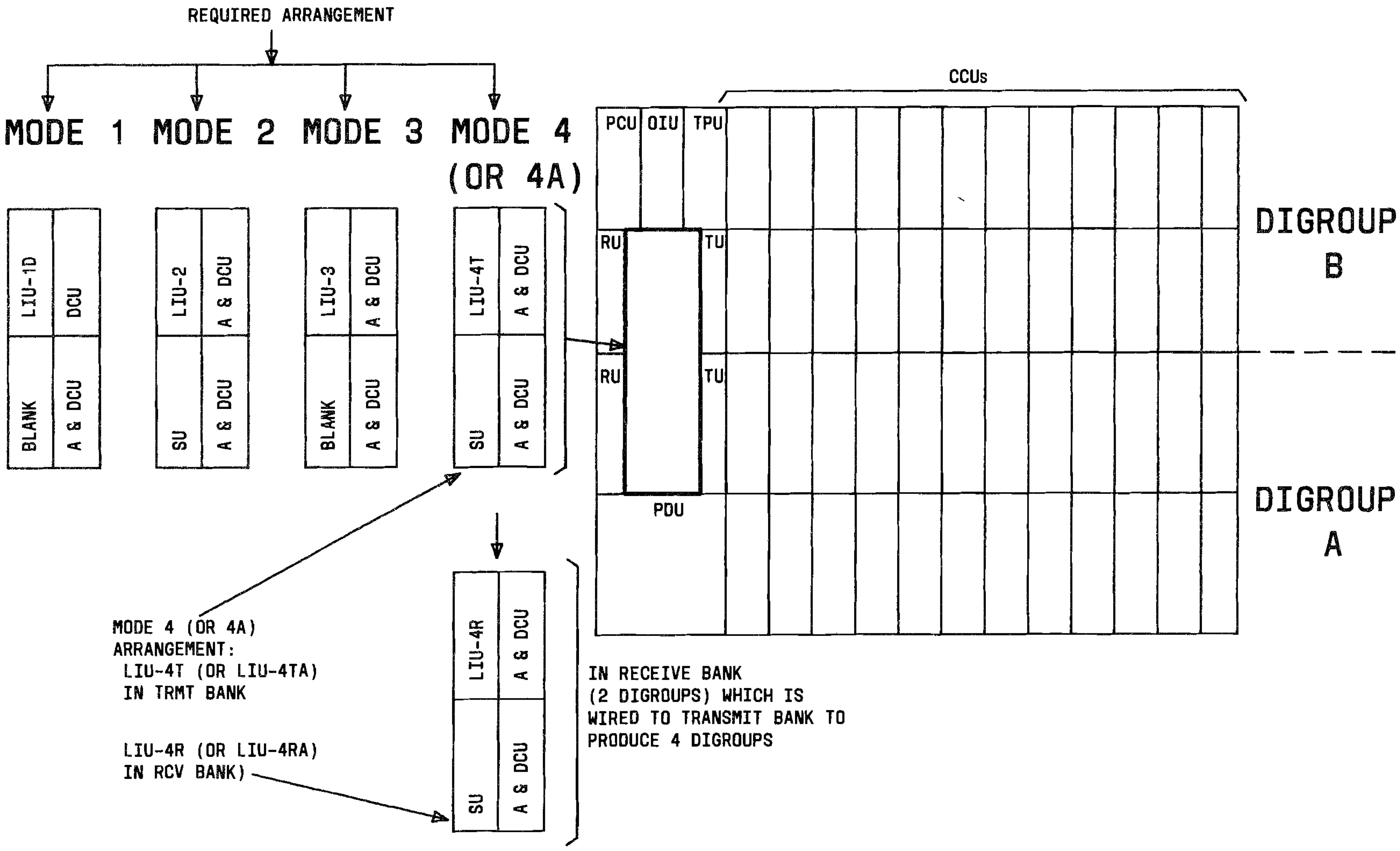


Fig. 5—Channel Bank Plug-ins

information is separately supplied to the transmit unit for periodic multiplexing with the voice samples. On the receiving side of the channel unit, the PAM signals are accepted from the receive unit and converted back to VF. In addition, signaling information from the receive unit is demultiplexed and converted to signaling and supervisory information for connection to the VF trunk. Signaling and supervisory information on the office side of the trunk is supplied via channel data leads to the digroup controller where it is sent to the PUC.

2.22 ➧Transmission measurements can be made using patch cords via jack access on the face of each channel unit.➧

C. Transmit Unit

2.23 The transmit unit (TU) encodes the PAM signal from each channel and combines the PCM words with framing pulses and signaling information.

D. Receive Unit

2.24 The receive unit (RU) performs the complementary function of the transmit unit. It decodes the PCM signals, demultiplexes the individual voice channel, and extracts framing and per-channel signaling information.

E. Syndes Unit

2.25 The syndes unit (SU) is used with the LIU2 unit for mode 2 operation, LIU4T and LIU4R for mode 4 operation, plus LIU4TA and LIU4RA for mode 4A operation. The SU and LIU2 furnish the functions provided by the M1C multiplexer used in 48 channel applications in existing systems; ie, it insures compatibility with the digital format required for T1C lines and that of two DCT digroups. This unit also adds synchronizing pulses to the data stream to synchronize digroup inputs. Unlike the other operational modes, digroup looping in modes 2 and 4 is performed in the SU rather than in the associated line interface unit when looping via the LT switch.

F. Line Interface Unit

2.26 The line interface unit (LIU), provides signal processing for the transmit and receive sections of each digroup. It converts the unipolar bit stream from the transmit unit to a bipolar bit stream for application to the digital line. The LIU also contains the transmit clock and receiving bipolar to unipolar converter circuitry.

2.27 There are four types of LIUs for the four operational modes of the DCT bank. Modes 1, 2, and 3 require LIU 1D, LIU 2, and LIU 3, respectively. Two LIUs are required for mode 4 and mode 4A. Mode 4 requires LIU 4T and LIU 4R. Mode 4A requires LIU 4TA and LIU 4RA.

G. Office Interface Unit

2.28 ➧The office interface unit (OIU) provides the means of locking the clock frequency of the DCT bank clock circuit to the incoming bipolar line bit rate. This circuit also provides interface between the T-carrier administration system (TCAS) and the bank alarms. The OIU is used in operational mode 3 with No. 4 ESS switch at far-end facility.➧

H. Alarm And Digroup Control Unit

2.29 The alarm and digroup control unit (A&DCU) is a plug-in consisting of two circuit boards. One board is the alarm control unit (ACU) and the other board is the digroup control unit (DCU). Separate alarm circuitry is not required for digroup B in mode 1 and in this case the digroup controller is self-contained in a DCU plug-in. In all cases, the functions of the digroup controller are independent of its physical association with the digroup alarm circuits.

Alarm Control Unit

2.30 The ACU provides the primary alarm indication and alarm control center for the DCT bank. It detects alarm conditions, controls local and remote office alarms, and initiates trunk processing for removal or restoration of service. The ACU also monitors particular -48 volt office battery leads and the output voltages of the bank dc-to-dc converter.

2.31 The ACU provides the means of testing bank performance by looping the high-frequency output to the input while holding the bank and trunks out of service.

2.32 Lamps and switches on the faceplate of the A&DCU are used for trouble indications and isolation (Fig. 6). When a trouble condition develops, the ACU initiates signals to the trunk processing unit and digroup controller which affects trunk conditioning appropriate for the given situation. When the trouble clears, service is automatically restored. One ACU for mode 1 or two ACUs for modes 2, 3, and 4 are required for each DCT bank.

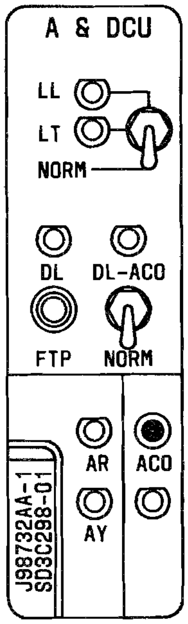


Fig. 6—Alarm and Digroup Control Unit

2.33 The ACU contains carrier group alarm (CGA) indicators identified as the AR (red) and AY (yellow) lamps located on the front panel to aid in maintenance. Refer to Table B for bank alarm lamp indicators and their causes. A data link-alarm cutoff switch (DL-ACO) is provided to inhibit remote reporting of data link failure. Bank operation and the receipt of information from the PUC is not affected by operation of the DL-ACO switch. An alarm cutoff pushbutton (ACO) is provided to turn off bank and office alarms.

