992614-0002

DATATAPE®

13-580 SHUTTLE CONTROL ASSEMBLY

OPERATION AND MAINTENANCE MANUAL

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BELL & HOWELL

This manual describes the operation and maintenance procedures for the Type 13-580 Shuttle Control Assembly with serial numbers 2001 through 2999.

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SECTION I

GENERAL DESCRIPTION

1-1. GENERAL.

1-2. The Bell & Howell 13-580 Shuttle Control Assembly operates in conjunction with the 13-501 Tape Transport as part of the VR-3700B Magnetic Tape System. The control panel for the 13-580 Shuttle Control Assembly is shown in figure 1-1. The shuttle control provides a means for automatic cyclical or repetitive playback of preselected portions of recorded tape. The portion of tape to be shuttled is manually selected at the front of the control unit.

1-3. EQUIPMENT DESCRIPTION.

1-4. Basically, the shuttle control is an electronic counter with a count memory. The counter counts the pulse output of the transport tachometer preamplifier for a required amount of tape movement within two selected points on the tape, and with this information causes the tape to be shuttled back and forth between these two points.

1-5. The shuttle control is contained in two assemblies: a control panel which is mounted in the upper end of the transport control panel, and a printed circuit board which is installed in connector J423 of the transport electronics and relay chassis. The control panel holds three switches: the operate switch, which is backlighted, and the zero set forward and reverse switches. All other components are contained on the printed circuit board. The two units are connected via the transport interconnecting cable.

1-6. The electronic circuitry is made up of integrated circuits such as counters, hex inverters, quad 2-input gates, and a multivibrator, as well as transistors and passive elements.

1-7. TYPICAL PERFORMANCE CHARACTERISTICS.

1-8. Performance characteristics for the 13-580 Shuttle Control are listed in table 1-1.

CHARACTERISTIC	PERFORMANCE
Power Requirements	-28 vdc +12 vdc -12 vdc +5 vdc All voltages supplied by tape transport.
Dimensions	
Control Panel	4 1/2 inches high, 2 3/8 inches wide, 2 1/2 inches deep; mounts in cutout in upper end of control panel of 13-501 Tape Transport.

Table 1-1. Typical Performance Characteristics, 13-580 Shuttle Control
(Sheet 1 of 2)

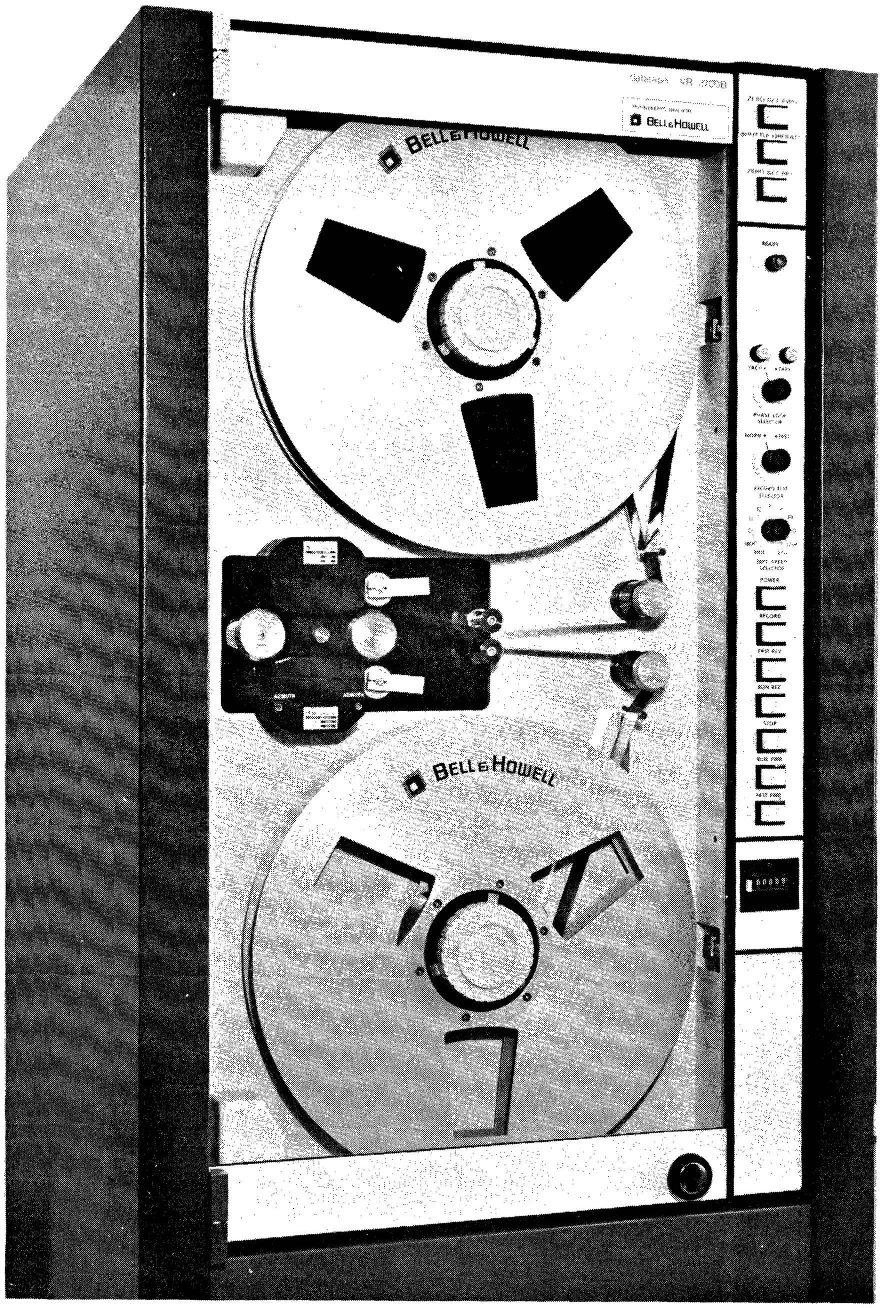

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Figure 1-1. 13-580 Shuttle Control Assembly Mounted on 13-501 Tape Transport

CHARACTERISTIC	PERFORMANCE
Circuit Board	5 1/2 inches high, 7 inches deep maximum; mounts in slot J423 of electronics and relay chassis of 13-501 Tape Transport.
Length of tape controllable by shuttle	12,000 feet maximum.
Accuracy per shuttle cycle	Will control length of tape over which shuttling operation takes place within ±2 inches.

Table 1-1. Typical Performance Characteristics, 13-580 Shuttle Control
(Sheet 2 of 2)

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. The shuttle control is normally installed at the factory and all electrical connections made at the time the system is being assembled. However, field installation is a simple procedure.

2-3. INSTALLATION OF THE CONTROL UNIT.

2-4. The control unit is mounted at the upper end of the transport control panel. A blank panel is installed when the shuttle control is not included in the system. To install the control unit proceed as follows:

a. Remove the two screws from the top edge of the blank panel and remove the blank panel from the transport control panel.

b. Set the control unit in place and guide the cable through the cabling cutout in the edge of the transport baseplate.

c. Secure the control unit to the transport control panel with the screws removed in step a.

d. Refer to the shuttle control assembly schematic, figure 7-2, and make the necessary electrical connections at TB507. This terminal board is the lower and shorter of the two in the upper left corner of the back of the transport baseplate.

2-5. INSTALLATION OF THE SHUTTLE CONTROL CIRCUIT BOARD.

2-6. The shuttle control circuit board is installed in slot J423 of the transport electronics and relay chassis. This is the slot second from the right, marked SHTL. To install the shuttle control circuit board proceed as follows:

a. Insert the circuit board into the upper and lower guide slots of the electronics and relay chassis, pin end first and with the component side of the board to the right.

b. Slide the card in the guides toward the rear until it stops against the connector.

c. Check that the card is correctly aligned with the connector, then push the card in firmly until it is completely seated in the connector.

2-7. A card extractor is attached to the upper front corner of the circuit board to facilitate removal of the card from the electronics and relay chassis. Lift up on the card extractor to pull the card out of the connector, then slide the card out of the guides.

2-8. ELECTRICAL CONNECTIONS.

2-9. Electrical connections to the control unit of the shuttle control assembly are completed when the unit is installed and wired as described in step d of paragraph 2-4.

