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ELECTRONIC SWITCHING SYSTEMS

NO. 3

JUNCTOR AND JUNCTOR CONTROL  
 CIRCUIT

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 The junctor unit, located on the network frame, provides a large number of functions needed to establish a switched connection through the network and to supervise lines during the talking state. The unit contains circuit packs used for junctors (FB372); peripheral decoder packs used for controlling the states of all trunks, junctors, and service circuits on the network frame (FC181); for ferrods used in scanning for supervision (FC182, FC183); for audible and overflow tone distribution to the junctor (FC185); and for providing boosted talking battery (S5, FB401).

2. GENERAL DESCRIPTION OF OPERATION

GENERAL

2.01 Tones are distributed to the junctor circuits by the FC185 splitting-resistor circuit. A 900-ohm balanced source, and isolation between ports is provided by a pair of 450-ohm resistors. A separate pair of resistors is used for each tone and for each junctor. The 128 resistors used on a network frame are all mounted on two FC185 circuit packs. The tones are generated in the ringing and tone plant on the miscellaneous power frame. Each tone is distributed on two separate buses to the FC185 circuit packs.

2.02 Supervision is monitored by the ferrod scanner. The 2B-type ferrods mounted on four FC182 circuit packs monitor junctor tip and ring current. The 2C-type ferrods mounted on four FC183 circuit packs monitor most of the functions of all the trunk and service circuits on the network frame.

2.03 Every junctor in this unit has a pair of ferrods assigned to it. Every trunk on this network frame has a single ferrod assigned to its equipment location.

Every regular ring circuit has a ferrod in the junctor unit and a ferrod in the master scanner assigned to it. Customer dial pulse receivers (CDPRs) have no ferrod in the junctor unit but do have one in the master scanner. These ferrods on the junctor unit have a fixed equipment location assignment and are not cross-connectable. The 37 remaining ferrods of the junctor unit are cabled to the master scanner and are cross-connectable on that unit.

2.04 The peripheral decoder controls all of the state relays in the junctors, trunks, and service circuits, based upon digital information received from the 3ACC via the peripheral pulse distributor. A single 7-bit order is capable of controlling the triplet of three relays associated with a single peripheral circuit. Each of the eight FC181 circuit packs is capable of controlling the triplet of three relays in eight circuits, or a total of 24 state relays.

2.05 The S5 power converter and its control circuit pack provide boosted talking battery. Regardless of the central office battery plant voltage,  $-54.6 \pm 1$  volts is always supplied to the subscriber loop via the junctor and CDPR. This is done by placing a 1-to-15 volt variable voltage supply in series with the normal -48 volt supply. As the battery voltage during commercial power failure gradually decreases, the series power supply voltage automatically increases just enough to keep the total voltage at  $-54.6 \pm 1$  volts. Boosted battery from the first network is also used to power the CDPRs on the control frame. Boosted battery is not supplied to the 2A line attending ferrods in the 296-6C reared switch because the 2A line attending ferrods operate on 10 mA, boosted battery is not required in order to reach 1600-ohm loop resistance.

#### CIRCUIT STATES

2.06 The junctor circuit, which is contained on a single circuit pack, FB372, is able to be placed in states as explained in the following paragraphs.

Note: A line over the relay designation in 2.07 through 2.13 indicates the relay is released, ie, for  $\bar{A} B C$ , A is released.

#### A. Open State ( $\bar{A} \bar{B} \bar{C}$ )

2.07 The open state completely opens the tip and ring path through the junctor and allows the network to be switched dry (without conducting any current) when connecting or disconnecting lines, trunks, or service circuits.

#### B. Line-To-Line State ( $A \bar{B} \bar{C}$ )

2.08 The line-to-line state furnishes proper supervision, transmission, surge protection, and boosted battery feed when lines are connected to both appearances such as during an intraoffice call.

#### C. Trunk-to-Line State and Line-to-Trunk State ( $\bar{A} B \bar{C}$ or $A \bar{B} \bar{C}$ )

2.09 The trunk-to-line and line-to-trunk states cause the network appearance associated with one junctor tip and ring terminal to be treated the same way as in the line-to-line state, and cause the other trunk connection to have only surge protection without battery feed or supervision. In line-to-trunk state, T and R are the line appearance and T1 and R1 are the trunk appearance. In the trunk-to-line state T1 and R1 are the line appearance and T and R are the trunk appearance. Otherwise, the two states are identical. On all calls involving a line and a trunk, one of these two states will be used for the talking connection.