2.34 The ACO pushbutton signals the alarm control unit to turn off the bank and office alarms. The ACO lamp is lit when the alarms are turned off. The AR and AY alarms are not extinguished until the trouble is cleared. If an alarm occurs as a result of a fuse failure, the ACO pushbutton cannot be used to turn off the bank and office alarms. In this case, the ACO lamp does not light. The defective fuse must be located and replaced to silence the alarms.

2.35 The ACU provides a three-position switch which is used as an aid in locating troubles. The positions are for normal (NORM) bank trunk looping (LT) and T-line looping (LL) operation. Two lamps are used to indicate LT or LL operation. This switch is used to condition the bank for looping procedures which are used in trouble locating. The switch is only functional when trunks are removed from service by the TPU, normally as a result of an AR or AY alarm, and after the ACO has been operated.

2.36 The LT operation can also be requested via the DCT-BANK TTY input message. The same restrictions as in the manual LT operation apply.

2.37 The LT operation causes the digital output of the bank to be looped at the LIU for operational modes 1 and 3. For operational modes 2 and 4, the looping occurs in the SU. Looping the digroup within itself aids in solving bank problems.

2.38 The LL operation causes a yellow alarm to be transmitted to the far-end. This will hold the far-end bank out of service and allow line troubleshooting. Proper operation of the LL feature requires that both banks (far-end and near-end) be in LL operation to avoid inadvertent restoral of one or both terminals under noisy line conditions.

Digroup Control Unit

2.39 The digroup control unit (DCU) receives status requests and trunk command information from the PUC via a serial data link. It selects the proper CCU and prepares it for service via channel data leads. Signaling and supervisory information from each CCU is received by the DCU via the same channel data leads. This information is then sent to the PUC. Two digroup controllers are required for each bank (digroup A and B).

I. Power Distribution Unit

2.40 The power distribution unit (PDU) accepts the -48 volt dc central office battery and provides a fused power distribution arrangement for application of power to the DCT bank. Office alarms are activated by any fuse operation.

2.41 The PDU also provides filtering for the talk battery to reduce noise and ripple.

TABLE B

BANK ALARM INDICATORS

LOCATION OF LAMP	LAMP STATE (LIGHTED)	PROBABLE CAUSE OF TROUBLE OR FUNCTION
PDU	ALM	Bank alarm; fuse or signal failure
PCU	FAIL ACO	Low converter output voltage PCU input switch off
RU	RCV	Loss of framing PCM receive signal
A&DCU	DL	1. Loss of data from PUC 2. Loss of clock from PUC 3. Babbling CCU 4. Glare in DCU to PUC
	AR	Baml alarm for: 1. Loss of −48F or −48S 2. Loss of PUC data 3. Loss of receive signal 4. Loss of receive multiplex
	AY	1. Far-end failure 2. Near-end transmit failure
	ACO	Office alarms have been cleared — depressing ACO
DCU	DL	1. Loss of data from PUC 2. Loss of clock from PUC 3. Babbling CCU 4. Glare in DCU to PUC

LOCATION OF LAMP	LAMP STATE (LIGHTED)	PROBABLE CAUSE OF TROUBLE OR FUNCTION
LIU-2	PASS	Fast loop test OK
LIU-4T LIU-4R	FAIL	Fast loop test fails; trouble in SU or LIU
	LOC	Incoming problem (LIU or SU)
	REM	Remote (far-end) problem
TPU	TPD-A TPD-B	Digroup (A or B) has completed trunk processing
A&DCU RU	AR,RCV flashing	Improper cross-connect has been made. The T&R is reversed at DSX or office repeater bay
A&DCU	AR,AY flashing	Hierarchy failure Mode 2 and Mode 4 only. Multiplexer at far-end
A&DCU TPU	AY,TPD-A or B flashing	1. Bank in loop mode but digroup has not been removed from sevice 2. Incorrect attenuation (not enough) in CCU transmit 3. Open CCU (T&R without termination)

J. Power Converter Unit

2.42 The power converter unit (PCU) accepts a fused output from the PDU and converts the nominal -48 volt dc central office battery to regulated dc voltages of +5.0 volts, -12 volts, and +12 volts required for the operation of the DCT circuitry.

MAINTENANCE BANK

2.43 The DCT maintenance bank (Fig. 7) provides "hot spares" of plug-in units, testing facilities, and centralized maintenance. The heart of the maintenance bank is the maintenance bank test set (MBTS). The MBTS (Fig. 8) has circuits which, when used in conjunction with a digroup of DCT common equipment, will monitor the performance of CCUs and the common plug-ins. A thorough functional test of the CCU is performed in conjunction with the DCU using a microprocessor in the MBTS. In addition, network loss and distortion tests are performed on the CCU and common equipment. These tests, in conjunction with the built-in alarms on the common equipment, will verify that all units which test good will perform satisfactorily in a working bank.

2.44 One shelf of plug-ins is required for testing DCT banks operating in modes 1, 2, or 3. To test mode 4 functions, an additional shelf is required which is hard wired to the first shelf.

2.45 Testing configuration requires the DL-ACO/NORM switch on the ADCU be set to DL-ACO and the 3-position switch set to NORM.

A. Maintenance Bank Test Set

2.46 The MBTS, in conjunction with bank common equipment, tests all DCT plug-in units. The switches and lamps on the MBTS are used for testing as described in the following paragraphs. The switch and lamp functions are described in Table C.

2.47 The alarm disable switch (ALM DISABL) is used to disable maintenance bank alarms generated by the common equipment and the MBTS. This switch will turn off office alarms to which the maintenance bank is connected through the PUC power alarm and control unit. When testing, operate the alarm disable switch to silence any office alarms caused by the testing. When testing is not in progress, leave the alarm disable switch in the released position (out) so that office alarms will be activated in the case of a maintenance bank alarm.

2.48 The test jack is used to check looped common equipment using the D3/D4 test set and channel access unit (CAU). The MBTS CCU simulator is tested at its four-wire points.

2.49 The transmit and receive attenuator switches (TRMT and RCV) complete or build out the loss of the transmit or receive paths under test. With the attenuators set, a CCU VF problem can be detected via the voice tests generated by the MBTS. Attenuator buttons pushed in indicates zero attenuation. With the button out, the attenuation is as marked.

2.50 The following test switches are activated when pushed in and only one can be activated at a time. The PASS and FAIL lamps provide the result of the test performed.

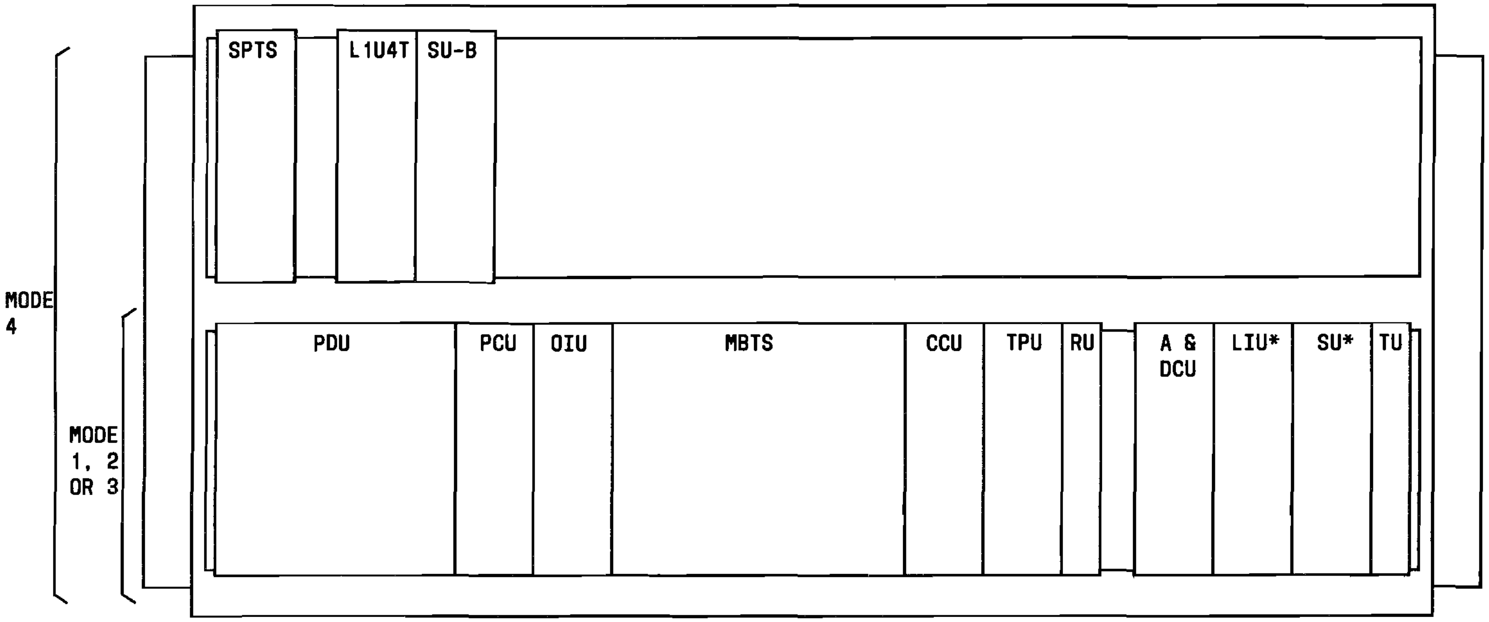
2.51 The DIGL CCU-DCU tests the digital portion of the microprocessor in the MBTS. The supervisory and control functions are tested in a manner similar to the way the CCU operates in a working system with the microprocessor communicating with the CCU. The replies from the DCU to the microprocessor are then compared with the desired results in memory. When testing a CCU in the DIGL CCU-DCU mode, the first test may fail because a unit just plugged in could have its logic and relays in any state but the correct state that the test sequence expected. In this case, the test should be repeated after performing a test using the following test switches.