2-10. Electrical connections to the shuttle control circuit board are completed when the card is correctly installed in its proper slot in the electronics and relay chassis as shown in figure 2-1.

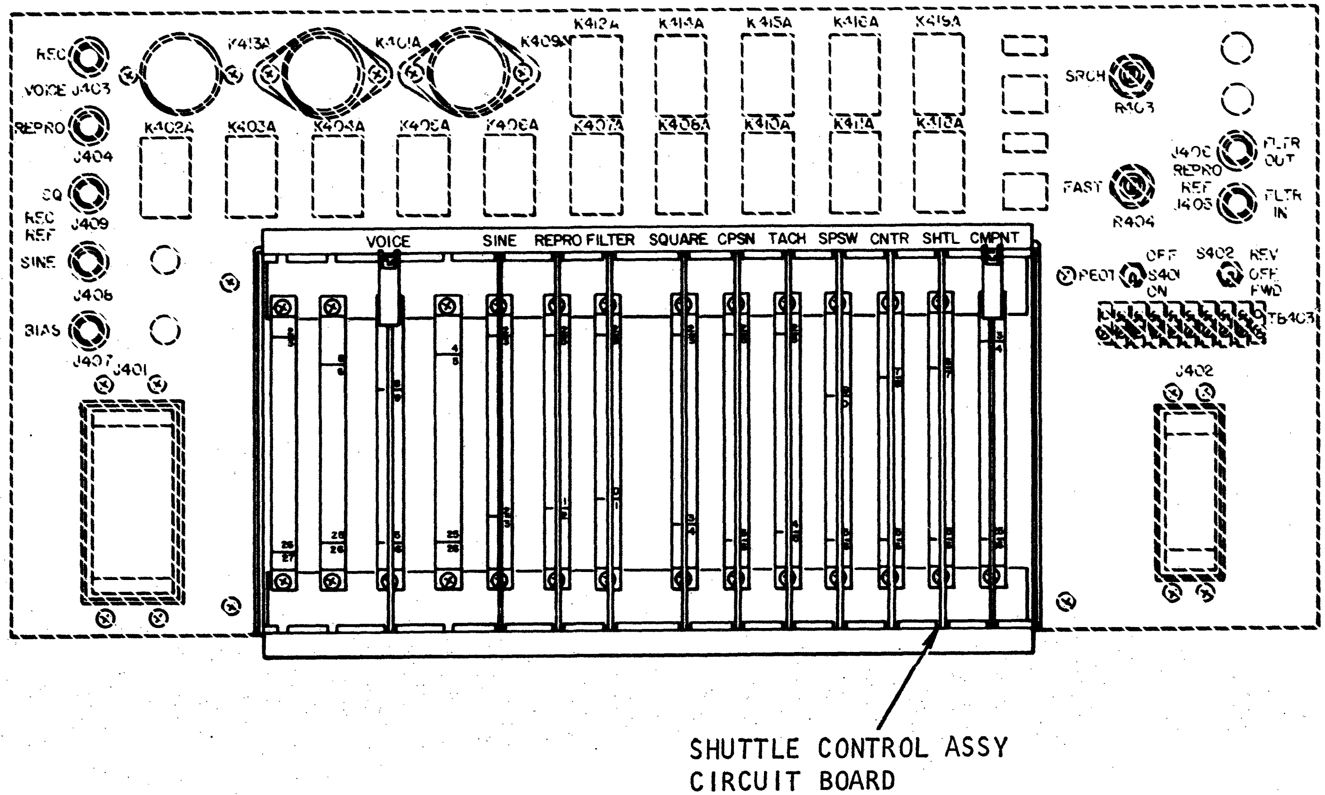

Figure 2-1. 13-580 Shuttle Control Assembly Circuit Board Location

SECTION III

OPERATION

3-1. GENERAL.

3-2. The shuttle control is operative when the two parts of the assembly are properly installed and the transport power turned on.

3-3. The setup and operating procedures that follow assume that the transport is in the READY condition, and is to be operated in the standard configuration as described in the system manual.

3-4. CONTROLS AND INDICATORS.

3-5. All controls and indicators for the shuttle control are located on the control unit mounted on the control panel of the tape transport. The controls and indicators are described in table 3-1 and shown in figure 3-1.

CONTROLS AND INDICATORS	FUNCTION
ZERO SET FORWARD (S3)	Momentary action pushbutton switch; sets initial limit of tape interval to be shuttled.
ZERO SET REVERSE (S2)	Momentary action pushbutton switch; sets final limit of tape interval to be shuttled.
SHUTTLE OPERATE (S1)	Momentary action, backlighted pushbutton switch; initiates shuttling operation once limits have been set by zero set switches.
SHUTTLE OPERATE LAMP (DS1)	Part of SHUTTLE OPERATE switch, S1; indicates shuttle in operation when lighted.

Table 3-1. Controls and Indicators, 13-580 Shuttle Control Assembly

3-6. OPERATING THE SHUTTLE CONTROL.

3-7. Operation of the shuttle control is described below for the general application. For specific applications, additional steps may be required depending on the nature of the user's data processing equipment. During the shuttling operations, the output signal from each reproduce amplifier should be utilized in the same manner as if the particular mode button on the tape transport was being operated manually.

3-8. The basic procedure is to set the ZERO SET FORWARD control at the beginning of the data to be shuttled and to set the ZERO SET REVERSE control at the end of the data. Either end of the data can be determined and set first.

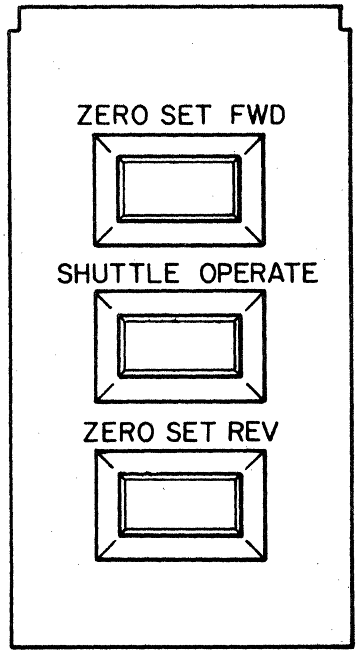

Figure 3-1. 13-580 Shuttle Control Assembly Control Unit

3-9. A specific procedure is as follows:

a. Using the transport (not the shuttle) controls, locate the beginning of the data to be shuttled.

b. Press the ZERO SET FORWARD switch.

c. Again using the transport controls, advance the tape to the end of the data of interest.

d. Press the ZERO SET REVERSE switch.

e. Press the SHUTTLE OPERATE switch.

3-10. The alternate procedure is as follows:

a. Using the transport (not the shuttle) controls, locate the end of the data to be shuttled.

b. Press the ZERO SET REVERSE switch.

c. Again using the transport controls, rewind the tape to the beginning of the data of interest.

d. Press the ZERO SET FORWARD switch.

e. Press the SHUTTLE OPERATE switch.

NOTE

The zero set switches may be set while tape is in motion.

3-11. When the shuttling operation has begun, the transport will alternate between the run forward and fast reverse modes within the limits set into the shuttle control counters until the STOP command is initiated. To stop the shuttle, press the transport STOP switch.

3-12. As long as power to the transport has not been turned off and the tape has not been run off the reel, the shuttle control counters will "remember" the shuttle limits and shuttling action can be restarted by pressing the SHUTTLE OPERATE switch. If the tape has not been moved since it was stopped, or if it is still within the limits set into the counters, the shuttle will start up to the mode to which it was last set. If the tape has been moved to a point ahead of the beginning of the area to be shuttled, the transport will start up in the run forward mode. If the tape has been moved to a point past the end of the area to be shuttled, the transport will start up in the fast reverse mode. Thereafter, the shuttling action will continue until the STOP command is initiated.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. When operating, the 13-580 Shuttle Control governs the operation of the 13-501 Tape Transport, causing it to alternate between the run forward and fast reverse modes, in order to shuttle a portion of magnetic tape between two preselected points. In operation, the shuttle counts pulses fed to it from the transport tachometer. After passing through a divider circuit which reduces the number of pulses per foot of tape to a quantity compatible with the shuttle circuitry, the pulses are fed to two banks of synchronous counters which are connected to count in opposite directions. When one of the counters crosses zero, a relay is energized which commands the transport to reverse direction.

