

OPERATING AND SERVICE MANUAL

12555B

DIGITAL-TO-ANALOG CONVERTER INTERFACE KIT

(FOR 2100 SERIES COMPUTERS)

Card Assembly

12555-60001, Rev. 1101, 1138



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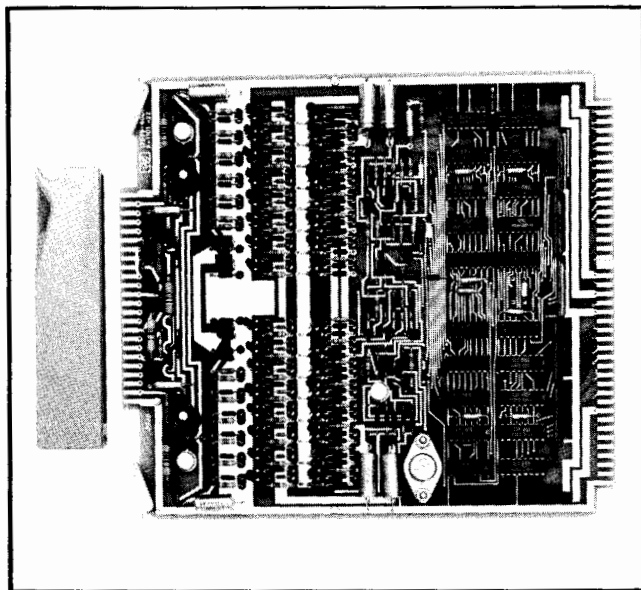
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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This operating and service manual covers general information, installation, programming, theory of operation, maintenance, and replaceable parts for the Hewlett-Packard 12555B Digital-to-Analog Converter (DAC) Interface Kit (figure 1-1).



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Figure 1-1. HP 12555B Digital-to-Analog Converter Interface Kit

1-3. GENERAL DESCRIPTION.

1-4. The DAC interface kit converts digital output signals from a computer to analog voltages for use by conventional and storage-type oscilloscopes, plotters, and similar devices. The kit contains the following items:

- a. Digital-to-Analog Converter Interface Card (part no. 12555-60001).
- b. Connector Kit (part no. 5060-8340).
- c. Operating and Service Manual (part no. 12555-90063).

1-5. The DAC interface card contains integrated and discrete circuits (positive-true logic) for transferring data and control signals between the digital computer and an external analog device. The interface card receives 16-bit binary words from the computer. Each 16-bit word is divided and stored in two 8-bit registers. Output from the two 8-bit registers is scaled to provide two analog output signals. These two analog output signals are the x-axis and y-axis input signals to the external analog device. For conventional oscilloscopes, the analog output signals are regenerated every 20 milliseconds to refresh the display. For storage-type devices, an Erase signal is generated to remove a previously generated display. Positive or negative unblanking signals are also generated and can be connected to the z-axis input of the device to provide the display after the DAC circuits have stabilized. The interface card also accepts a Device Flag signal from the external device that indicates when the device is ready to receive new data.

1-6. The interface card also contains control and interrupt logic circuits that permit programming of the interface I/O operations using the non-interrupt, interrupt, or direct memory access (DMA) method.

1-7. IDENTIFICATION.

1-8. Printed-circuit card revisions are identified by a letter, a revision code, and a division code stamped on the card (e.g., A-1101-22). The letter code identifies the version of the etched trace pattern on the unloaded card. The revision code (four middle digits) refers to the electrical characteristics of the loaded card. The division code (last two digits) identifies the Hewlett-Packard division that manufactured the card. If the revision code stamped on the printed-circuit card does not agree with the revision code shown on the title page of this manual, there are differences between your card and the card described in this manual. These differences are described in manual supplements available at the nearest HP Sales and Service Office.

1-9. SPECIFICATIONS.

1-10. Specifications for the DAC interface kit are given in table 1-1.

Table 1-1. Interface Kit Specifications

PARAMETERS	REQUIREMENTS
LOGIC VOLTAGE LEVELS:	
To and From Computer:	
Logic 1:	+2.4V dc (minimum)
Logic 0:	+0.4V dc (maximum)
ANALOG VOLTAGES:	
To External Device:	
Output Signals:	
Level:	0 to +10V dc (nominal)
Accuracy:	± 100 mV dc full scale
Zero Offset:	± 40 mV dc (1 count)
Linearity:	± 40 mV dc within $1.6 \mu\text{s}$ from the end of the output instruction (OTA/OTB).
Unblanking Pulses:	
Hi:	+10 to -10V dc
Lo:	+1 to -1V dc
Length:	$3.2 \mu\text{s}$ for 2116 Computers $4.0 \mu\text{s}$ for 2114/2115 Computers $3.0 \mu\text{s}$ for 2100 Computers
Erase Signal:	NPN transistor conduction to ground.
From External Device:	
Device Flag Signal:	+22V dc at 10 milliamperes minimum
CURRENT REQUIRED FROM COMPUTER:	
+12 Volt Supply	0.50 amperes
-12 Volt Supply	0.36 amperes
+4.5 Volt Supply	2.40 amperes
-2 Volt Supply	1.80 amperes

SECTION II

INSTALLATION



2-1. INTRODUCTION.

2-2. This section provides information on unpacking and inspection, installation, and reshipment for the HP 12555B DAC Interface Kit.

2-3. UNPACKING AND INSPECTION.

2-4. If the shipping carton is damaged upon receipt, request that the carrier's agent be present when the kit is unpacked. Inspect the kit for damage (cracks, broken parts, etc.). If the kit is damaged and fails to meet specifications, notify the carrier and the nearest Hewlett-Packard Sales and Service Office immediately. (Sales and Service Offices are listed at the back of this manual.) Retain the shipping container and the packing material for the carrier's inspection. The Hewlett-Packard Sales and Service Office will arrange for the repair or replacement of the damaged kit without waiting for any claims against the carrier to be settled.

2-5. INSTALLATION.