#### D. Bypass State ( $\bar{A} \bar{B} C$ )

2.01 The bypass state provides a clean metallic path between T and T1 and between R and R1. This is equivalent to a wire-type junctor.

#### E. Audible Tone State ( $A \bar{B} C$ )

2.11 The audible tone state applies audible ringing tone from either, but not both ports, to the calling customer while the system is waiting for the called customer to answer. Supervision for abandon is done by the A-side ferrod.

#### F. Overflow Tone State ( $\bar{A} B C$ )

2.12 The overflow tone state applies overflow tone in the event that all of the network paths, trunks, or service circuits are busy. Supervision for abandon is done by the B-side ferrod.

#### G. Not Used State ( $A B C$ )

2.13 The state with all three relays operated, is not used.

### SECTION II - DETAILED DESCRIPTION

#### 1. JUNCTION - FS 1

1.01 Three relays A, B, and C, operated by the peripheral decoder under program control, are used to provide the necessary circuit states for control of the circuit. Resistors R1, R2, and P3 are placed in

series with the coils of these relays by a break contact on that relay in order to limit the current drain required to hold the relays operated and to decrease the release time of the relays.

1.02 The relays operated during the junctor states are as given in Table A.

TABLE A  
JUNCTOR STATES

JUNCTOR STATE	RELAYS OPERATED OR RELEASED		
	A	B	C
OPEN	REL	REL	REL
LINE-TO-LINE	OPR	OPR	REL
TRUNK-TO-LINE	REL	OPR	REL
LINE-TO-TRUNK	OPR	REL	REL
BYPASS	REL	REL	OPR
AUDIBLE RING	OPR	REL	OPR
OVERFLOW TONE	REL	OPR	OPR
NOT USED	OPR	OPR	OPR

1.03 A junctor state is determined by the processor-controlled operation of a specific relay or relays to give the defined states as depicted in Table A. For example, relays A and B operated and relay C released place the the junctor in the line-to-line state.

1.04 Two ferroids associated with this circuit are used to report supervisory changes of the connected lines to the 3A CC via the scan controller.

1.05 The open state, with all three relays released, is the transition state for reconfiguring the switching network to connect or disconnect lines, trunks, or service circuits. The circuit is normally left in this state when it is not in use.

1.06 With relay A operated, the circuit is in the line-to-trunk state. This allows a local customer on the network-concentrator-group side of the junctor to be connected via the network to a trunk appearance on the junctor grid side. The supervisory ferrod, (FS 3) feeds boosted talking battery to the local customer via the battery-feed inductor L1, and supervises the line status. The contact protection network, Z1, limits the inductive surge generated by the 2-henry inductance of L1. Varistor RV1 prevents network Z1 from attenuating voice-level signals because it approximates an open circuit until the voltage across it reaches

30 to 50 volts. Surge protection prevents transients generated in the outside plant from causing more than 3 amperes of instantaneous current to flow in the associated remreed network contacts. This presumes that the carbon blocks on the distributing frame limit the peak voltage to 600 volts.

1.07 With only relay B operated, the junctor is placed in the trunk-to-line state and the appearances of the trunk and line are reversed in relation to the junctor. Due to the folded design of the network, there is no fixed relation between the direction of call (incoming or outgoing) and the side of the junctor to which the trunk is connected.

1.08 With relays A and B operated, the junctor is placed in a line-to-line state and the circuit connects two local customers via the network and performs supervision of both lines.

1.09 With relay C operated, and relay A and B released, the circuit is in the bypass state, which is a metallic path connecting network tip and ring terminals. This state is used prior to every talking connection to conduct a false cross and ground test. The junctor is also placed in this state anytime it is used with a CDPF, multifrequency (MF) receiver, MF transmitter, dial pulse transmitter, or ringing circuits. Supervision is conducted at the service circuit.

1.10 With relays A and C operated, the junctor is placed in the audible tone state. Ferrod sensor C associated with L-- and H-- monitors in either direction, but a path is connected to only one side of the junctor circuit while using this state.