4-3. In the following detailed description, the individual NAND and NOR gates are designated by the integrated circuit schematic reference number and the number of the output terminal of the component. When necessary, the integrated circuit flip-flops are identified by the schematic reference number and the number of the Q output terminal. All other components are identified by their schematic reference designator. Figure 4-1 is a block diagram of the shuttle control. The complete schematic for both the control unit and the circuit board is figure 7-2 in Section VII of this manual. Figure 7-1 shows the connections via the tape transport between the control unit and the corresponding points on the circuit board.

4-4. The TTL (transistor-transistor logic) elements used in the shuttle control see an open line as a high input. They are also quite sensitive to fast pulses or spikes that may occur on open lines which are located in electrically noisy environments, such as the tape transport. For this reason, the normally open input lines to the shuttle board are all protected with RC noise filters such as R1-C1 and R3-C3.

4-5. MASTER RESET.

4-6. The master reset circuit makes sure that the shuttle control stays off when power is first applied to the system. The circuit is made up of capacitor C2 and resistor R2. When power is turned on, pin 12 of Z6-11 is kept low for 20 to 70 milliseconds (determined by the time constant of R2-C2). This action has the same effect as if the shuttle stop line were taken low (transport stop switch pressed). Once C2 has reached its full charge through R2, a high level is maintained on pin 12 of Z6-11 until power is turned off.

4-7. SHUTTLE OPERATE LATCH (Z1-9).

4-8. The shuttle operate latch is one half of a dual D-type, edge-triggered flip-flop, Z1-9. This flip-flop features direct clear and preset inputs and complementary Q and $\overline{Q}$ outputs. In this configuration only the preset and clear inputs, which are independent of the clock pulse, are used. The unused input terminals (pins 11 and 12) are connected to +5 vdc through R4 to improve noise immunity.

4-9. In the quiescent state a high input is maintained at both the preset and clear terminals. The high level at preset is due to the normally open shuttle operate switch. The high level at clear is maintained by Z6-11, which has one input connected to the normally open shuttle stop switch and the other held up by the master reset RC. The normally low output of Z6-11 is connected to clear via Z6-3 which is used as an inverter. A low input (0 volts) to preset (pin 10) sets Q high (+5 v), and $\overline{Q}$ low; a low input to clear (pin 13) sets Q low and $\overline{Q}$ high.

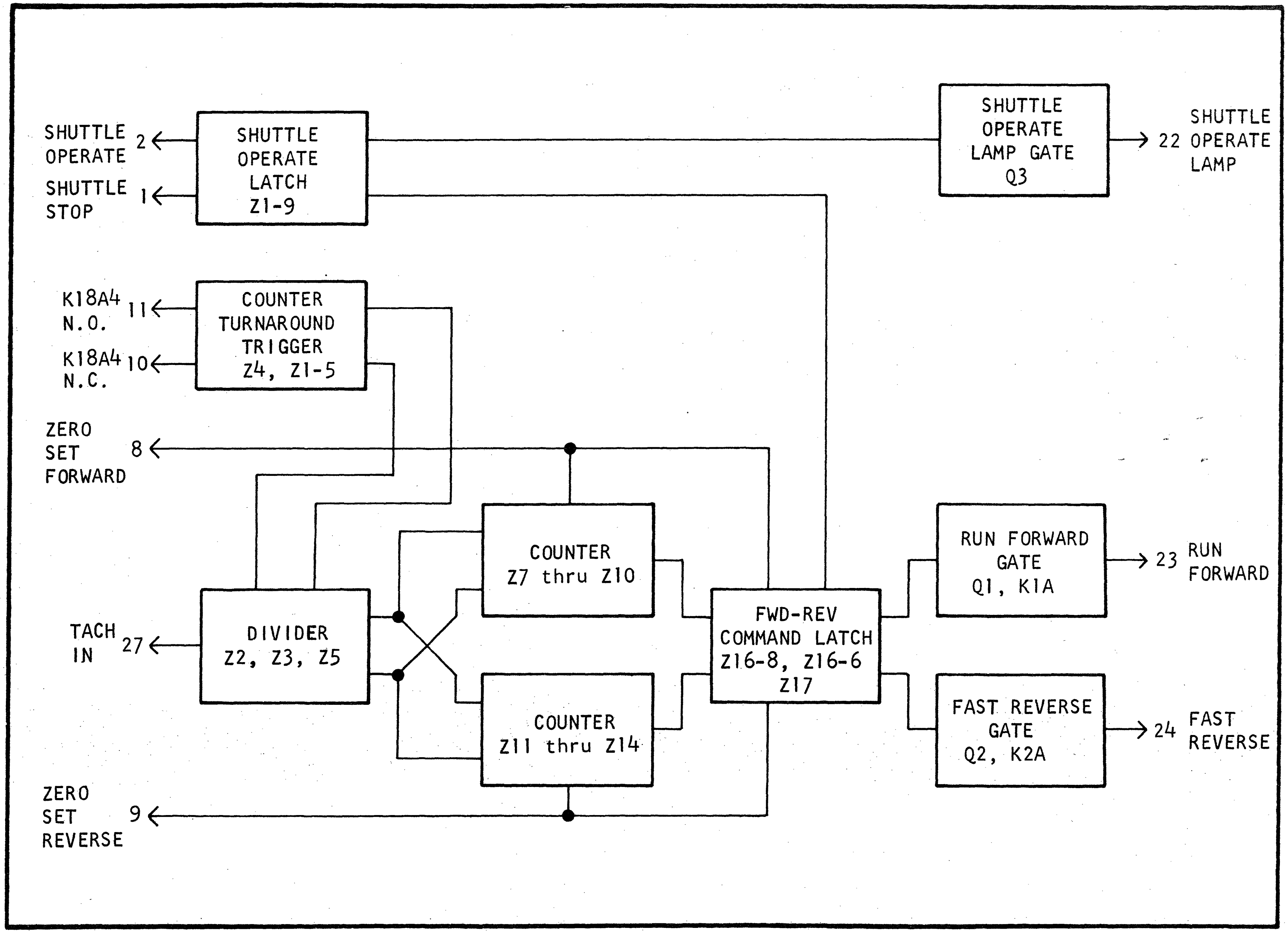

Figure 4-1. Block Diagram, 13-580 Shuttle Control

Once set either way, the latch will remain so until the command line (preset or clear) to set the other way is taken low.

4-10. When the shuttle operate switch is pressed, preset is taken low (grounded via S1) which results in a low output at $\bar{Q}$. This low level is applied to terminals 8 and 11, respectively, of Z17-10 and Z17-13, which enables the forward-reverse latch. Concurrently, Q (pin 9) goes high, is inverted by Z15-6, and ultimately turns on Q3, which lights the shuttle operate lamp, DS1. The Q and $\bar{Q}$ outputs will remain high and low, respectively, until the clear input is taken low when the stop switch on the tape transport is pressed.

4-11. SHUTTLE OPERATE LAMP GATE (Q3).

4-12. The shuttle operate lamp gate is a saturated transistor switch, Q3, with the lamp, DS1, acting as the collector load. When the shuttle is not operating, the transistor is biased off by the high (positive) level at Z15-6. When the shuttle operate switch is pressed, the level at Z15-6 goes low and allows the bias at the base of Q3 to become sufficiently negative (-0.7 v) to drive the transistor to saturation and thus light the shuttle operate lamp.

4-13. The level at the output of Z15-6 is the same as that at pin 8 of Z1 (the $\bar{Q}$ output). However, Z15-6 serves to isolate Q3 from the other gates which are driven by Z1. This isolation is necessary to prevent overloading Z1 and to guard against noise spikes which might be reflected back to Z1 from the light circuit.

4-14. CLOCK DIVIDER (Z2, Z3, Z5).

4-15. The clock divider is a series of counters that takes the output of the transport tachometer (10,000 pulses per foot of tape) and reduces the pulse count by a factor of 1920 to 5.2 pulses per foot, or approximately 1 pulse per 2 inches of tape. This gives good resolution consistent with moderate sized storage.