2.52 The VF TRMT switch tests the CCU transmit circuitry. It inserts a test tone into the tip/ring of the CCU under test, then routes its PAM pulses through the looped common equipment and into the receive side of the CCU simulator where it is detected. A deviation of $\pm$ 0.5 dB is detected as a failure.

2.53 The VF RCV switch tests the CCU receive circuitry. It inserts a VF tone into the transmit side of the CCU simulator. The PAM pulses from the simulator are then looped through the common equipment into the receive portion of the CCU under test. This tone is detected at the tip/ring of the CCU as VF. A deviation of $\pm$ 0.5 dB is detected as a failure.

2.54 The MC TRMT switch tests the CCU transmit side for multichannel interference or crosstalk.

2.55 The MC RCV switch tests the CCU receive side for multichannel interference.



*EQUIP AS SHOWN:

MODE	LIU( )	SU
1	LIU(1)	NOT INSTALLED
2	LIU(2)	INSTALLED
3	LIU(3)	NOT INSTALLED
4	LIU(4R)	INSTALLED

LEGEND:

- A&DCU - ALARM & DIGROUP CONTROL UNIT
- CCU - COMBINED CHANNEL UNIT
- LIU - LINE INTERFACE UNIT
- MBTS - MAINTENANCE BANK TEST SET
- OIU - OFFICE INTERFACE UNIT
- PDU - POWER DISTRIBUTION UNIT
- PCU - POWER CONVERTING UNIT
- PDU - POWER DISTRIBUTION UNIT
- RU - RECEIVE UNIT
- SPTS - SIGNALLING PATH TEST SET
- SU - SYNDES UNIT
- TPU - TRUNK PROCESSING UNIT
- TU - TRANSMIT UNIT

Fig. 7—Maintenance Bank

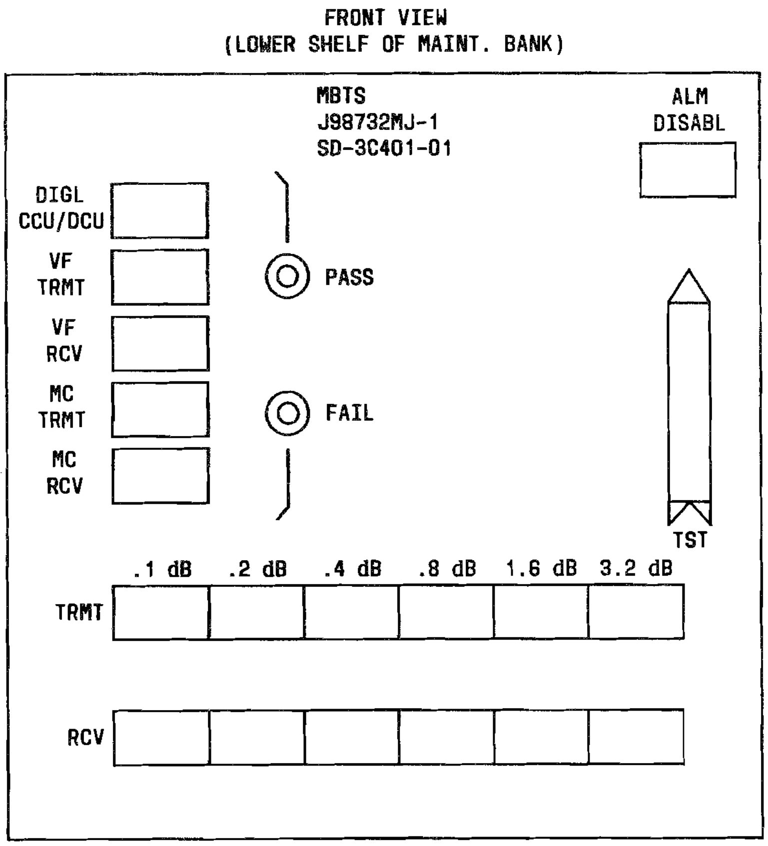


Fig. 8—Maintenance Bank Test Set

B. Common Unit Testing

2.56 ***Warning: Excessive plug-in removal and insertion in the maintenance bank may cause wear on the connector. This may lead to erroneous fault indications by the maintenance bank. Do not use the maintenance bank for routine testing of plug-ins.*** Common equipment plug-in units suspected of being faulty are tested by performing one of the VF tests and the DIGL CCU/DCU tests. To test the digroup control unit, place it into the alarm and digroup control unit position and perform the DIGL CCU/DCU test. The DL-ACO switch selection should be made during the test in order to silence the alarm.

3. MAINTENANCE

3.01 Maintenance procedures pertaining to DCT are contained in the following task oriented practice (TOP) documents:

- TOP 231-050-015: DCT frame maintenance (DCT and PUC)
- TOP 231-050-006: DCT trunk testing (1E6 or 1AE6 generic program)
- TOP 231-050-007: DCT trunk testing from the manual trunk test position (MTTP)
- TOP 231-050-008: DCT trunk testing from the supplementary trunk test position (STTP)
- TOP 231-050-009: DCT trunk testing from the trunk and line test panel (TLTP).

3.02 Maintenance for DCT is performed using TTY messages, switches and lamps on the DCT frame, and various trunk test positions. Remote maintenance from a console at the Switching Control Center (SCC) is also available to the DCT which is similar to that available in the central office.

♦TABLE C♦

MAINTENANCE BANK TEST SET CONTROLS

TEST KEY	FUNCTION
DIGL CCU-DCU	Test logic portion of the CCU and DCU. Causes DCU to set and check signaling bits, operates CCU relays K1 and K2, and compares the results with the desired result in memory.
VF TRMT	Tests the transmitting portion of the CCU. Signal path for the test includes common equipment.
VF RCV	Test the receiving portion of the CCU. Signal path for the test includes common equipment.
MC TRMT	Tests interference into other time slots.
MC RCV	Tests interference from other time slots.
ALM DISABL	Prevents maintenance bank alarms from being reported when depressed.
TRMT (.1dB — 3.2 dB) RCV (.1 dB — 3.2 dB)	Level adjust attenuators used to build out loss in channel unit transmit and receive paths.
PASS/FAIL LAMP	Indicates the result of test.

Printouts are available and maintenance messages are inputted to manually call up lists, diagnostics, etc.

TESTS

3.03 Tests are done to verify that the DCT and associated circuits are operating properly.

A. Installation Tests

3.04 The DCT banks must pass the installation requirements before they are ready for service. These tests include:

- Power verification
- Common unit configuration
- Bank functional tests.

3.05 For acceptance procedures, refer to TOP 231-050-015.

B. Growth

3.06 After adding a DCT bank (or a DCT frame) to an office, with connection being complete between central control and the T-lines, circuit order tests are required.

3.07 Refer to TOP 231-050-015 for growth procedures.

C. Testing from the Trunk Test Positions

3.08 The DCT tests from the trunk test positions consist of operational tests and signaling tests. These tests are contained in the following documents:

- TOP 231-050-006: DCT trunk testing (1E6 or 1AE6 generic program)
- TOP 231-050-007: DCT trunk testing from the manual trunk test position (MTTP)

- TOP 231-050-008: DCT trunk testing from the supplementary trunk test position (STTP)
- TOP 231-050-009: DCT trunk testing from the trunk and line test panel (TLTP).

3.09 The operational test is to verify that the CCU can be placed in all states by the central control. This is achieved by manual selection of each state from the MTTP, STTP, or TLTP.