1.11 With relays B and C operated, the junctor is placed in its overflow tone state. Ferrod sensor 1 associated with L1-- and H1-- detects the call status while the circuit is applying overflow tone in either direction. While in this state a path is connected to only one side of the junctor circuit.

## 2. FERROD SCANNER - FS 3

2.01 The ferrod scanner functions under control of the 3A central control (3A CC) via the frame input/output circuit (FIOC) and the scanner portion of the peripheral control circuit.

2.02 Each point to be scanned is connected to a current sensing device called a ferrod sensor. The ferrod consists of a ferrite stick which is wound with a pair of control windings. The control windings are connected in series with the circuit to be supervised. A single-turn interrogate winding and a single-turn readout winding are threaded

through two holes in the center of the ferrite stick.

2.03 The magnetic coupling between the interrogate and readout windings is determined by the magnetic state of the ferrite stick. When current flows in the control windings, the ferrite stick is in a saturated magnetic condition. When no current flows in the control windings, the ferrite stick is in a nonsaturated magnetic condition.

2.04 To determine the state of a ferrod, an 800-mA bipolar pulse is applied to the interrogate winding. The 1-USEC negative half-cycle of the interrogate pulse is used to reset the ferrite stick to its maximum negative magnetic remnant state. The 1-USEC positive half-cycle of the interrogate pulse is used to readout the magnetic state of the ferrite stick.

2.05 When the control windings are not energized, the interrogate pulse changes the magnetic state of the ferrite stick. Changing the magnetic flux induces a nominal voltage of 200 millivolts in the readout winding. This readout is a logical 0. When the control windings are energized, the interrogate pulse does not change the magnetic flux of the ferrite stick because it cannot overcome the state established by the control windings. Therefore, practically no voltage is induced in the readout winding (less than 25 millivolts). This readout is a logical 1. Thus, when an interrogate pulse is applied, the presence or absence of a readout pulse indicates whether there is a current flow in the control windings. If the circuit being observed is, for instance, a customer line, the on-hook (open) condition results in a 0 and the off-hook (closed) condition results in a 1. Because these output voltages are quite low, it is very important that lead dress, pairing, and twisting be maintained. If this is not carefully adhered to, excess noise can be anticipated. As an additional precaution, all critical scan points are scanned twice or software bit protection is used.

2.06 The scan control (SC) interface with the ferrod array is a pair of wires from each transformer in the interrogate matrix to the interrogate winding of a row of ferrod sensors. The bipolar interrogate pulse is looped through two sets of eight ferrods to make one ferrod row on leads SDP (24 - 31) P/V. The readout windings of each row of 16 ferrod sensors are connected to data detectors in the SC. The readout pulse of each ferrod sensor is looped through 32 ferrods. The ferrod array is not duplicated but can be accessed by either system control 0 or 1.

2.07 In order to be able to remove a ferrod circuit pack (FC182, FC183) without

completely disrupting all scanning on a network frame, 15-ohm resistors are placed across the connector terminals. These resistors provide continuity in the readout loop when a ferrod circuit pack is unplugged. Unplugging more than one circuit pack at a time should be avoided.

### 3. PERIPHERAL DECODER - PS 4

3.01 Two peripheral decoders (PD) are mounted together on one FC181 circuit pack. The two PDs control 2<sup>4</sup> outputs and are referred to as a peripheral decoder group (PDG).

3.02 The data is transmitted in the serial bipolar pulses from the PPD to the PD.

3.03 The PD consists of the following:

- (a) Transformer
- (b) Shift register
- (c) A 1-out-of-4 translator
- (d) Four buffers
- (e) 12 output circuits.

3.04 Incoming pulses are detected by the transformer and placed into the 7-bit shift register. These bits are received sequentially.

3.05 Upon receipt of the last data bit, the shift register gates the stored information into one of the four buffers. The start bit and the stop bit in an order are always a 1.

3.06 Within each buffer, the necessary circuitry is provided to receive the data from the shift register and, according to the data received, control three state relays. The relays are typically located on one trunk, junctor, or service circuit. These circuits must contain their own internal diode-surge protection.

3.07 The peripheral decoder can also light lamps or operate any device that does not require more than 45 mA at -48 volts.