4-16. The circuit consists of three integrated circuit elements: a divide-by-twelve counter, a divide-by-ten counter, and a divide-by-sixteen counter. Counter Z2, the divide-by-twelve unit, has a single clock input and a single output. It is reset by a high level at the reset input (pin 6). Counters Z3 and Z5 are synchronous units that have count-up and count-down inputs and carry and borrow outputs. The direction of count is determined by which input is pulsed while the other input is maintained at a high level. The borrow output produces a pulse equal in width to the count-down pulse when the counter underflows. A pulse equal in width to the count-up pulse is produced at the carry output when an overflow condition exists. Counter Z3 and Z5 are similar except that Z3 divides the clock rate by 10; Z5 divides by 16.

NOTE

Since Z2 is a ripple-through counter, one pulse is output for every 12 pulses that are fed into it. There is no up-down count distinction. If Z2 was not reset each time the tape reversed, there might be as many as nine pulses stored in it. As soon as the tape had moved back far enough to cause one more tach pulse, Z2 would put out a pulse. If unchecked, this tends to be cumulative at one end of the shuttle path and soon leads to considerable inaccuracy. Clearing Z2 at each turnaround ensures that it will pulse only after 12 tach pulses.

4-17. Counter Z2 receives the transport tachometer pulses at pin 14. The output at pin 11 is split and fed in parallel to pin 5 of Z6-6 and to pin 10 of Z6-8. These gates steer the clock pulse to the count-up or count-down input of the remaining stages of the divider circuit as directed by the turnaround trigger. When the transport is moving in the forward direction, Z6-6 is enabled by a high level from pin 5 (Q) of the counter turnaround trigger, Z1-5. Gate Z6-8 is inhibited by a low level from pin 6 ($\bar{Q}$) of Z1-5. The output of Z6-6 is connected to the count-up input (pin 5) of Z3; the output of Z6-8 is connected to the count-down input (pin 4) of Z3. Thus, the count-down input is held high by the output of Z6-8, and the count-up input is pulsed by Z6-6.

4-18. The carry output from Z3 is connected to the count-up input of Z5; the borrow output of Z3 is connected to the count-down input of Z5. The carry output (pin 12) of Z5, the last divider element, is connected to the count-up input (pin 5) of the forward counter chain (Z10, Z9, Z8, and Z7), and to the count-down input of the reverse counter chain (Z11 through Z14). Similarly, the borrow output (pin 13) of Z5 is connected to the count-down input of the forward counter chain and the count-up input of the reverse counter chain. This causes the two counter chains to count in opposite directions.

4-19. COUNTER TURNAROUND TRIGGER.

4-20. The counter turnaround trigger has two functions: to clear the first stage of the divider circuit, and to steer the clock pulse to the count-up or count-down input of the remaining divider elements. The two main elements of the turnaround trigger are Z4, a one-shot multivibrator, which is used to clear the first stage of the clock divider; and the second half of Z1, a D-type, edge-triggered flip-flop, which steers the clock pulse to the second and succeeding stages of the divider.

4-21. The one-shot is triggered by a low level at either pin 3 (input A_1) or pin 4 (input A_2). The output at pin 6 (Q) is a positive pulse, the duration of which is determined by the time constant of R11 and C9. This pulse is fed to pin 6, the reset input, of counter Z2, which causes it to be reset to zero. Flip-flop Z1-5, like Z1-9, is used as a latch.

4-22. The inputs to the turnaround trigger circuits are taken from section A4 of the transport reverse direction relay K18. This relay changes state when the transport changes direction and is energized when the transport is in the run reverse or fast reverse mode. The voltage on the K18A4 contacts is also affected by section A3 of relay K9, the transport reverse command relay, which is energized when the reverse command has been given, in both reverse modes, and in the stop mode. The voltage on the lines, then, is either 0 or -28 vdc, depending on the state of both relays. This is illustrated in figure 4-2. For further discussion on the logic functions of the transport, refer to the transport manual.

4-23. To achieve the necessary 0 to 5 volt logic levels, a level shifting network is used in each line. The network in the line at terminal 11 on the shuttle circuit board is R5, R6, C5, and CR1. This network is followed by two buffer stages, Z15-10 and Z15-4. The level shifting network in the line at terminal 10 on the shuttle circuit board is R7, R8, C6, and CR2. This network is followed by two buffer stages, Z15-12 and Z15-2. Thus, a -28 vdc level at the input to the level shifting network results in a low (0 volt) logic level at the output of the buffers. Similarly, a 0 volt input to either network results in a high (+5 vdc) logic level at the output.

4-24. The K18A4NO line (terminal 11) is connected through the level shifting network and buffers to the A_2 input (pin 4) of Z4, and to the preset input (pin 4) of Z1. The K18A4NC line (terminal 10) is connected through its level shifting network and buffers to the A_1 input (pin 3) of Z4, and to the clear input (pin 1) of Z1. A low level at terminal 11 (turnaround from reverse

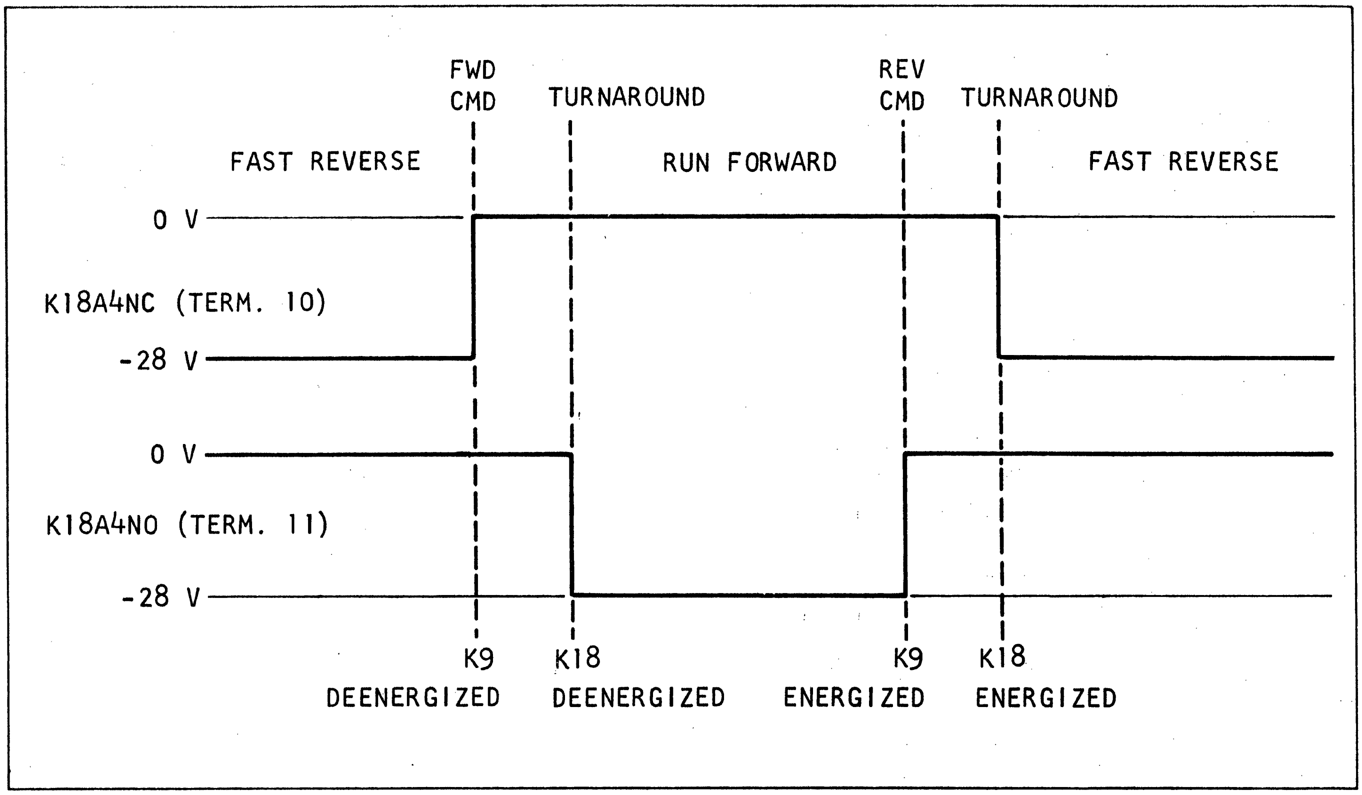

Figure 4-2. Voltages on Lines from K18A4

to forward) triggers the one-shot (Z4) to reset counter Z2 to zero and presets Z1-5 to steer the output of Z2 to the count-up input of Z3. A low level at terminal 10 (turnaround from forward to reverse) triggers the one-shot to reset Z2 to zero and clears Z1-5 to steer the output of Z2 to the count-down input of Z3.