3.10 The signaling test is to verify that the signaling is transmitted properly through the network and the CCU. From the MTTP, STTP, or the TLTP, the signaling tests are performed by selecting the trunk network numbers (TNN) as in any trunk circuit test. There are no visual indicators at the MTTP to inform the operator that the trunk under test is a DCT circuit. The channel unit is placed in a special access state using the same procedure (key operation at the MTTP or STTP) which would be used to place a conventional E&M trunk circuit into the E&M access state. Test results are obtained by observation of the E&M lamps.

D. Testing from the Digital Carrier Trunk Frame

3.11 End-to-end tests verify that the circuit is operating as a complete facility. These tests are contained in TOP 231-050-015. Tests that fall in this category are:

- Net loss
- Noise
- Signaling.

E. Testing from the Teletype

3.12 Maintenance messages for DCT can be inputted from the switching office maintenance TTY or from a remote location such as the SCC.

3.13 For the DCT, the input message for commands is DCT-BANK-aaa bb cc. and is used for:

- Looping
- Restoring the looped terminal
- Requesting alarm status
- Clearing out-of-frame count
- Displaying error history
- Clearing CGA count
- Reading and clearing CGA count
- Activating or removing digroups to or from service
- Requesting functional tests of digroup hardware.

3.14 Refer to the appropriate input and output message manuals for the format and description of TTY messages.

TROUBLE INDICATORS

3.15 Trouble associated with the DCT frame is indicated by audible office alarms, alarm lamps on the DCT frame, and TTY messages. Procedures contained in TOP 231-050-015 are used to clear troubles. Refer to Table B for bank alarm lamp indicators.

3.16 Facility maintenance and associated trouble indicators refer to the maintenance of all the equipment on the T-line side of the common channel unit. It extends from the bank common equipment transmit unit and receive unit out through the T-line proper. This equipment is partially self-checked in that some failures are detected internally and reported to the CC via the PUC as alarms.

3.17 The purpose of facility maintenance for DCT is to protect service and provide sectionalization information in the event of serious failure. The maintenance personnel is informed of certain conditions indicating that the system, end-to-end, is not performing at design levels.

A. Carrier Group Alarm

3.18 A carrier group alarm (CGA) relay is provided by the DCT on a digroup basis, with contact pairs for connection to a scan point in the master scanner. This alarm is remoted to the SCC and in turn remotes it to the T-carrier administration system (TCAS). The CGA gives an indication that the facility is unable to provide voice communications end-to-end. Upon a detection of a CGA, the following actions are initiated in the trunk hardware after a nominal 2.5 second delay:

- A disconnect is sent backwards on all channels to the network (in the affected digroup).

- A seize forward is sent on all channels to the far-end.

- The CGA is continuously monitored for bank restoral (an alarm will remain for at least 15-20 seconds).

3.19 The CGA is indicated by the AR and AY lamps on the alarm control unit.

3.20 The RED alarm (AR lamp lighted) is an indication that the near-end receive unit is unable to frame in the incoming bit stream.

3.21 The RED alarm is caused by one of the following:

- Loss of filtered talk battery (-48S). The circuit path for this alarm is from the fuse at the PDU to the CCU and then to the ACU. The cause of this alarm could be a fuse failure, ACU detection circuit, or backplane wiring error.

- Loss of battery (-48S). The circuit path for this alarm is from the PDU to the ACU. The cause of this alarm could be fuse failure, ACU detection circuit, or backplane wiring error.

- Receive framing (RFAL) out-of-frame or loss-of-clock alarm. This alarm is generated by the RU from the incoming PCM digital stream. The cause of this alarm at the near-end office could be a faulty RU, LIU, SU, cross-connect panel, office repeater, or line repeater. The cause of this alarm at the far-end office could be a faulty TU, SU, TPU, cross-connect panel, office repeater, or line repeater.

- Digroup control unit failure (DCUF). This is caused by a loss of the serial bit stream and/or loss of the clock pulses from the PUC to the DCU. Possible causes of this alarm are a faulty PUC digroup buffer, PUC to DCU cable, A&DCU, DCU, TU, or CCU.

- Loss of receive multiplex signal (LOSP). This alarm is caused by the loss of the bipolar signal from the T-line to the LIU for modes 2 and 4 only. Causes of this alarm at the near-end could be the cross-connect panel, office repeater, line repeater, SU, or LIU. At the far-end this alarm could be caused by the SU, LIU, TPU, cross-connect panel, or office repeater.

3.22 A YELLOW alarm (AY lamp lighted) is an indication that the far-end receive unit is unable to frame on the output of the near-end transmit unit. This alarm can be caused by a near-end transmit failure or a far-end receive failure. A unit with a RED alarm is able to transmit a signal causing a YELLOW alarm at the far-end (ie, when a RED alarm occurs at the far-end bank, it transmits a signal and causes a YELLOW alarm at the near-end bank).

3.23 A RED over YELLOW alarm occurs when an existing YELLOW alarm becomes a RED alarm because the far-end bank has been looped, opening the T-line. Both RED and YELLOW states are reported to the PUC.

3.24 Alternate RED and YELLOW alarms are a result of a failure higher up in the digital hierarchy. If the lamps alternate RED-YELLOW-RED-YELLOW —— at a rate of approximately 1.8 seconds each, the indications imply the trouble is not in the local T1 system but a trouble in a higher order system (T2, T3 or above). If the failure occurs (above T1 rate), it creates down stream failures at the T1 rate; therefore, the first indication seen would be a RED (which would stay up long enough to create a CGA) then alternate YELLOW-RED-YELLOW-RED, etc.

3.25 When a CGA occurs, the following actions are automatically taken by the CC:

- Remove from service all idle circuits in the affected digroup (ie, place them in a software CGA state).

- Camp on non-idle circuits until they are free to be removed from service.

- If the No. 1/1A CC is the control end of the facility, the count of the CGA occurrence is incremented in translation records.

- Print out on the maintenance TTY the following message:

  FM01 CGA DCT aa DIG bb cc ddd e ff:ff:ff

  and if the alarm is determined to be an hierarchy failure, then the second FM message is printed out:

FM02 DCT aa DIG bb HIERARCHY FAILURE

3.26 The data link alarm (DL lamp lighted) occurs when the DCU losses incoming serial data or clock from the PUC.

B. Automatic Line Monitoring

3.27 Automatic line monitoring and reporting to the PUC and CC is part of the overall maintenance plan. The error conditions reported are line error monitoring and line out-of-frame monitoring.

3.28 For line error monitoring, the receiving T-line's performance is monitored and reported back to the PUC. The bank and digroup controller will report to the PUC (and hence to the CC) when line error performance exceeds the low threshold (10^{-6} bit error rate) or the high threshold (10^{-3} bit error rate). These conditions will be reported in two separate reports; however, if the error rate exceeded both high and low threshold in one report interval, only the high threshold report will be made. Reporting is done via the FM03 DCT output message. When the high threshold is exceeded, the customer data transmission is significantly impaired. The information at the maintenance TTY will show the affected digroup and the error threshold exceeded.

3.29 The receiving T-line signal is continually monitored in the receive unit for an out-of-frame (OOF) state. The PUC accumulates the OOF count and a report is generated when OOF exceeds low threshold of 17 or high threshold of 512. Reporting is accomplished via the FM04 DCT output message.

FAULT ISOLATION

3.30 When a DCT related trouble is indicated to maintenance personnel, raw data analysis and looping are used to isolate the fault.

A. Raw Data Analysis

3.31 A raw data TTY output message (MN02 DCT) is printed if the CC detects a DCT order failure. This message identifies the content of various registers at the time of failure. Conversion of the identified DCT circuit numbers in the message is necessary to identify the DCT bank and digroup having the order failure. Refer to Table D for this conversion.

B. Looping

3.32 If a DCT related fault is detected, it is important to determine which equipment is causing the fault. The failure is isolated by looping data back at different points in the transmission path and observing the lighted lamps on the channel banks. The looping procedures are contained in TOP 231-050-015. Looping diagrams for operating modes 1, 2, 3, and 4 are shown in Fig. 9, 10, 11, and 12, respectively.

3.33 The looping procedures should be used to isolate a fault to the DCT bank, near-end office repeater bay, transmission line, or far-end office. The far-end office is required to participate when setting up the looping configuration. Should the far-end office be unable to set up the proper loop, they should refer to the appropriate TOP volumes as follows:

- TOP 365-800-001: D1, D2, D3 Channel Bank
- TOP 365-170-000: D4 Channel Bank
- TOP 365-800-002: T-Carrier, T1 Line.