2-6. Before installing the DAC interface kit, an adequate cable must be supplied by the user and jumper wires must be installed or removed to adapt the interface card to the computer and device being used. Paragraphs 2-7 through 2-10 describe the cable assembly fabrication and paragraphs 2-11 through 2-13 describe the jumper wire configurations. The procedures in paragraphs 2-7 through 2-13 must be performed before the interface card is installed in the computer.

2-7. CABLE ASSEMBLY FABRICATION.

2-8. The DAC interface kit may be used with a variety of analog devices. Therefore, the user must fabricate a cable assembly that inter-connects the interface card and the particular analog device. The connector kit supplied with the interface kit provides the connector required at the computer end of the cable. This connector slides onto the 48-pin edge of the interface card. The connector for the device end of the cable and the cable required must be supplied by the user.

2-9. For minimum loss on the Analog Output No. 1 and No. 2 signal lines, and also on the Unblanking signal line, it is recommended that separately shielded wires be used and that the cables be kept as short as possible. When a 15-foot long, 75-ohm coaxial cable is used and terminated with a 75-ohm resistive load, the maximum analog output voltage is attenuated to approximately 5 volts. The 75-ohm coaxial cable can be ordered from Hewlett-Packard by part number 8120-0061. The type of wire used for the remaining signal lines is not critical. However, the combined diameter of all signal lines cannot exceed the maximum cable diameter (0.4-inch) that will fit in the connector hood.

2-10. Table 2-1 lists the signals available at the interface card 48-pin connector and their pin number assignments. Figure 2-1 shows details of cable fabrication and lists the parts of the connector kit. To fabricate the interconnecting cable, proceed as follows:

- a. Strip the outer jacket of the cable back 5 inches.

Note

Five inches is the maximum wire length past the outer jacket for the connection to pin 1. As connections are made to higher numerical value pins (ie, closer to where the outer jacket of the cable ends), make the wire appropriately shorter.

- b. Solder the shield of one shielded wire (coaxial) to pins 1, 3, 4, and 5 of the 24-pin connector (7). Solder the conductor of the shielded wire to pin 2.

- c. Solder the shield of the other shielded wire (coaxial) to pins 22 and 24; solder the conductor of the shielded wire to pin 2.

- d. Connect wires to each of the remaining signal pins listed in table 2-1. If any of these wires are shielded, connect the shields to the Ground signal pins.

- e. Insulate each pin with shrinkable tubing as shown in figure 2-1.

- f. Fasten the connector to the mounting block (3) with self-tapping screw A (2).

- g. Mount the connector and mounting block to the hood (1) with self-tapping screw B (4), pan head screw (5), and hex nut (6). Do not tighten the pan head screw.

Note

Two cable clamps (8) are supplied with the connector kit. Use the clamp that holds the cable securely and discard the other one.

Table 2-1. Cable Assembly, Connector Pin Functions

PIN NO.	FUNCTION
1,3,4,5	Shield for wire at pin 2
2	Analog Output No. 1
6	Device Flag (from analog device)
7 thru 11,13,14, 15,17,19,20,21	Ground
12	Erase
16	Unblanking (Lo) } (dc unblanking only)
18	Unblanking (Hi) }
22,24	Shield for wire at pin 23
23	Analog Output No. 2

h. Set the cable clamp (8) between the mounting block and cable. Then tighten the set screw (9).

i. Tighten the pan-head screw.

j. Connect the other end of the cable to a suitable connector for the external analog device. Normally, Analog Output No. 1 is connected to the X-axis input, Analog Output No. 2 is connected to the Y-axis input, and the Unblanking signal output is connected to the Z-axis input.

2-11. JUMPER WIRES.

2-12. The DAC interface card is shipped with jumper wires W2, W3, and W4 installed because this configuration

uses the maximum number of circuits during final testing. Before installing the interface card refer to table 2-2 and change the jumper wire configuration as required for the type of device and computer that are being interfaced. Refer to figure 5-1 (parts location view) to determine the physical location of the jumpers.

Table 2-2. Interface Card Jumper Wire Positions

REF. DESIG.	CIRCUIT EFFECTED	COMMENT
W1	Unblanking output	For positive dc unblanking pulses, W1 is installed and W2 is removed.
W2	Unblanking output	For negative dc unblanking pulses, W2 is installed and W1 is removed.
W3	Device flag timer	Install for conventional oscilloscope to regenerate display every 20 milliseconds. Disconnect W3 and change values of C9 and R131 for storage-type devices that do not require refreshed displays. (Refer to paragraph 2-13.)
W4	Unblanking cycle timer	Install for HP 2100 Computer. Disconnect for 2114, 2115, and 2116 Computers.

2-13. When storage type oscilloscopes, plotters, and other devices that have data storage capability are being used, the refresh operation is not required. Instead, an Erase signal is used. To use the Erase signal, disconnect W3 and then replace C9 and R131 in the device flag timer circuit. The values of C9 and R131 are changed to provide the Erase signal pulse width required by the interfaced device. For example, if C9 is changed to 100 μ F, the pulse width is approximately 0.5 second. Mark the schematic diagram (figure 5-2) to show the new values for C9 and R131.

2-14. CARD INSTALLATION.