4-25. COUNTERS (Z7 THROUGH Z14).

4-26. Each bank of counters is made up of four synchronous binary counters, ripple-connected to give a total count memory per bank of 65,536 counts. In the configuration used in this circuit, each counter element has two inputs, count-up and count-down, and two outputs, carry and borrow. The direction of count is determined by which input is pulsed while the other input is kept at a high level. The borrow output of each counter element produces a pulse equal in width to the count-down input when the counter underflows. Similarly, the carry output produces a pulse equal in width to the count-up input when an overflow condition exists.

4-27. The carry output (pin 12) of one element is connected to the count-up input (pin 5) of the next element and the borrow output (pin 13) is connected to the next count-down input (pin 4). The last borrow output in the chain is connected to one input of the appropriate command latch NAND gate. Thus, when the counter crosses zero counting down, the last borrow pulse produces a low level at the input to the corresponding NAND gate which ultimately results in the appropriate mode command to the transport.

4-28. The two banks of counters operate identically; however, they are connected to count in opposite directions: the output of the divider circuit pulses the count-up input of one bank of counters and the count-down input of the other bank of counters at the same time. The opposite input line is kept high by the corresponding output of the divider. The borrow lines of the counters are locked out internally (high level) when the counters are going up which eliminates the possibility of trying to set the command latch both ways at once.

4-29. When the transport is running forward, the clock divider and Z7 through Z10 will be counting up, while Z11 through Z14 will be counting down. The opposite is true when the transport is running reverse.

4-30. Transient suppression is provided by two capacitors: C14, connected at Z9 pin 14 and Z9 pin 8; and C15, installed from Z13 pin 14 to Z13 pin 8.

4-31. ZERO SET FORWARD, ZERO SET REVERSE.

4-32. The upper and lower limits of the shuttle path are determined by the point at which one bank of counters crosses zero. Zero is set by clearing all counters of one bank at once. The counters are cleared by a high level at pin 14. The clear line for the reverse counters (Z11 through Z14) is held low by Z16-3 (connected as an inverter). When a zero set switch is pressed, a low level (ground through the switch) is applied to the input of the inverter which results in a high level on the clear line of the appropriate counter chain. The same low level is applied to one input of the corresponding command latch NAND gate which results in the appropriate mode command to the transport (the same action as the counter crossing zero).

4-33. FORWARD-REVERSE COMMAND LATCH (Z16-8, Z16-6, Z17) AND MODE GATES (Q1, Q2).

4-34. The forward-reverse command latch is made up of NOR gates Z17-1 and Z17-4. The latch is preceded by the forward and reverse NAND gates Z16-8 and Z16-6, and is followed by the operate-stop NOR gates Z17-10 and Z17-3. A positive pulse at the output of Z16-8 will provide a low level output at Z17-1 which, if not inhibited by the operate-stop NOR gate Z17-10, will produce a high level at the base of transistor Q1 and turn that transistor on. When Q1 is turned on, the voltage across C10 will discharge through relay K1A to make a momentary closure and switch the transport to the run forward mode. Similarly, a high level at the output of Z16-6 will ultimately switch the transport to the fast reverse mode.

SECTION V

CALIBRATION AND MAINTENANCE

5-1. ACCESS TO COMPONENTS.

5-2. The printed circuit card for the shuttle control assembly is installed in connector J423 of the transport electronics and relay chassis. The control unit is mounted at the upper end of the transport control panel. For details on removal and replacement of these components, refer to Section II of this manual.

5-3. PREVENTIVE MAINTENANCE.

5-4. Preventive maintenance consists of general cleaning and periodic visual inspection.

5-5. GENERAL CLEANING. Accumulation of dust, dirt, grit, and/or grease on both the printed circuit card and the control unit should be guarded against by periodic inspection and cleaning. This will prevent foreign matter from clinging to components and causing unwanted short circuits. The period of cleaning depends on the particular operating environment and should be determined by visual inspection.

5-6. VISUAL INSPECTION. Every six months, under normal laboratory conditions, visually inspect the printed circuit card and the control unit for signs of defects or deterioration, loose connections, insecurity of mounting, and general cleanliness. Repair or replace, as necessary, any defective electrical components or connections.

5-7. TROUBLESHOOTING.

5-8. Before attempting the repair of any unit suspected of a malfunction, check to make sure the symptom of defect is not caused by associated equipment. This can be done by substituting a known good unit for the suspected unit or by making continuity checks from unit to unit. If such a check eliminates the associated equipment as a source of trouble, check the input power and visually inspect the unit. Visual inspection will eliminate the possibility of obviously damaged components as a source of trouble.

CAUTION

Be sure to turn off power to the transport before removing the printed circuit card or disconnecting any cables.

5-9. The best troubleshooting tool is complete familiarity with the equipment and a thorough understanding of the theory of operation as given in Section IV of this manual. As an aid in checking continuity between the control unit and the circuit card, refer to the transport interconnection cable diagram and the schematic of the electronics and relay chassis in the operation and maintenance manual for the 13-501 Tape Transport.

5-10. TTL (transistor-transistor logic) as used in the shuttle circuit is made to operate at high speeds. Because of this it operates very well off high speed spikes of the type radiated by motors and relays. Any troubleshooting procedure will be difficult, if not impossible, without the use of a high speed oscilloscope which will enable the technician to see any noise which may be picked up. The oscilloscope should be capable of displaying at least 80 MHz (Tektronix 585A/82, or equivalent).

5-11. Intermittent triggering of the shuttle, as well as other intermittent problems, can usually be traced to radiated noise. If a specific logic package is suspected of responding to noise, a disc ceramic capacitor from 0.01 to 0.1 μf should be installed from VCC to ground as close as possible to the package; preferably carefully soldered to the package pins. Inducing ground loops from the ground plane to the suspected package ground pin or to its circuit path may also prove helpful.

5-12. Noise problems are more difficult to fight if the extender card is used. It is recommended that the shuttle card be removed from the transport, the scope probe attached where desired, and that the card, with probe, be reinstalled in the electronics and relay chassis for test.

5-13. Problems of a more specific nature are usually solved by tracing signals from the input pins through their designated paths, noting levels and waveforms. Digital integrated circuits are very reliable and loss of signal is more often due to cold solder joints, shorts, etc., than to a package malfunction.

5-14. For test purposes, one output of any package may be shorted to ground as long as desired without harm to the logic. Thus, Z4 could be manually triggered by grounding either of its inputs which also grounds the output of Z15-2 or Z15-4.

5-15. Tracing the divided clock through the counters is difficult because the levels seldom change at Z7 through Z9 or Z12 through Z14. Each or all of the counters can, however, be loaded with a full count (high levels on pins 2, 3, 6, and 7) by grounding the load pin (pin 11 of the integrated circuit). If one pulse is then input on the count-up line, the counter will output a negative pulse on the carry line and return to zero (low levels on pins 2, 3, 6, and 7). Similarly, if the counters are cleared by using the zero set forward or zero set reverse switch, the next pulse on the count-down line will cause a negative pulse on the borrow line and set the counters to full count. This method of forcing an input and then checking for proper output is probably the most direct way to isolate a malfunction.

5-16. REPAIR.

5-17. Repair should be attempted only by electronics technicians and personnel experienced in printed wiring techniques. Recommended repair is limited to the replacement of defective wiring and components. When removing and replacing defective components, be careful not to burn or damage surrounding circuit parts or wires. Be sure replacement parts are known to be good and of the correct type and value. When installing a new part, place it in the exact position of the replaced part, and, after replacement, inspect for evidence of cold solder joints, solder splashes, and insecurity of mounting. Any new wiring should be the same type, the same insulation color, and the same length as the wiring being replaced.

5-18. ADJUSTMENTS AFTER REPAIR.