C. Voice Frequency Signal Flow and Looping

3.34 For mode 3 operation, the VF signal flow into the the channel units is converted to a PAM signal and sent to the transmit unit. The PAM signal is converted to a PCM signal in the transmit unit and sent to the line interface unit. The line interface unit converts the signal to the bipolar format required for the T1 line and sends it to the trunk processing unit equalizers. The signal is then sent out on the T1 line. The inverse occurs on the receive side.

3.35 For mode 3 operation, LT looping (LT position of 3-position switch on the A&DCU) causes the signal output to be looped back to the input in the line interface unit. This occurs on an individual digroup basis.

3.36 Mode 1 LT looping is identical to mode 3 looping except that both digroups are looped.

3.37 Operating modes 2 and 4 require the addition of the syndes unit between the transmit or receive unit and the line interface unit. Looping occurs on an individual digroup basis within the syndes unit for LT looping.

3.38 Looping can also be performed using the LP jacks on the line interface units. All looping

▶TABLE D◀

DCT DIGROUP TO CIRCUIT NUMBER CONVERSION (NOTE)

CCU NO.	DCT FRAME HALF 0										
	1		2		3		4		5		BANK
	A	B	A	B	A	B	A	B	A	B	DIGROUP
	0	1	2	3	4	5	6	7	8	9	DIGROUP
1	0	24	48	72	96	128	152	176	200	224	CIRCUIT NUMBERS (SOFTWARE)
2	1	25	49	73	97	129	153	177	201	225	
3	2	26	50	75	98	130	154	178	202	226	
4	3	27	51	75	99	131	155	179	203	227	
5	4	28	52	76	100	132	156	180	204	228	
6	5	29	53	77	101	133	157	181	205	229	
7	6	30	54	78	102	134	158	182	206	230	
8	7	31	55	79	103	135	159	183	207	231	
9	8	32	56	80	104	136	160	184	208	232	
10	9	33	57	81	105	137	161	185	209	233	
11	10	34	58	82	106	138	162	186	210	234	
12	11	35	59	83	107	139	163	187	211	235	
13	12	36	60	84	108	140	164	188	212	236	
14	13	37	61	85	109	141	165	189	213	237	
15	14	38	62	86	110	142	166	190	214	238	
16	15	39	63	87	111	143	167	191	215	239	
17	16	40	64	88	112	144	168	192	216	240	
18	17	41	65	89	113	145	169	193	217	241	
19	18	42	66	90	114	146	170	194	218	242	
20	19	43	67	91	115	147	171	195	219	243	
21	20	44	68	92	116	148	172	196	220	244	
22	21	45	69	93	117	149	173	197	221	245	
23	22	46	70	94	118	150	174	198	222	246	
24	23	47	71	95	119	151	175	199	223	247	
CCU NO.	10	11	12	13	14	15	16	17	18	19	DIGROUP
	A	B	A	B	A	B	A	B	A	B	DIGROUP
	6		7		8		9		10		BANK
	DCT FRAME HALF 1										

Note: Circuit numbers 120 through 127 and 248 through 255 are not used for DCT application.