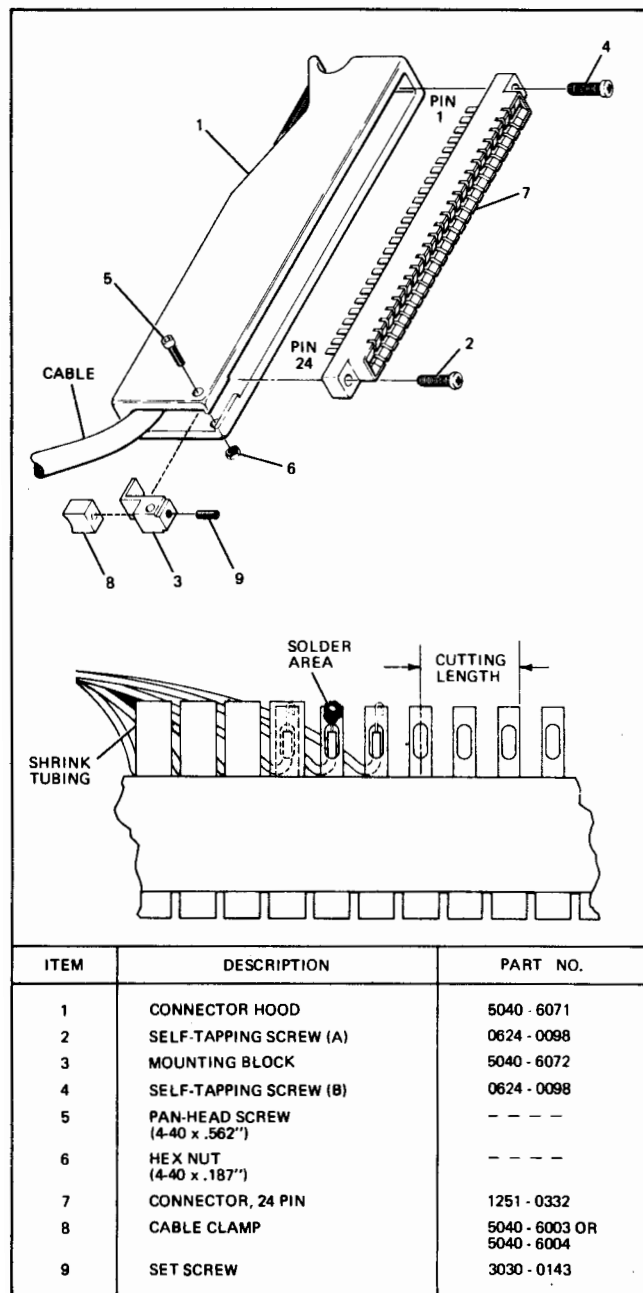
2-15. Install the interface card and fabricated cable assembly as follows:

a. Determine if the computer power supplies will provide the additional current required for operation of the interface card. Current requirements for the interface card are listed in table 1-1. Refer to the Hewlett-Packard computer documentation (I/O System Operation) for instructions on how to determine the current available from the computer power supplies.

b. Turn off power at the computer and external analog device.

CAUTION

Computer power must be off before installing the interface kit. Failure to turn off power may cause damage to the computer or interface kit.



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Figure 2-1. Cable Fabrication Diagram and Parts List

c. Check interface card to determine if jumper wires are properly installed (refer to paragraph 2-11).

d. Open computer for access to I/O card slots.

e. Plug the interface card into I/O slot assigned for the particular computer system. Make certain that all higher priority slots have either another I/O card or a priority jumper card installed.

Note

If the interface kit is used in conjunction with DMA in a 2114, 2115, or 2116 computer, the interface card must be installed in the computer card cage and not in the 2151A or 2150B Extender.

f. Pass the interface card connector end of the cable assembly through opening at rear of computer. Slide connector onto interface card and close computer.

g. Connect other end of cable assembly to the external analog device.

h. Run a simple test program (refer to Section III, Programming, for a sample assembly language program) to verify that the interface card is functioning properly.

2-16. RESHIPMENT.

2-17. If an item of the kit is to be shipped to Hewlett-Packard for service or repair, attach a tag to the item identifying the owner and indicating the service or repair to be accomplished. Include the model number of the kit.

2-18. Package the item in the original factory packaging material, if available. If the original material is not available, standard factory packaging material can be obtained from a local Hewlett-Packard Sales and Service Office.

2-19. If standard factory packaging material is not used, wrap the item in Air Cap TH-240 cushioning (or equivalent) manufactured by Sealed Air Corp., Hawthorne, N.J. and place in a corrugated carton (200 pound test material). Seal the shipping carton securely and mark it "FRAGILE" to assure careful handling.

Note

In any correspondence, identify the kit by model number. Refer any questions to the nearest Hewlett-Packard Sales and Service Office.

SECTION III

PROGRAMMING

3-1. INTRODUCTION.

3-2. This section provides information for programming the DAC interface card to provide analog data to an external analog device. The information consists of characteristics of the analog device, timing considerations, and sample assembly language programs. Additional programming information is available in the software manuals supplied as part of the computer system documentation.

3-3. DEVICE CHARACTERISTICS.

3-4. The DAC interface card converts the digital output from the computer into analog voltages suitable for driving the input of an analog device such as an oscilloscope or plotter. For inputs to the analog device, the two analog outputs from the interface card are connected to the X- and Y-axis inputs and the dc blanking pulse is connected to the Z-axis input. A suitable convention must then be adopted to properly scale the inputs. For example: the eight least significant bits to the X-axis (Analog Output No. 1), and += right; the eight most significant bits to the Y-axis (Analog Output No. 2), and += up. With this convention, each of the 65,536 possible 16-bit numbers that may be transmitted to the interface card will cause a unique point in a 256 by 256 array to be plotted. Using this convention for non-storing oscilloscopes, the array is related to the output data word as shown in figure 3-1. Analog devices used with this interface card should have linear X-and Y-channel amplifiers and a bandwidth of 5 MHz or more.

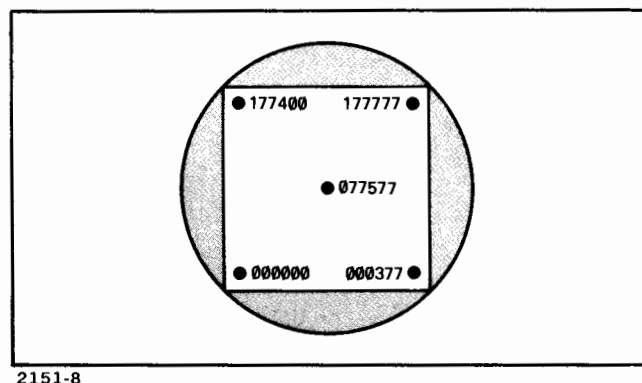


Figure 3-1. Oscilloscope Display Array

3-5. TIMING CONSIDERATIONS.