5-19. After repairs to the shuttle control assembly, it should be checked out for correct operation as described in Section III of this manual. No actual adjustment of the unit is required.

5-20. CIRCUIT EXTENDER CARD.

5-21. A circuit extender card (Bell & Howell part number 472149-1) is available for use with all printed circuit cards housed in the transport electronics and relay chassis and is intended to be an aid to troubleshooting the printed circuit cards. To use the extender card, remove the selected printed circuit card from its slot in the electronics and relay chassis and install the extender card in its place. Then mount the printed circuit card on the extender card.

5-22. FIELD REPAIR SERVICE.

5-23. Regular scheduled maintenance service is available from the Bell & Howell Instruments Division Sales and Service Office on a contract basis. If immediate service is required, it may be obtained on an emergency basis. Every effort is made to furnish the needed repair as soon as possible. For a complete description of Bell & Howell's maintenance service plans and their costs, contact the Instruments Division Sales and Service Office.

5-24. FACTORY REPAIR SERVICE.

5-25. If desired, instruments (or major assemblies) may be returned to the factory for repair. When an instrument or assembly is returned:

a. Indicate the symptom of defect. State as completely as possible, both on an instrument tag and on the order form, the nature of the problem encountered. Too much information is far better than too little. If the trouble is intermittent, please be specific in describing the instrument's performance history.

b. Give special instructions. If any changes in the instrument or assembly have been made, and it is desired to retain the modified form, please indicate this specifically.

c. State the desired invoicing procedure. In the first correspondence, indicate whether repair work may begin immediately with billing in accordance with the standard pricing system or whether Bell & Howell should secure prior approval of the price before proceeding with the repair. The price will be the same in both cases, but any delay will be minimized by permission to start work immediately. The order acknowledgment copy will, of course, always show the price.

d. Pack securely and label. Proper packaging saves money. The small amount of extra care and time it takes to cushion a part or instrument properly may prevent costly damage while in transit. Make certain that the address is both legible and complete; failure to do so often results in needless delay. Address all shipments and correspondence to:

Bell & Howell
Instruments Division
360 Sierra Madre Villa
Pasadena, California 91109
Attention: Repair Department

e. Show return address on repair correspondence. Please indicate clearly the exact address to which the equipment should be returned after repair is completed. All shipping costs will be borne by the owner of the equipment, not by Bell & Howell.

SECTION VI

PARTS LISTS

6-1. Appropriate parts lists and illustrations for the 13-580 Shuttle Control Assembly follow the instructions given below. The parts lists include the Bell & Howell Instruments Division part number, description, figure and index and/or schematic reference symbol, and where applicable, the manufacturer's or military part number for each component. Manufacturers are identified in the parts lists by code number in accordance with the Federal Supply Code for Manufacturers, Cataloging Handbook H4-2, and as listed in table 6-1. The components are illustrated in figures 6-1 and 6-2.

6-3. ORDERING REPLACEMENT PARTS.

6-4. Parts should be ordered through the nearest Bell & Howell Instruments Division Sales and Service Office. Price and delivery information on parts or complete instruments may be obtained there also. To assist in making this contact, a list of Sales and Service Offices is included in the front of this manual. Bell & Howell recommends that whenever possible, and particularly when an instrument is used in a critical application, the user maintain a minimum stock of spare parts. Instruments Division has specialized personnel ready to assist the user in making a selection of spares at any time. The same personnel are also ready and able to prepare or quote on the preparation of illustrated parts breakdowns (IPB's), provisioning parts breakdowns (PPB's), and other parts documentation that might be required.

6-5. When ordering parts, the following information should always be supplied to the field office engineers:

a. A description of the part or assembly, obtained from the parts list.

b. The Bell & Howell part or assembly number, also on the parts list, or on the component itself.

c. The figure and index, and/or reference symbol, given on the applicable diagram and on the parts list.

d. The part or type number of the major assembly, shown on the instrument nameplate.

e. The production serial number, also on the nameplate.

f. The Bell & Howell register number applying to the complete system or order.

CODE	MANUFACTURER
01295	Texas Instruments, Incorporated Semiconductor-Components Division Dallas, Texas
02660	Bunker & Ramo Corporation Amphenol Connector Division Broadview, Illinois
04009	Arrow-Hart, Incorporated Hartford, Connecticut
04713	Motorola Semiconductor Products, Incorporated Phoenix, Arizona
07088	Kelvin Electric Company Van Nuys, California
08806	General Electric Company Miniature Lamp Department Cleveland, Ohio
24546	Corning Glass Works Bradford, Pennsylvania
31433	Union Carbide Corporation Greenville, South Carolina
56289	Sprague Electric Company North Adams, Massachusetts
81349	Military Specifications
96906	Military Standards

Table 6-1. List of Manufacturers

Table 6-2. Parts List for the 13-580 Shuttle Control Assembly (Sheet 1 of 2)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	472197	13-580 Shuttle Control Assembly	1			
2	472142	Front Panel Assembly	1	6-1		
3	471586	Panel, front	1	6-1/1		
4	472146-0001	Switch, push	3	S1, 2, 3	04009	83501-30-70-334
5	19785-32	Lamp, 28 v	1	DS1	08806	334
6	7138-2015	Res, 200Ω ±5%, 1/2 w	1	R18	81349	RC20GF201J
7	471876-2299	Wire, elec, 22 AWG	A/R	6-1/2		
8	156071-1	Terminal, lug	6	6-1/3	02660	324608
9	19362	Insul, slv, elec	A/R	6-1/4		
10	8793	Band, marker, cable	6	6-1/5		
11	472185-1	Circuit Card Assembly	1	6-2		
12	472185	Printed Wiring Board	1			
13	197998	Extractor, card	1	6-2		
14	70131-61	Pin, spring	1		96906	MS171493
15	471922-6212	Res, 620Ω ±2%, 1/4 w	4	R1, 3, 9, 10	24546	C4-621G
16	471922-1032	Res, 10K ±2%, 1/4 w	1	R2	24546	C4-103G
17	471922-1022	Res, 1K ±2%, 1/4 w	1	R4	24546	C4-102G
18	471922-1132	Res, 11K ±2%, 1/4 w	3	R5, 7, 17	24546	C4-113G
19	471922-4722	Res, 4.7K ±2%, 1/4 w	2	R6, 8	24546	C4-472G
20	471922-3032	Res, 30K ±2%, 1/4 w	1	R11	24546	C4-303G
21	471922-3022	Res, 3K ±2%, 1/4 w	2	R12, 15	24546	C4-302G
22	471922-6812	Res, 680Ω ±2%, 1/4 w	2	R13, 14	24546	C4-681G
23	471922-1622	Res, 1.6K ±2%, 1/4 w	1	R16	24546	C4-162G

Table 6-2. Parts List for the 13-580 Shuttle Control Assembly (Sheet 2 of 2)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	215095-492	Cap, 0.1 µf ±10%, 80 v	6	C1, 3, 7, 8, 9, 12	56289	192P1049R8
2	471863-4	Cap, 10 µf ±20%, 20 v	2	C2, 4	31433	T320B106 M20AS
3	215095-592	Cap, 0.01 µf ±10%, 80 v	2	C5, 6	56289	192P1039R8
4	95222-80	Cap, 150 µf +75 -10%, 15 v	2	C10, 11	56289	30D157G015DD4
5	202790-0013	Cap, 0.05 µf +80 -10%, 500 v	1	C13	56289	33C58
6	169812-0005	Cap, 0.05 µf ±20%, 50 v	2	C14, 15	56289	TG-S50
7	372295-1	Diode	4	CR1 thru 4	04713	1N4002
8	253082-4	Transistor, NPN	2	Q1, 2	04713	2N3904
9	252501-4	Transistor, PNP	1	Q3	04713	2N3906
10	472463	Integrated Circuit	1	Z1	01295	SN7474N
11	365855	Integrated Circuit	1	Z2	01295	SN7492N
12	472465-0001	Integrated Circuit	1	Z3	01295	SN74192N
13	471955	Integrated Circuit	1	Z4	01295	SN74121N
14	472465-0002	Integrated Circuit	1	Z5, 7 thru 14	01295	SN74193N
15	471934	Integrated Circuit	2	Z6, 16	01295	SN7400N
16	471941	Integrated Circuit	1	Z15	01295	SN7404N
17	471939	Integrated Circuit	1	Z17	01295	SN7402N
18	246626-1	Relay, sub-miniature	2	K1A, 2A	07088	CIC15