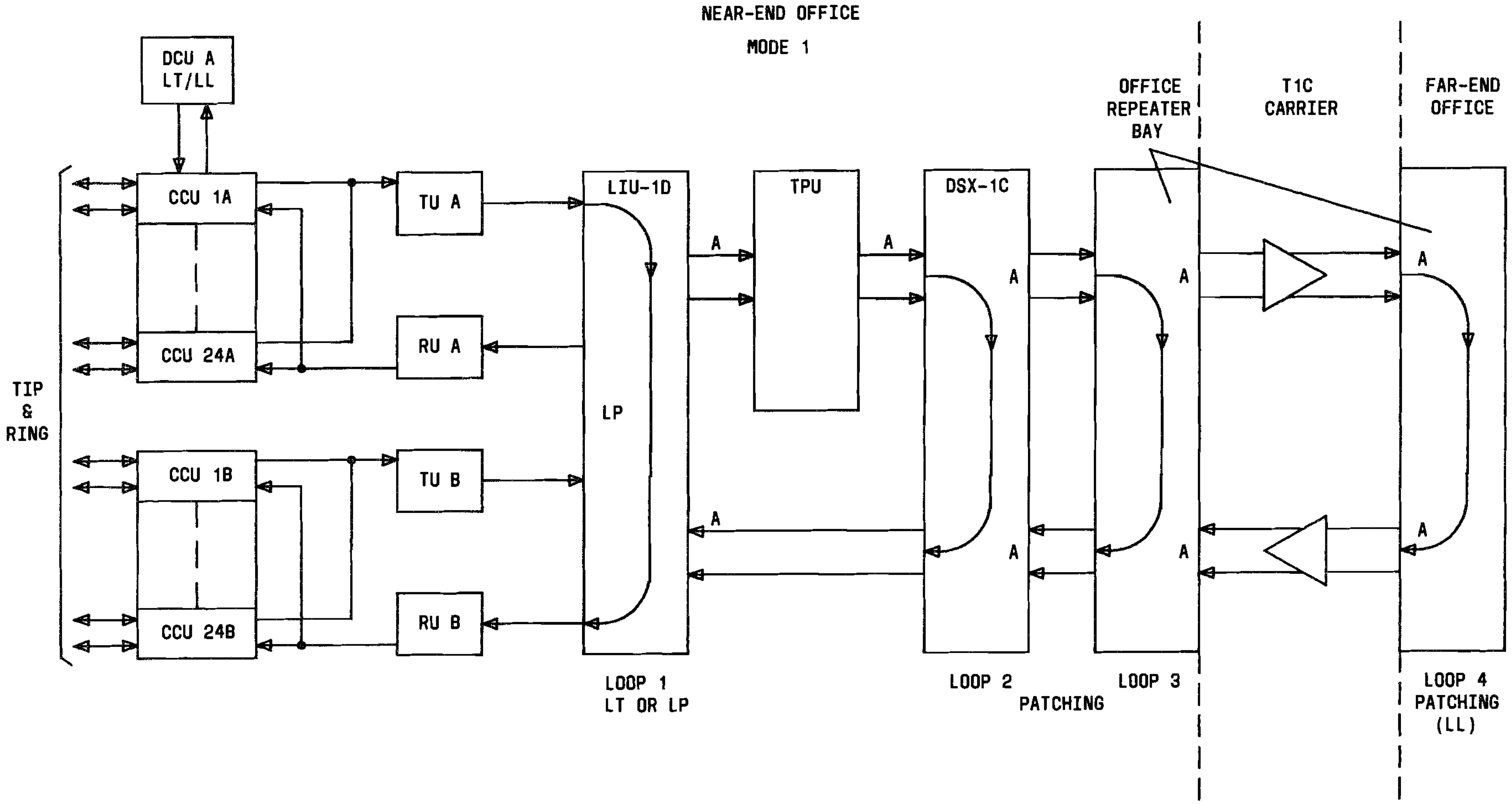


Fig. 9—Looping Diagram for Mode 1

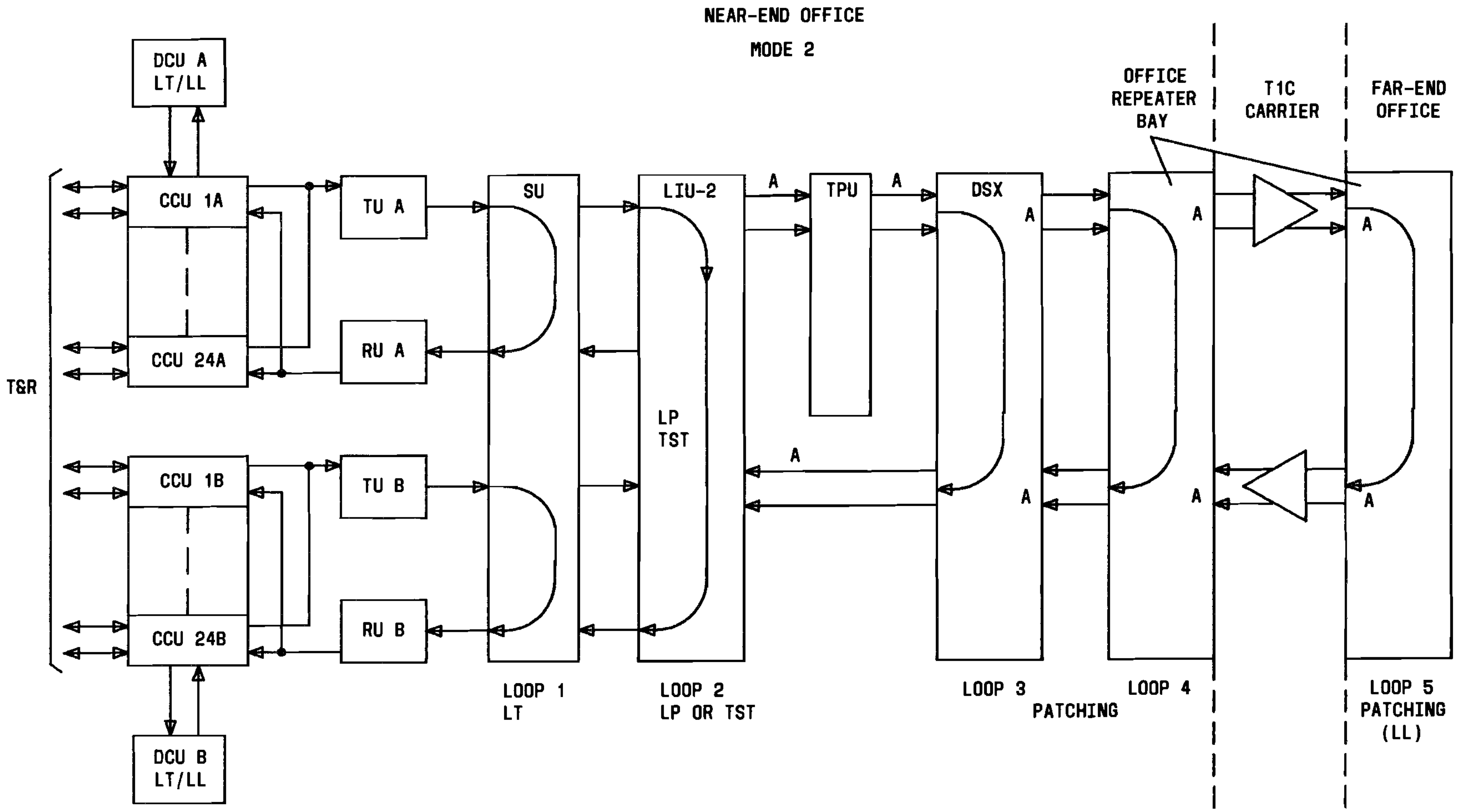


Fig. 10—Looping Diagram for Mode 2

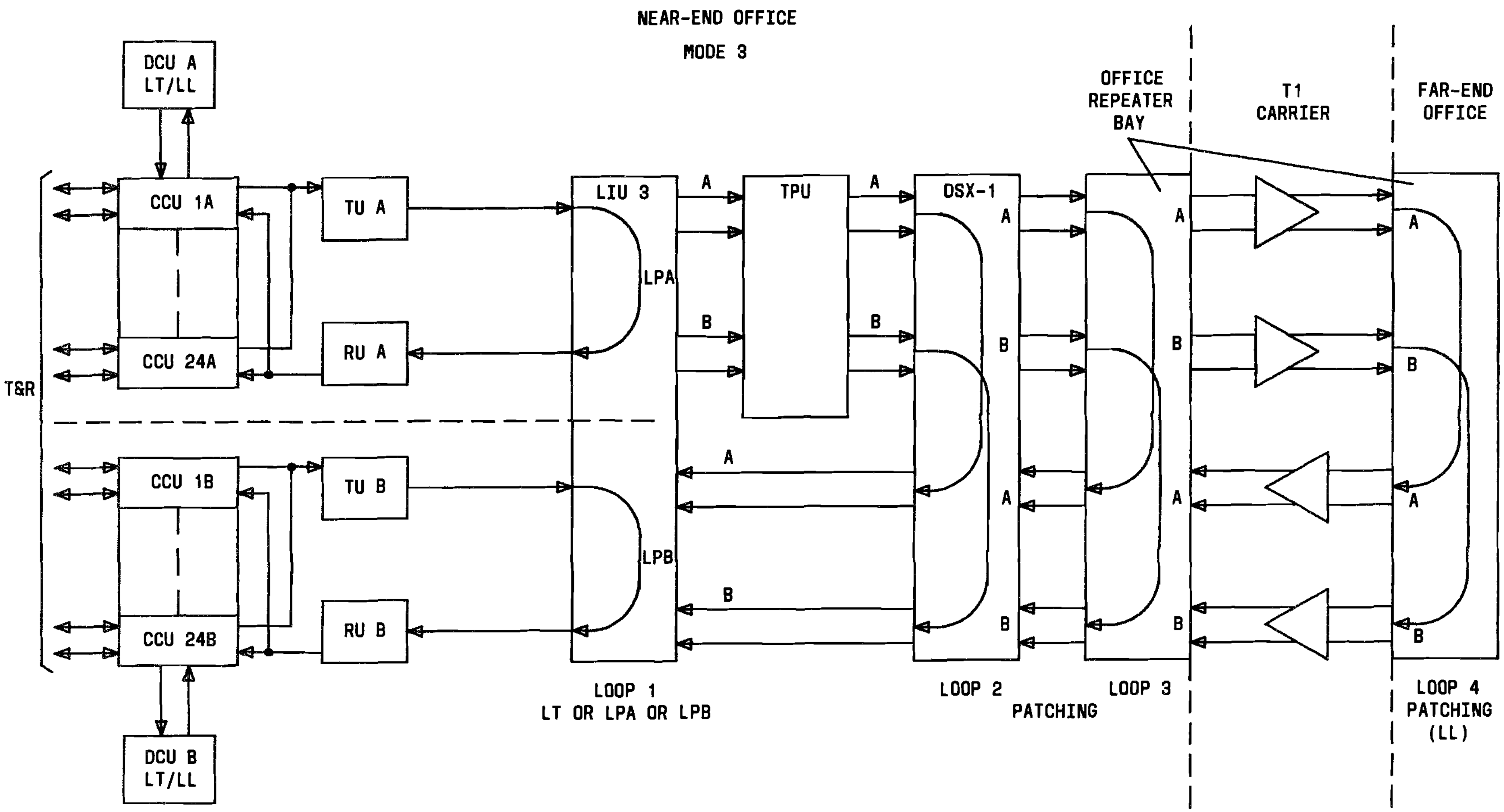


Fig. 11—Looping Diagram for Mode 3

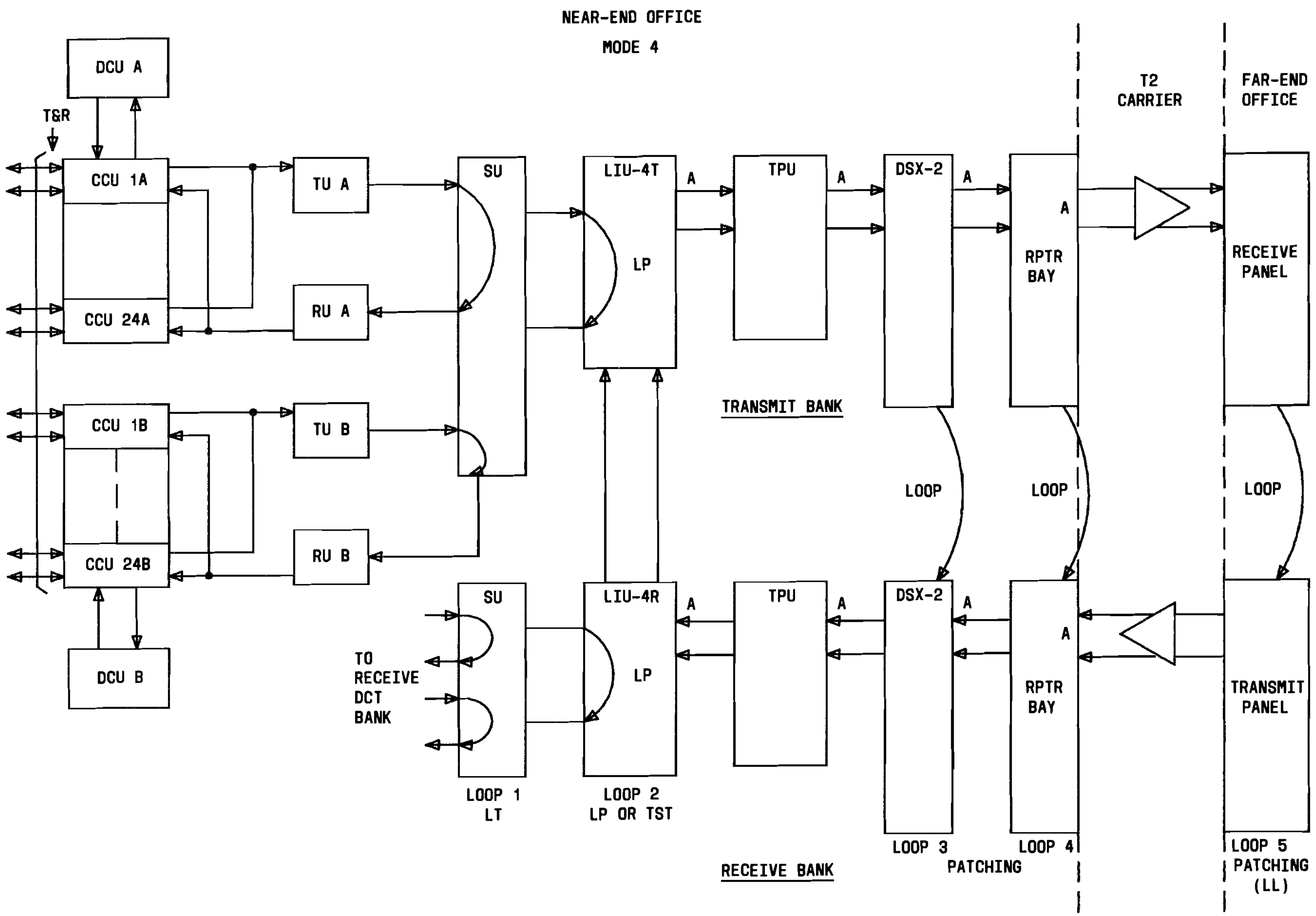


Fig. 12—Looping Diagram for Mode 4

will then occur within the LIUs. In modes 1 and 2, both digroups are looped. Mode 3 configuration has individual digroup LP jacks. In mode 4 all four digroups are looped.

3.39 Modes 2 and 4 have an additional form of looping called the "fast loop." The "fast loop" occurs internal to the line interface unit and is similar to a loop using the LP jack on the line interface unit. The difference is that the digroups to be looped need not be removed from service for a "fast loop." To avoid dropping customer connections, signal bit storage is used in all CCUs. If a receive failure alarm remains during an LT loop, the probable cause is the receive unit or syndes unit. If the alarm clears, the test (TST) pushbutton can be pressed to activate the "fast loop." This loops all digroups in the bank internal to the line interface unit for 300 milliseconds. If no receive failures are detected, the PASS lamp on the line interface unit lights which indicates that the trouble is outside the local bank. If a receive failure is detected, the FAIL lamp on the line interface unit lights which positively identifies the local syndes unit or line interface unit as defective. After the test, the LT switch should be returned to NORM. This will clear the test indications on the line interface unit.

PLUG-IN REPLACEMENT USING MAINTENANCE BANK PLUG-INS

3.40 If a fault is detected and looping procedures isolate the failure to a DCT bank, plug-in replacement can be used to determine the responsible plug-in. The plug-in replacement procedures are in TOP 231-050-015.

3.41 ***Warning: Excessive plug-in removal and insertion in the maintenance bank may cause wear on the connector. This may lead to erroneous fault indications by the maintenance bank. Do not use the maintenance bank for routine testing of plug-ins.*** Maintenance bank plug-ins are constantly diagnosed by the MBTS in order to be maintained fault free. These plug-ins are termed "hot spares" and should be used for plug-in replacement. If a DCT bank plug-in is suspected of causing a failure, the plug-in can be removed and replaced with a "hot spare."