3.08 The power required to operate the logic is obtained from a -48 volt dc to -7 volt dc switched regulator mounted on the FC181 circuit pack. A special overlapping-grounding-lead arrangement is used to minimize the ground impedance and prevent problems that could be caused by ground induced noise interfering with the logic.

### 4. BATTERY BOOST - PS 5

4.01 The battery boost power is supplied by an S5 dc-to-dc converter (SD/CD-82250-01) and battery boost

auxiliary board, FB401. A single FB401 controls the function of both S5 converters on a network frame. Each S5 is able to supply  $2.9 \pm .5$  amperes, at between 1 volt and  $14.1 \pm 1$  volts, to convert the central office battery ( $-42.75$  volts to  $-52.5$  volts) into a regulated  $54.6 \pm 1$  volt supply.

4.02 The auxiliary board, FB401 supplies +5 volts with respect to -54 volts (ie, -49 volts) as a precision reference (+5 volts REF) and also +24 volts with respect to -54 volts (ie, -30 volts) as a converter start indication (24ST).

4.03 The auxiliary board, FB401, monitors the amount of boost voltage supplied and if this falls below approximately one-half volt, transistors Q2 and Q3 release, releasing alarm relay K1. Its break contact closes a path to the alarm ferrod. When this happens, the PAT lead to the converter goes high. If it remains high for .3 through 1.0 second, the pulse width modulator in the S5 shuts down, the alarm light emitting diode (LED) comes on, and the K1 relay is locked down by the PA lead from the S5.

4.04 If the voltage between pins 208 and 209 on the S5, (boosted battery voltage) exceeds  $56.8 \pm 1.1$  volts, this same latch-down function will occur after the same time delay. If the output voltage of the converter (pins 100 through 107 and 201 through 207) exceeds  $14.4 \pm 1$  volts or if the output current exceeds  $2.9 \pm .5$  amperes the S5 will shut down without any delay. Any shutdown will result in the release of K1 and an alarm indication. This alarm may be released manually by operating and releasing the out-of-service key on the network frame.

4.05 The S5 can be removed from service by operating the converter-off locking key on the network frame. This removes the 24-volt start voltage. When this key is released, the NPA lead is briefly connected to -54 volts. This releases the silicone control rectifier (SCR) in the S5, extinguishing the alarm LED in the S5.

4.06 When the S5 is not in service or is removed for servicing, the output voltage to the junctors is maintained through a bypass diode mounted on the network frame. A 15-volt zener diode is used to limit the maximum amount of boost voltage to 15 volts.

4.07 There is a possibility that noise could shut down and lock the S5 out of service. If this happens, the processor can apply ground to a pin on the FB401 for a few seconds via the peripheral decoder. An autonomous timer in the FB401 will remove the 24ST voltage long enough to reset the latch in the S5. The autonomous timer prevents the program from permanently

removing boosted battery voltage. Since there is only one scan point for all of the S5s in the office, the processor can determine which S5 was in trouble by sequentially trying to reset each converter. This technique will also serve as an alarm test feature to verify that the no-voltage alarms are functional.

### SECTION III - REFERENCE DATA

#### 1. WORKING LIMITS

##### 1.01 Battery Voltage Levels:

Boosted battery voltage  $-54.6 \pm 1$  volts.

##### 1.02 Ferrod Current Levels:

Junctor maximum operate (saturate) current - 18 mA.

Junctor minimum release (nonsaturate) current - 9 mA.

Trunk and service circuits maximum operate (saturate) current - 6 mA.

Trunk and service circuits minimum release (nonsaturate) current - 3 mA.

##### 1.03 Loop Resistance:

Maximum subscriber loop resistance - 1600 ohms.

Nominal subscriber set resistance - +200 ohms.

Minimum subscriber loop leakage resistance - 10,000 ohms.

##### 1.04 Tone Levels:

Overflow tone level - 21 dbm  $\pm 1.5$  DB

Audible ringing tone level - 16 dbm  $\pm 1.5$  DB

1.05 The peripheral decoder has a peak output current of 60 mA and an average output current of 45 mA.

#### 2. FUNCTIONAL DESIGNATIONS

##### 2.01 Relay:

<u>Designation</u>	<u>Meaning</u>
A,B,C	These relays are designated for program reference.