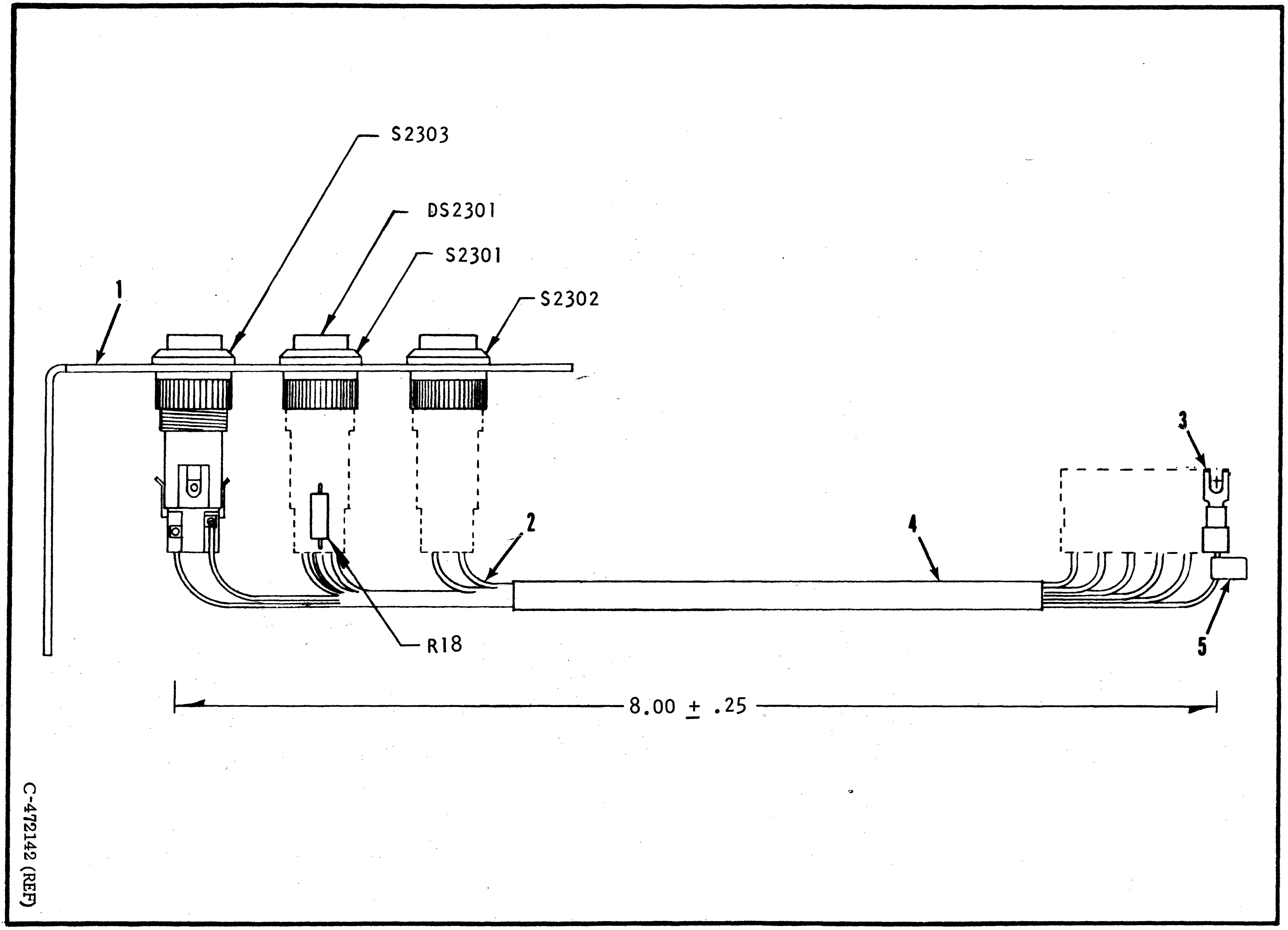

Figure 6-1. Front Panel, 13-580 Shuttle Control

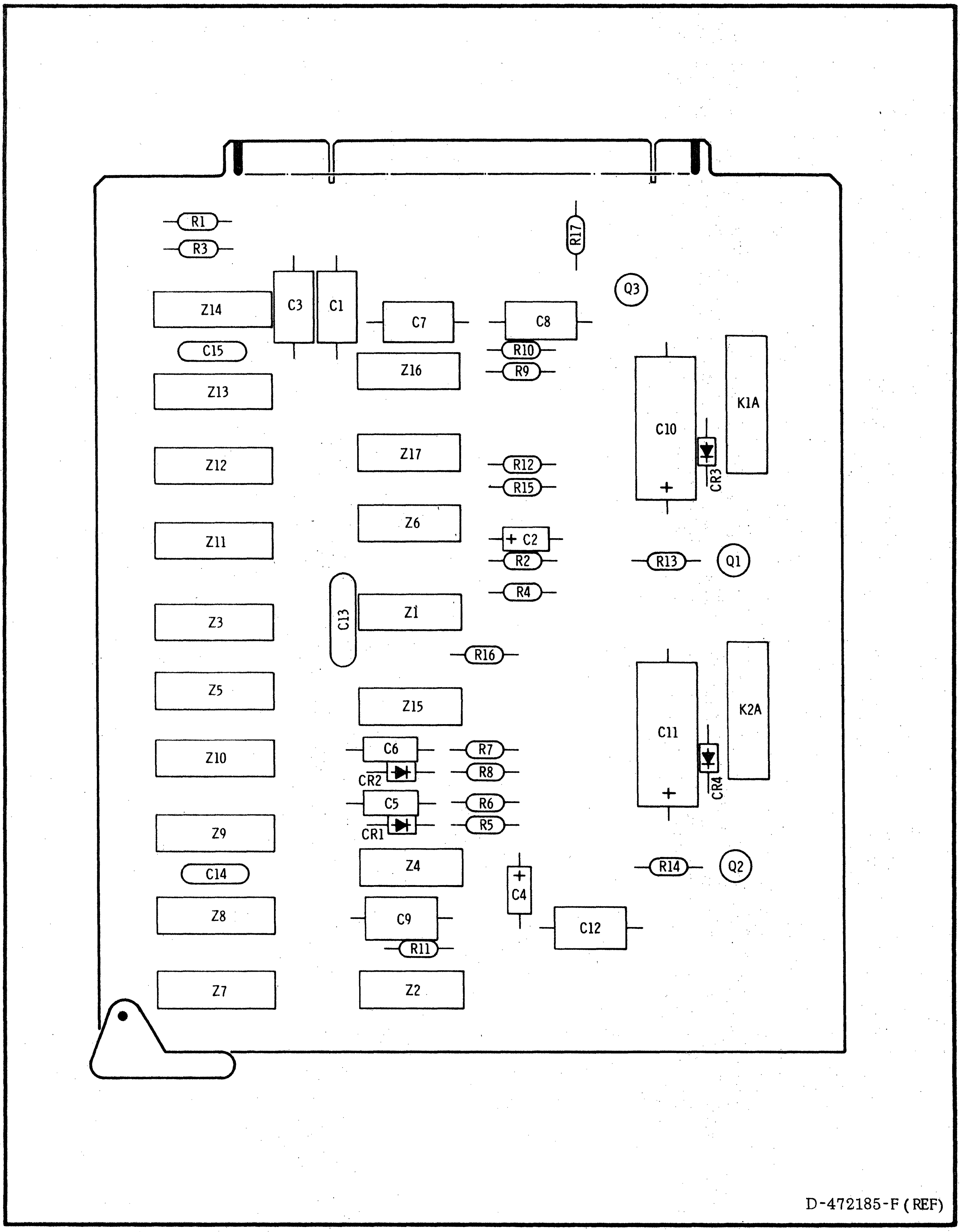

Figure 6-2. Circuit Card Assembly, 13-580 Shuttle Control

SECTION VII

DRAWINGS AND SCHEMATICS

7-1. GENERAL.

7-2. This section contains the schematic diagram and other pertinent drawings for the 13-580 Shuttle Control Assembly.