3.42 After replacing the suspect plug-in, the equipment should be returned to service. If the problem is corrected, the "hot spare" should be left in the bank and a new plug-in should be inserted in the maintenance bank. If it is still questionable whether the suspect plug-in caused the failure, it can be inserted in the maintenance bank for testing.

4. ▶CIRCUIT SWITCHED DIGITAL CAPABILITY (CSDC) FEATURE

4.01 The DCT provides the trunking requirements for CSDC voice/data end-to-end customer service, with the far-end customer being accessed via No. 4 ESS switch or No. 1A with DCT/CSDC. The local connect is made by any of three connections: a 2-wire loop and metallic facility terminal (MFT) for direct customer service; SLC*-96 subscriber loop carrier; and D4 remote exchange trunk. The CSDC feature is available in the 1AE7 generic. The PUC firmware requirement is MC1A008.

4.02 The DCT bank is configured in any of three modes (Fig. 13) for T1 carrier facilities with the following equipment modification being required in the near-end DCT bank:

- Office Interface Unit (OIU-4) providing slip detection
- Combined alternate data/voice (CADV) channel units
- Alarm and digroup control unit (A&DCU), list 2, slip detection and reporting
- Digroup control unit (DCU), list 2, slip detection
- Channel bank wiring addition (option Y) providing ASLIP, BSLIP signals to A&DCU. Banks manufactured after 6/81 should contain this wiring option. This can be verified by "LIST 7" on the bay and "GROUP WA" on the bank (ED3C811).

4.03 See TOP 231-050-015 for DCT-CSDC frame growth.

4.04 A DCT frame need not be dedicated to CSDC banks only but can be mixed with standard DCT trunking application; the digroup also can be mixed but a channel restriction occurs. Because of high current drain, a digroup having some channels for CSDC cannot assign all 24 channels as it would normally for DCT. Channel assignment is dependent

* Trademark.

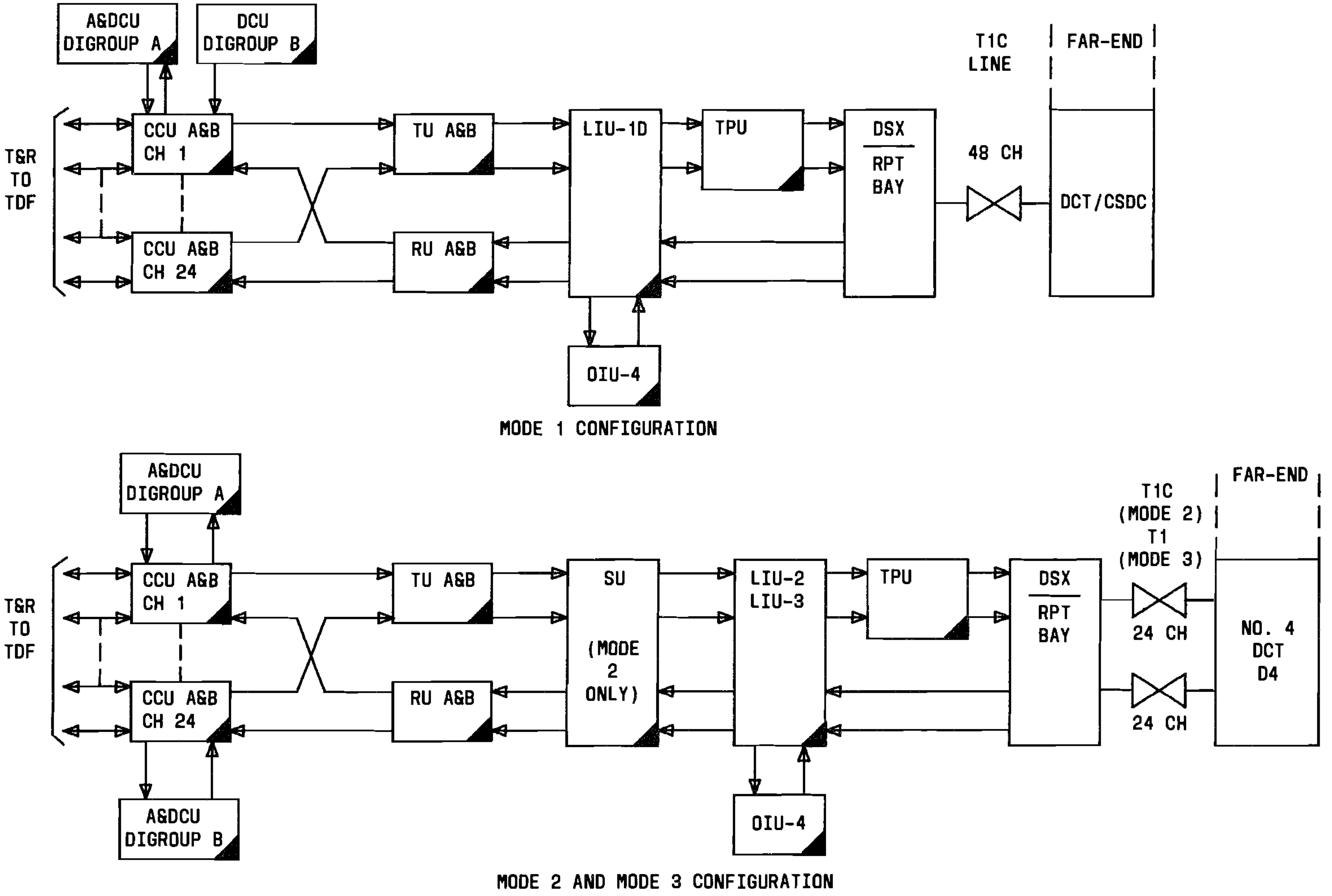


Fig. 13—DCT-CSDC Mode Configuration

on CSDC channel use and engineering requirements. The plug-in units required for DCT bank configuration is shown in Fig. 14.