3-6. To maintain a graphical display on a conventional oscilloscope, the display must be regenerated (refreshed)

about 50 times a second. This is done automatically by a timer on the interface card that triggers a new data transfer about every 20 milliseconds. This places a limit on the number of points that can be plotted. For example: when seven machine cycles are used in the data transfer loop, a model 2116 computer (1.6 microsecond cycle time) can transfer about 1780 plotted points in the available 20 milliseconds.

3-7. If the computer is equipped with Direct Memory Access (DMA), only three machine cycles are required to transfer data. This increases the number of points to 4140 which may be transferred for the 2116 Computer. When DMA is used for data transfer it should be initialized with STC,C instructions and the packing options disabled. Under these conditions, the interface card requests data from DMA without generating a program interrupt on every third machine cycle. The first data word to transfer initializes the timer automatically and a program interrupt occurs 20 milliseconds later.

3-8. Graphical displays on storage-type oscilloscopes and plotters do not require regeneration due to the image storage capability of the device. Therefore, data transmission is not time-limited and can be done at a slower rate than for conventional oscilloscopes. This also allows a greater number of points to be plotted. Prior to initiating a new display on storage-type devices, the existing display must first be erased. For storage-type devices, the interface card provides an Erase signal on receipt of a CLF instruction. The Erase signal is controlled by the 20-millisecond timer circuit that has been modified to provide an Erase signal with the proper pulse width, after which a program interrupt occurs if an STC instruction was programmed. When operating a storage-type device, DMA should not be used because it interferes with the erase function.

3-9. Data transmission through the DAC interface card is asynchronous and is limited to the following restriction. Between data transmissions to the interface card, a minimum of two machine cycles should elapse for 2114, 2115, and 2116 computers and a minimum of four machine cycles should elapse for the 2100 computer. Failure to observe this restriction will not affect the program, but will result in incorrect blanking signals. For non-storage oscilloscopes, this requirement is automatically met by DMA.

3-10. ASSEMBLY LANGUAGE PROGRAMS.

3-11. Table 3-1 provides a sample assembly language program which indicates the operations and instructions

required to transfer data from the digital computer to an external analog device. The program transfers data to a conventional oscilloscope, and the interface card 20-millisecond timer is used to regenerate and maintain the display.

3-12. This program, when assembled on an object tape, will perform a data transfer using the non-interrupt method. The program assumes the interrupt system was disabled by programming a CLF instruction to select code 00, and the DAC select code is 10B.

Table 3-1. Sample Assembly Language Program for Conventional Oscilloscopes

```

0001          ASMB,A,B,L,T
0002 01000          ORG 10000
0003* THIS IS A SAMPLE PROGRAM FOR THE 12555 D-A
0004* INTERFACE CARD. THE PROGRAM TRACES THE
0005* PATTERN "HP" ON A CRT.
0006*
0007 01000 065012 TRACE LDB BUFAD
0008 01001 103110 CLF SCOPE START THE REFRESH TIMER
0009* SEND DATA NECESSARY TO TRACE PATTERN
0010 01002 160001 NEXT LDA B,I PICK UP X,Y COORDINATES FROM
0011 01003 102610 OTA SCOPE CHARACTER BUFFER AND OUTPUT
0012 01004 006004 INB TO DISPLAY. KEEP OUTPUTING
0013 01005 002002 S7A CHARACTERS UNTIL END (0)
0014 01006 025002 JMP NEXT CHARACTER IS REACHED
0015 01007 102310 SFS SCOPE WAIT FOR FLAG INDICATING
0016 01010 025007 JMP *-1 CHARACTERS ARE TO BE RETRACED
0017 01011 025000 JMP TRACE RETRACE CHARACTERS
0018 01012 001013 BUFAD DEF BUFR
0019 01013 054160 BUFR OCT 54160,54170,54200,54210,54220
      01014 054170
      01015 054200
      01016 054210
      01017 054220
0020 01020 060200 OCT 60200,64200,64210,64160,64170
      01021 064200
      01022 064210
      01023 064160
      01024 064170
0021 01025 064200 OCT 64200,64210,74160,74170,74200
      01026 064210
      01027 074160
      01030 074170
      01031 074200
0022 01032 074210 OCT 74210,74220,100200,100220,104200
      01033 074220
      01034 100200
      01035 100220
      01036 104200
0023 01037 104210 OCT 104210,104220,0
      01040 104220
      01041 000000
0024 00001 B EQU 1
0025 00010 SCOPE EQU 10B
0026          END
** NO ERRORS*

```

SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a functional description and a detailed circuit description of the Digital-to-Analog Converter (DAC) interface card. Also included at the back of this section is an operational flow diagram (figure 4-3) of the interface card.

4-3. FUNCTIONAL DESCRIPTION.

4-4. The DAC interface card contains two 8-bit output registers and the necessary control circuits to transfer data from the computer to an external analog device. Programmed instructions initiate the control signals that are sent from the computer to the interface card (figure 4-1). These control signals (IOO, T3(B)) enable the interface card data registers so that data is transferred from the computer to the registers. Control signals (CLF, ENF) initialize erase and blanking circuits to control the output to the analog device between data transmissions. When the analog device is ready to receive the next set of data bits it can set the Flag FF with a Device Flag signal.

4-5. On the interface card, the Device Flag signal initiates either a Skip Flag (SKF) or Interrupt Request (IRQ) signal depending on the method programmed for data transfer. The initiated signal is sent to the computer to start the next data transfer. Data transfer continues as long as the computer is programmed to transfer data.

4-6. DETAILED CIRCUIT DESCRIPTION.