7-3. Figure 7-1 is a diagram showing the interconnections through the tape transport between the control unit and the circuit board of the shuttle control. For more detail refer to the operation and maintenance manual for the 13-501 Tape Transport.

7-4. Figure 7-2 is the complete schematic diagram for the shuttle control.

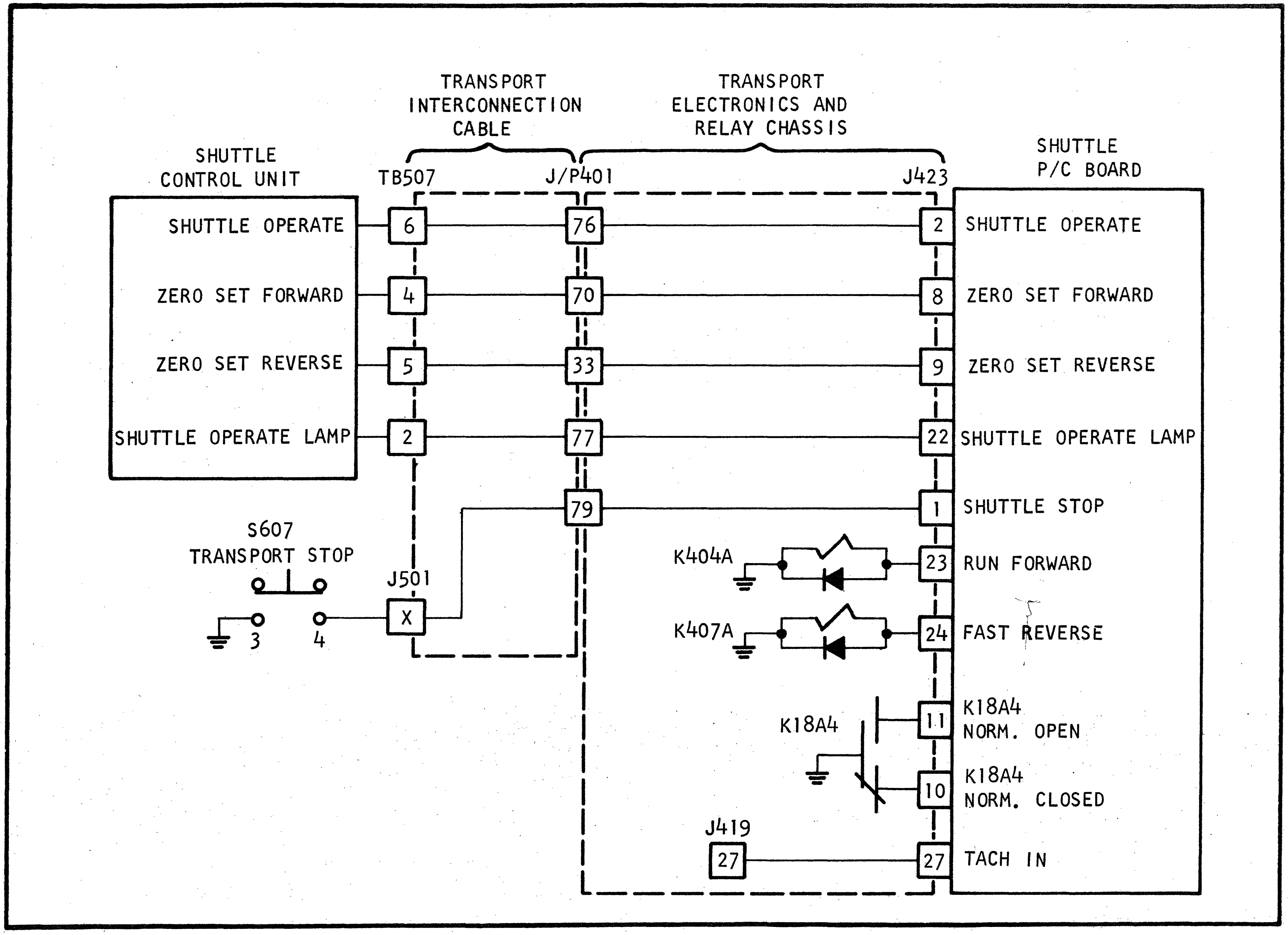

Figure 7-1. Connections between Control Unit and Printed Circuit Board of the 13-580 Shuttle Control Assembly, and 13-501 Tape Transport

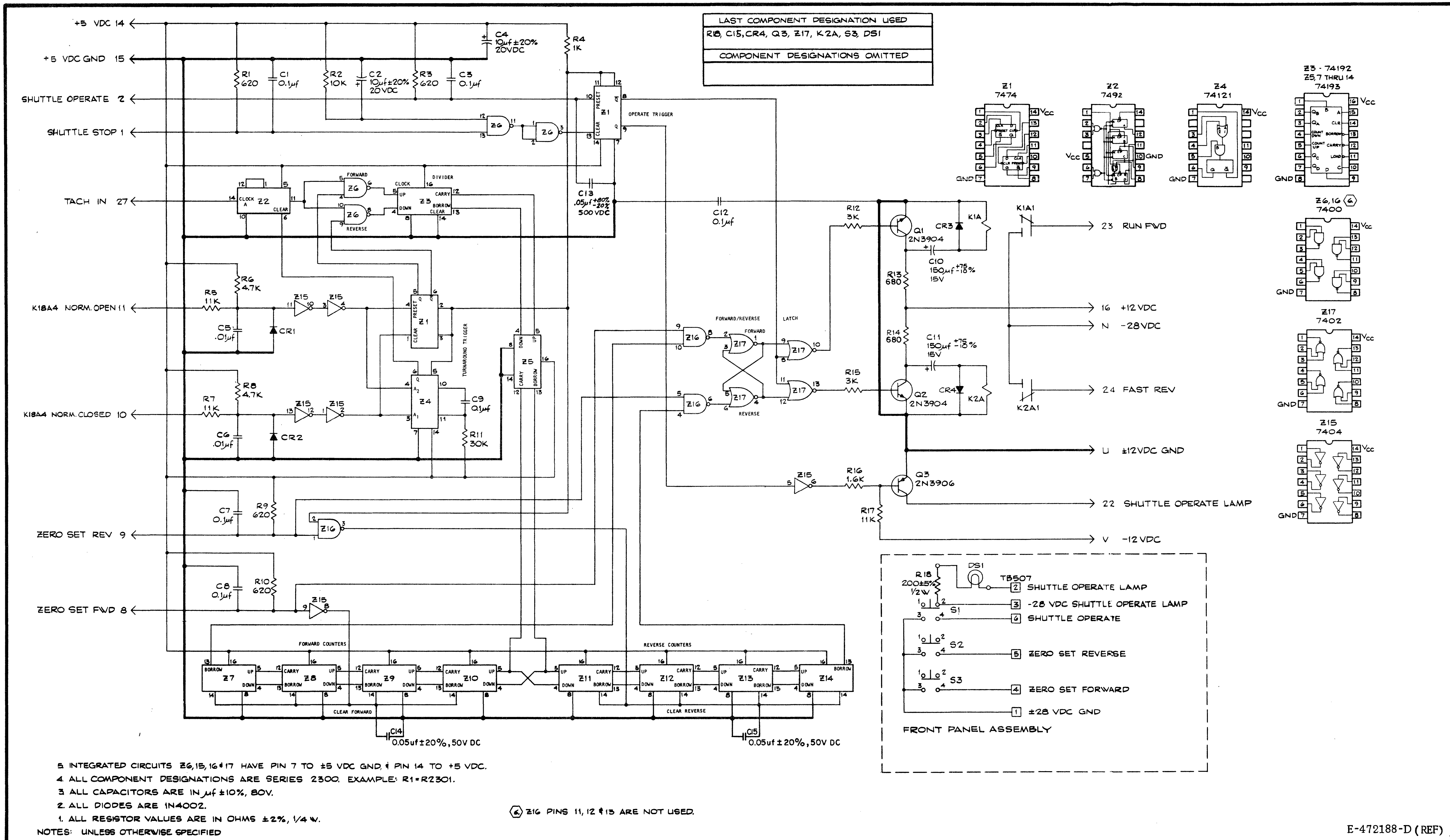

Figure 7-2. Schematic, 13-580 Shuttle Control Assembly