#### 3. FUNCTIONS

##### A. Junctor

3.01 Supplies talking battery.

3.02 Provides transmission coupling between two lines.

3.03 Provides transmission coupling from lines to trunks and from trunks to lines.

3.04 Supplies audible ringing tone to the calling party.

3.05 Provides overflow tone to the calling line or incoming trunk.

3.06 Limits high current surges in the transmission path.

3.07 Transposes the ac voltage between tip and ring on the two sides of the junctor such that for alternating current the T is connected to R1 and R is connected to T1.

#### B. Splitting Resistors

3.08 Provides audible and overflow tones to the junctors.

3.09 Maintains a 900-ohm source impedance.

3.10 Maintains isolation between tones and between tone ports.

#### C. Ferrod Scanner

3.11 Generates a reply pulse upon receipt of an interrogate pulse from the scan controller, indicating the presence or absence of current in the control winding.

3.12 The 2B ferrod used with the junctor, saturates with 18 mA, and gives no reply pulse upon interrogation. With 9 mA, it will provide a full amplitude reply pulse.

3.13 The 2C ferrod used with the trunk and service circuits saturates with 6 mA and gives no reply pulse upon interrogation. With 3 mA it, will provide a full amplitude pulse.

3.14 Provides means for a single circuit pack to be removed and the remainder of the scanner to continue to operate.

#### D. Peripheral Decoder Group

3.15 Receives pulses from peripheral pulse distributor in the peripheral controller.

3.16 Controls the operation or release of 24 state relays, three at a time.

#### E. Boosted Battery Supply

3.17 Provides 1 to 14.1  $\pm$ 1 volts in series with the -48 volt battery to supply -54.6  $\pm$ .75 volts to the junctors and CDPRs.

3.18 Provides a means for boosted battery power to be supplied at a current of 2.9  $\pm$ .5 amperes from each of the two S5 dc-to-dc converters.

3.19 Provides a means for converter trouble to release the alarm relay in FB401 and thus close a path to the battery boost alarm ferrod.

3.20 Provides a means for converter output in excess of 14.1  $\pm$ 1 volts or in excess of 2.9  $\pm$ .5 amperes to shut down the converter and lock it out of service.

3.21 Provides a means for an alarm to operate and the converter to lock itself out of service, if the boosted battery voltage exceeds 56.8  $\pm$ 1.1 volts for .3 through 1 second.

3.22 Provides a means for an alarm to operate and the converter to lock itself out of service if the converter output voltage falls below .5  $\pm$ .2 volt for .3 through 1 second.

3.23 Provides a means for the LED on the front of the converter to operate any time either converter is in an alarm condition.

3.24 Provides a means for a converter to be removed from an alarm status and returned to service under program control but prevents it from being locked out of service under program control.

3.25 Provides a means for a converter alarm to be released manually by operating and releasing the converter-off key on the network frame.

#### 4. CONNECTING CIRCUITS

4.01 When this circuit is listed on a keysheet, the connecting information thereon is to be followed.

- (a) Peripheral Controller - SD-3H110-01.
- (b) 15-B Grid Circuit - SD-3H121-01.
- (c) 15-C Grid Circuit - SD-3H130-01.
- (d) Master Scanner Circuit - SD-3H140-01.
- (e) Universal Trunk Circuit - SD-3H220-01.
- (f) Customer Dial Pulse Receiver and Regular Ring Circuit - SD-3H410-01.
- (g) Network Frame Circuit - SD-3H901-01.
- (h) Control Frame Circuit - SD-3H902-01.
- (i) Power Systems dc-to-dc Converter -48 and +24 Volt Inputs -10 Volts, 2-Ampere Output - SD-82250-01.
- (j) Ringing and Tone Plant - SD-82255-01.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 The manufacturing testing requirements are specified in X-79037.

6. ALARM INFORMATION

6.01 Any failure in the battery booster converters will take them out of service and operate alarm ferrod 00-25-11.

7. TAKING EQUIPMENT OUT OF SERVICE

7.01 The associated fuse should be removed before removing any circuit pack. See Information Note 302.

SECTION IV - REASONS FOR REISSUE

D. Description of Changes

D.1 Provided complete CD information.

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DEPT 5341-ECP-LEG