4-7. The DAC interface card uses integrated circuits with positive-true logic. There are four jumper wires used to select modes of operation for the interface. Table 2-2 lists the functions controlled by the various jumper positions. A schematic diagram and parts location view for the interface card are contained in figure 5-2. Circuits described in this section are divided into the following circuit groups:

- a. Turn-on and preset circuit.
- b. Select code detector circuit.
- c. Flag circuit.
- d. Control and interrupt circuits.
- e. Skip flag circuit.
- f. Device flag timing circuit.
- g. Unblanking circuit.
- h. Output circuits.
- i. -10 volt supply circuit.

4-8. TURN-ON AND PRESET CIRCUIT.

4-9. The turn-on and preset circuit establishes initial conditions for the interface card logic circuits. At computer

power turn-on or when computer preset is enabled, the computer sends true POPIO and CRS signals to the interface card. The true POPIO signal is inverted to set the Flag Buffer FF which then enables the Flag FF at the next time T2. This inverted POPIO signal is also sent to the output register clock input gates. Computer inputs to the output register are false during turn-on and preset so that the output register is cleared by the POPIO signal. The true CRS signal is inverted to clear the Control FF.

4-10. SELECT CODE DETECTOR CIRCUIT.

4-11. The select code detector circuit enables the DAC interface card to accept and perform the instructions intended for the analog device. When the analog device is addressed by programmed instructions, the SCM and SCL signals are both true at the interface card. The IOG signal goes true when any instruction is programmed for an I/O device. All three signals must be true before the interface card will accept a programmed instruction.

4-12. FLAG CIRCUIT.

4-13. The flag circuit provides initial conditions that allow the computer to send data to the analog device by either the interrupt or skip flag method. This circuit contains the Flag and Flag Buffer FFs. The Flag FF is always set at T2 (ENF signal true) of the following machine cycle after the Flag Buffer FF is set. Setting the Flag Buffer FF is done by any of three methods; during power turn-on and preset by the POPIO signal, by programming an STF instruction, and by the Set Flag signal from the device flag timing circuit. The Flag and Flag Buffer FFs are both cleared by a CLF instruction and the Flag Buffer FF can also be cleared by an IAK signal from the computer.

4-14. CONTROL AND INTERRUPT CIRCUITS.

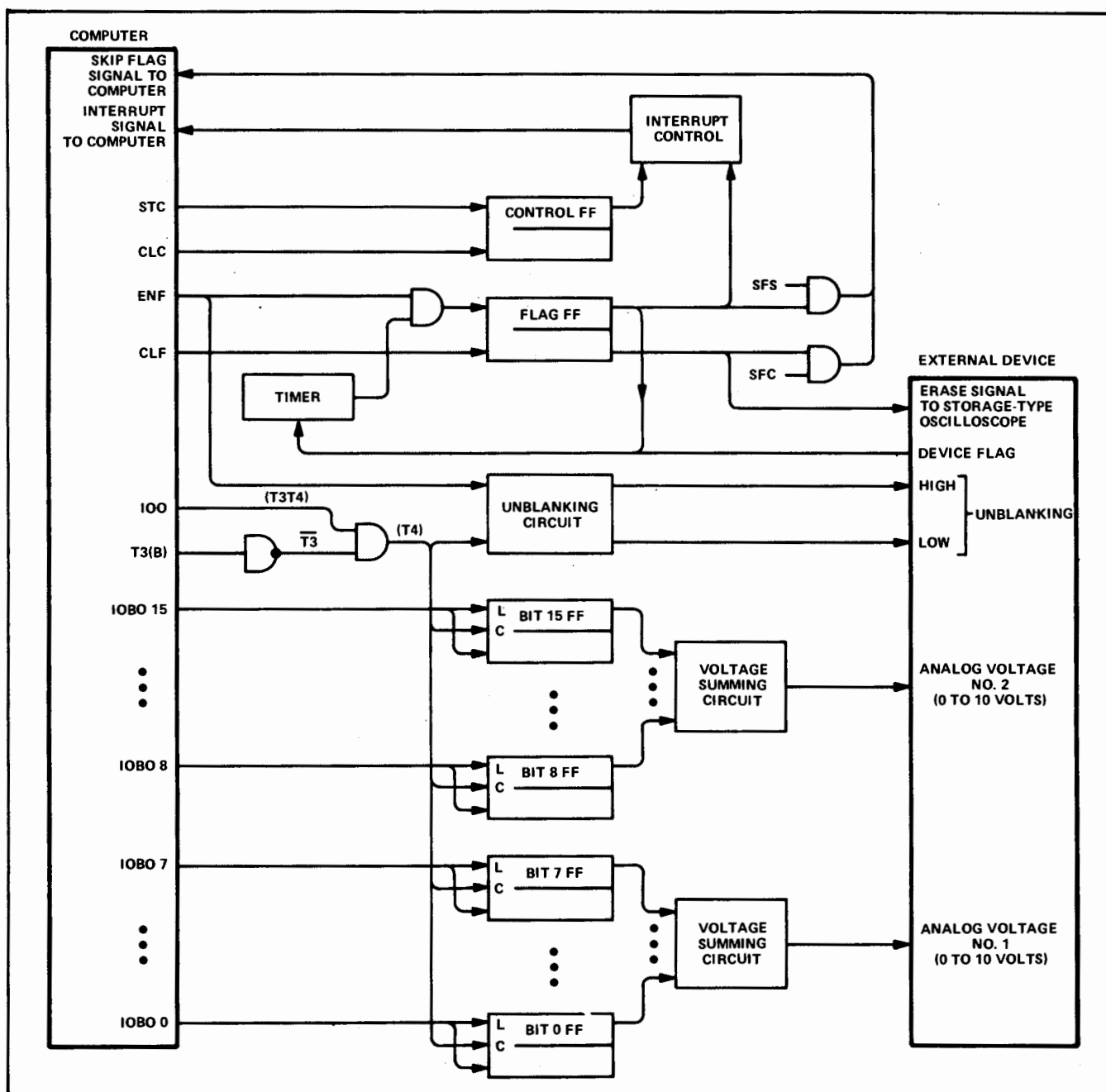
4-15. The control circuit contains the Control FF that is set by an STC instruction and cleared by a CRS signal or a CLC instruction. Normally, the Control FF is set by the first STC instruction to the interface card and remains set until a CRS signal or a CLC instruction is received. When set, the Control FF provides one condition for enabling the interrupt circuit.