OFFICE INTERFACE UNIT (OIU-4)

4.05 The OIU-4 provides (1) synchronization for the line interface unit (LIU) (2) synchronization loss (slip) detection between the received T-carrier line timing and the external clock signal (3) clock for the combined alternate data/voice channel unit (4) composite clocks for office use as required.

4.06 The OIU-4 can be operated in any of three timing modes: external (EXT), loop (LT), and local (LOC T) timing.

(a) In the EXT mode an external 64 or 8 kHz clock signal is provided by a digital office timing supply (DOTS), digital data system (DDS) clock supply, or another OIU-4.

(b) The LT mode of timing does not use an external timing clock but derives its own synchronized 64 kHz clock (INCLK) by using an internal voltage controlled oscillator and phase comparator with input signals (4 kHz subframe clock) from the TU (ATMF or BTMF) and RU (ARIFT or BRIFT).

(c) The LOC T mode allows the LIU oscillator to free run at its nominal frequency, thus bypassing the OIU, but this mode cannot be used for CSDC.

4.07 The slip detection function is performed in the EXT mode only. A compare of the received T-carrier clock (ARIFT or BRIFT) with the external clock (CCIN) looking for a loss of synchronization between the two. A sampling of this synchronization phase comparison is done once per second for a non-compare condition known as a "slip." Should a slip be detected, the following occurs: (1) A&DCU notified of error condition (ASLIP or BSLIP goes to a zero) (2) PUC notified of error by A&DCU (3) slip detection counter incremented, and finally (4) comparison circuit is reset. Should more than 15 slips occur in a 5-minute interval, the LED on OIU-4 face plate will be lighted and will remain lighted until the slip circuit is reinitialized by depressing the RST SLIP switch on the OIU-4 (Fig. 14).

4.08 An office major alarm occurs when more than 255 slips are reported in a 24-hour period, and a minor alarm when 3 or more slips in the same period. A slip detection alarm also occurs when improper timing selection has been made at a remote bank OIU-4 or when the external clock signal has been lost.

COMBINED ALTERNATE DATA-VOICE (CADV) CHANNEL UNIT

4.09 The CADV provides normal voice frequency transmission interface between the No. 1A ESS switch and the T-carrier line, similar to the CCU in standard DCT voice use. In addition, digital data transmission interface is provided to the customer at a 56 kilobit per second rate (56 kb/sec). Once the customer voice loop has been established, loop signalling from the customer will cause the CADV to configure for conversion of the customer's 56 kb/s data to 64 kb/s data (DSØ) for T-carrier transmission. The conversion process in the CADV is the same for the received DSØ data from the far-end facility to the customer loop.

ALARM AND DIGROUP CONTROL UNIT (A&DCU)

4.10 The A&DCU functions the same as normal DCT operations but in addition, List 2 has been modified to provide slip detection and reporting to the PUC, the same is true for the DCU plug-in. Signaling and control are provided by the PUC through the A&DCU.

TTY SLIP ERROR MESSAGE REPORTING

4.11 Slip detection is reported by the PUC with TTY message formats FM10 and FM11. The FM10 is restricted to digroups having only CSDC use and will report the failure rate (major or minor) and number of slips detected. The FM11 reports both out-of-frame errors and slips for mixed digroups.◀

5. ▶GLOSSARY OF ABBREVIATIONS AND ACRONYMS

5.01 The following abbreviations and acronyms are used in this section.

A&DCU	Alarm and digroup control unit
CADV	Combined alternate data-voice
CAU	Channel access unit
CC	Central control
CCU	Combined channel unit

CGA	Carrier group alarm
CSDC	Carrier group alarm
DCT	Digital carrier trunk
DCU	Digroup control unit
DCUF	Digroup control unit failure
EPROM	Erasable programmable read only memory
LIU	Line interface unit
LOSP	Loss of receive multiplex signal
MBTS	Maintenance bank test set
MFT	Metallic facility terminal
MTTP	Manual trunk test position
OIU	Office interface unit
OOF	Out-of-frame
PAM	Pulse amplitude modulated
PCU	Power converter unit
PDU	Power distribution unit
PUAB	Peripheral unit address bus
PUC	Peripheral unit controller
PURB	Peripheral unit reply bus
RFAL	Receive framing alarm
RU	Receive unit
SCAB	Scanner answer bus
SCC	Switching Control Center
STTP	Supplementary trunk test position
SU	Syndes unit
TCAS	T-carrier Administration System
TLTP	Trunk and line test panel
TNN	Trunk network number
TOP	Task oriented practices
TPU	Trunk processing unit
TTY	Teletypewriter
TU	Transmit unit
VF	Voice frequency.

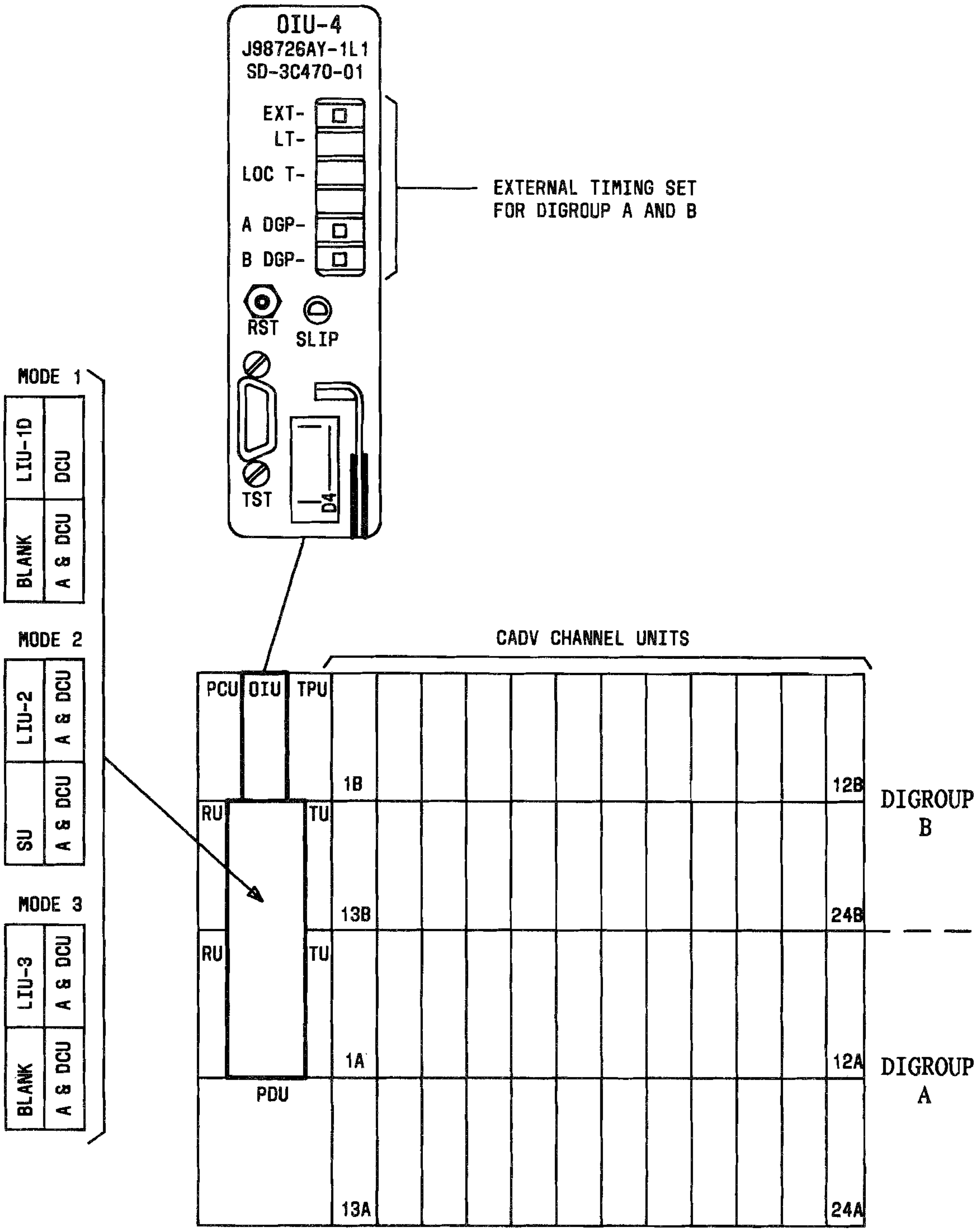


Fig. 14—DCT Bank Configuration for CSDC