4-16. The interrupt circuit interrupts computer operation on a priority basis. During the interrupt, data is transferred from computer memory to the analog device. The interrupt circuit contains the IRQ FF. Initial conditions are established when the Flag and Control FFs are set and an IEN signal is received to enable gate U36A. An IEN signal is received after an STF instruction is programmed with select code 00. The false output from gate U36A

is sent to gate U17A and inverted and sent to gate U47A. Gates U17A and U47A also receive a true PRH signal, indicating that there are no higher priority cards requesting an interrupt. The output of gate U17A goes false, sending a PRL signal to all lower priority cards. The PRL signal inhibits all lower priority cards from interrupting operation. Gate U47A also receives a signal from the set-side output of the Flag Buffer FF, and an SIR (T5) signal. If all the inputs to gate U47A are true, the output goes false and sets the IRQ FF. Setting the IRQ FF provides FLG and IRQ output signals. When the IRQ FF is first set, the true FLG and IRQ signals are sent to the computer to initiate an I/O interrupt during the next machine cycle.

4-17. At time T2, after interrupt is initiated, the ENF signal goes true and the SIR (time T5) signal is false. The ENF signal then clears the IRQ FF to allow any higher priority cards to use the requested interrupt. If a higher priority card does not use the requested interrupt, the PRH signal remains true, as do the other inputs to gate U47A, and the IRQ FF is set a second time at time T5 (SIR goes true). When the IRQ FF is set the second time, the true FLG and IRQ signals are used to decode the interrupt address.

4-18. The next machine cycle is then controlled by the instruction located at the interrupt address in the computer



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Figure 4-1. Simplified Logic Diagram

memory. During this machine cycle, the computer sends an IAK signal to the interface card that clears the Flag Buffer FF and the ENF signal clears the IRQ FF at time T2. Clearing the Flag Buffer FF prevents the IRQ FF from being set again after the requested interrupt is enabled. However, the Flag FF remains set to provide a false PRL signal and inhibit lower priority cards from interrupting until the requested interrupt is complete. To clear the Flag FF and enable lower priority cards to interrupt, a CLF instruction must be programmed.

4-19. SKIP FLAG CIRCUIT.

4-20. The skip flag circuit is used to transfer data from computer memory to the analog device using a non-interrupt method. Before using the non-interrupt method, a CLF instruction is usually issued to select code 00 to disable the IEN signal and ensure that interrupt cannot occur. To enable the skip flag circuit, an SFS or SFC instruction is issued with the analog device select code. With the SFS instruction, the Flag FF must be set to provide a true SKF output signal to the computer. For the SFC instruction, the Flag FF must be cleared to provide a true SKF output signal. The true SKF signal tells the computer that the analog device is ready to receive data. With this method of transferring data, the computer is programmed to wait in a recycling loop before each data transfer until the SKF signal is true.

4-21. DEVICE FLAG TIMING CIRCUIT.

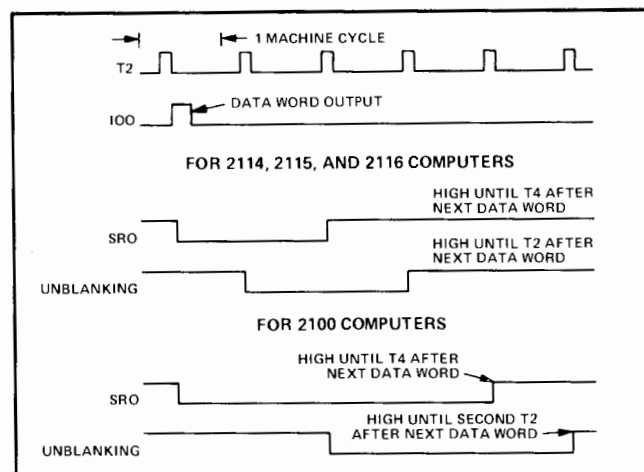
4-22. The device flag timing circuit provides a Set Flag signal to indicate that the device is ready to accept additional data. If the Device Flag signal line is used, the analog device may directly request service. A positive voltage on pin 6 of the 48-pin connector is applied to the base of Q39. This causes a true input signal to be applied to U106C. At the next time T3, if the Flag FF has been cleared, the Flag Buffer FF is set. The Flag FF is then set at the next time T2. At this point the state of the Flag FF may be tested under program control or if the Control FF is set, an interrupt can be generated.

4-23. The device flag timing circuit is controlled by the Flag FF set-side output when jumper W3 is installed. With the Flag FF set, transistor Q41 is turned on and Q40 is turned off. The timing cycle is initialized by clearing the Flag FF with a CLF instruction. When the Flag FF is cleared, the positive voltage on the collector of Q40 holds Q41 on. The voltage on the base of Q40 then rises as capacitor C9 charges. Approximately 1.0 millisecond later, Q40 starts conducting. Transistor Q41 is then turned off and the voltage on the collector of Q41 begins rising. At approximately 5.6 volts, diode CR36 applies a positive voltage to the base of Q39. This initiates the Set Flag signal approximately 20 milliseconds after the Flag FF was cleared by the CLF instruction. The Set Flag signal then sets the Flag Buffer and Flag FFs causing the device flag timing circuit to return to the starting condition and causing the computer to send data to "refresh" the display. The next timing cycle is initialized by repeating the CLF instruction.

4-24. If a storage-type oscilloscope is used, a refresh operation is not required. An Erase signal is used instead to clear the previous display and prepare to receive data. Capacitor C9 and resistor R131 are changed to increase the time delay and provide the required Erase signal pulse width. For example, if the value of C9 is changed to 100 μ f, the time delay is increased to approximately 0.5 second. To initiate an Erase signal, a CLF instruction is programmed. The CLF instruction causes the Erase signal to drop, clearing the previous display. When the time delay elapses, the timer circuit output sets the Flag FF causing the Erase signal to return to its normally high state.

4-25. UNBLANKING CIRCUIT.

4-26. Unblanking signal pulses are sent to the analog device to prevent the device from accepting the Analog Output signals until the signals have settled to their correct values. An unblanking cycle timer is used to control the unblanking signal and to generate SRQ signals to DMA. A 5-bit register is preset when the OTA/B instruction is used to output data. Jumper W4 controls the preset input to the register. At each time T2 after the register is preset, the register is shifted one bit position. Figure 4-2 shows the output of the timer.



2151-4

Figure 4-2. Output Timing Diagram

4-27. When the output at pin 10 of U56 goes true, the transition is used to switch the unblanking output circuit. If jumper W2 is in place and W1 is removed, a negative going voltage is applied to the base of transistor Q42. This results in a negative going unblanking signal until the output at pin 10 goes false. If jumper W1 is installed and W2 removed, a positive going blanking signal results.

4-28. OUTPUT CIRCUITS.

4-29. Each output circuit is made up of an 8-bit output register, a constant current source, and an analog output circuit. The output register is loaded from the computer

IOBO lines by an OTA/B instruction or by a POPIO signal during power turn-on or preset. The output of each flip-flop in the register is applied to the analog output circuit. The analog output circuit then provides a scaled analog output voltage.

4-30. If the Bit 15 FF is set, transistors Q31 and Q15 are turned off. A negative voltage is applied through resistors R35 and R36 to the current summing point at the base of transistor Q6A. As current is drawn from the base of Q6A, transistor Q5 conducts more heavily, raising the output voltage on pin 23 of the 48-pin connector. If all flip-flops of the output register are in the clear state the output on pin 23 is 0 volts.

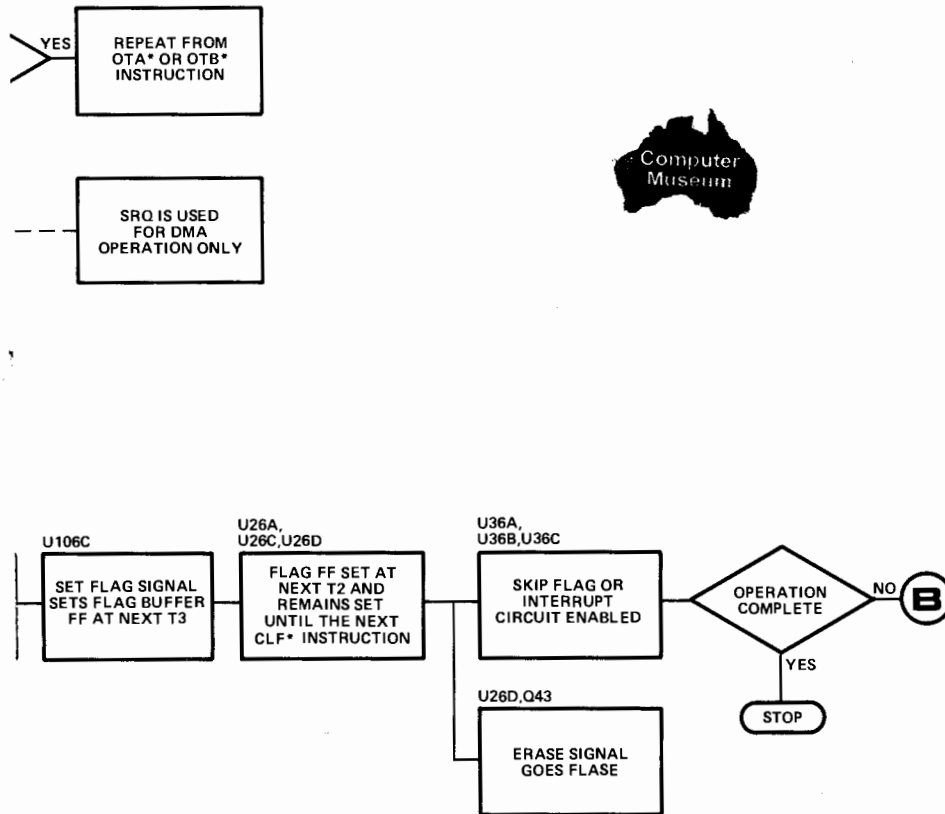
4-31. Data bits 0 through 7 from the computer are loaded into one interface card register to form the Analog Voltage No. 1 output. Data bits 8 through 15 are loaded into the other interface card register to form the Analog Voltage No. 2 output. The magnitude of the respective analog voltage is determined by the formula $(N/255) \times 10$, where N is the decimal value represented by the combination of bits in each group of 8 bits. The maximum of each analog output voltage is +10 volts.

4-32. Transistors Q3 and Q4 act as constant current sources for the analog output circuits. Diode CR1 clamps the base voltages so that if the analog output circuits attempt to draw more current through transistors Q1 and Q6 the emitter resistors R7 and R12 reverse bias the respective source transistors. This holds the current available to transistors Q1 and Q6 constant. Current is drawn instead from output transistors Q2 and Q5.

4-33. -10 VOLT REGULATED SUPPLY.

4-34. The -10 volt regulated supply provides a constant voltage to the current summing network. Transistor Q48 drops the -12 volt supply voltage to a constant -10 volts. The -10 volt output is compared to a reference voltage by transistors Q46A and Q46B. If the regulated voltage goes positive, the voltage on the base of transistor Q47 causes more drive to be applied to transistor Q48.

4-35. Resistor R155 is a selected value to properly scale the voltage applied to the current summing network. Special replacement procedures for resistor R155 are provided in Section V and part numbers for selected values are listed on figure 5-2.



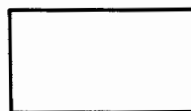
PREFIXED BY T INDICATE TIME INTERVALS
COMPUTER CYCLE.

ISK (*) INDICATES A PROGRAMMED INSTRUCTION
IRES THE INTERFACE SELECT CODE TO BE EFFECTIVE.

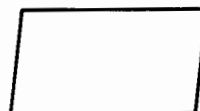
END



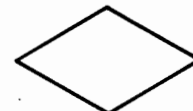
MBOL SHOWS
CARD OPERA-
ICAL SE-



ANNOTATION SYMBOL SHOWS
FUNCTIONS EXTERNAL TO
THE INTERFACE CARD OR
DESCRIBES OPERATION.



INPUT/OUTPUT SYMBOL
SHOWS DATA TRANSFER.



DECISION SYMBOL SHOWS
LOGICAL DIVISION OF INTER-
FACE CARD OPERATIONAL
FLOW.

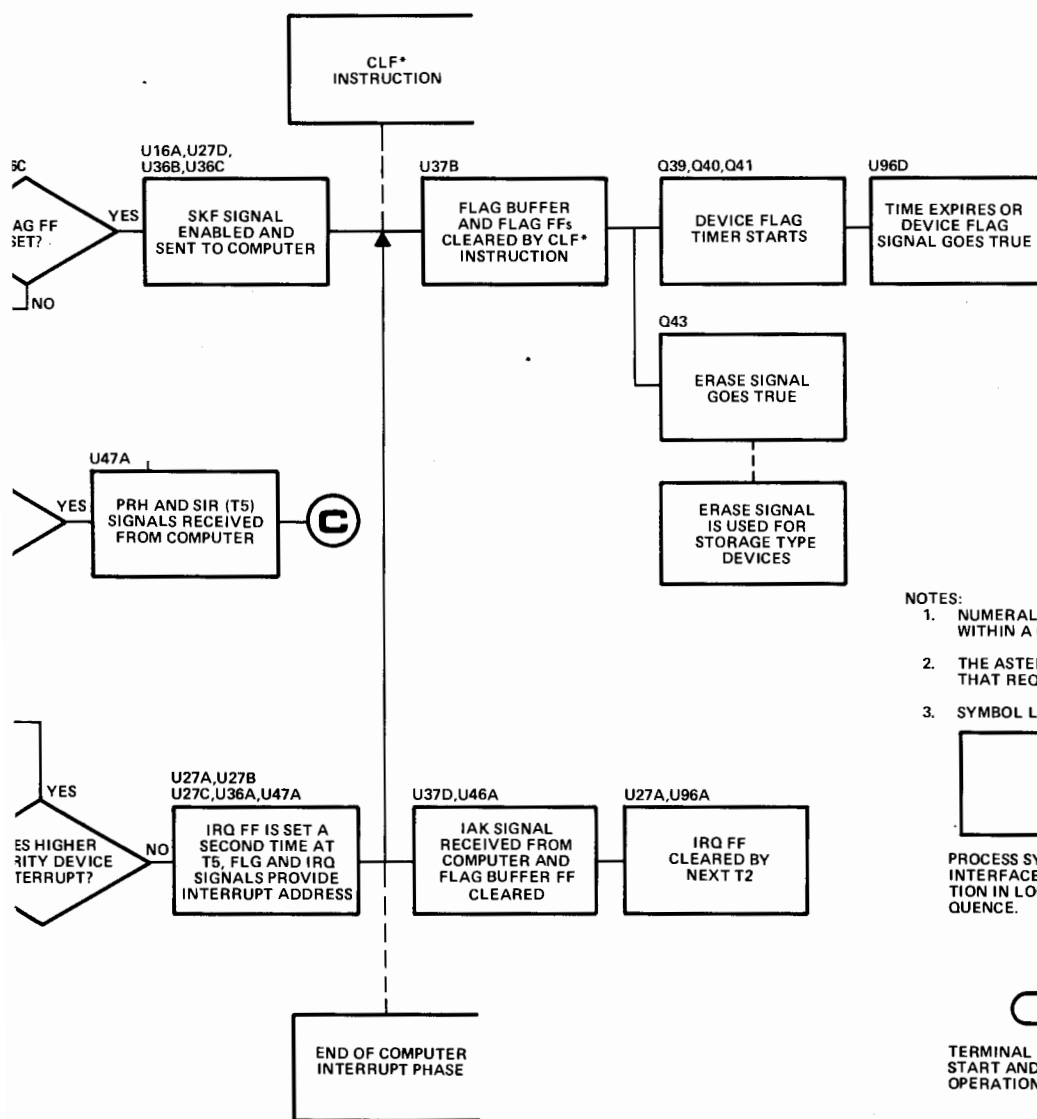
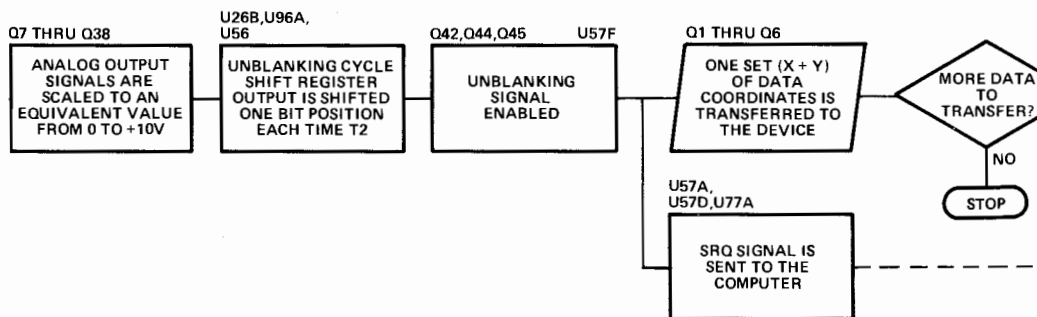


YMBOL SHOWS
STOP OF

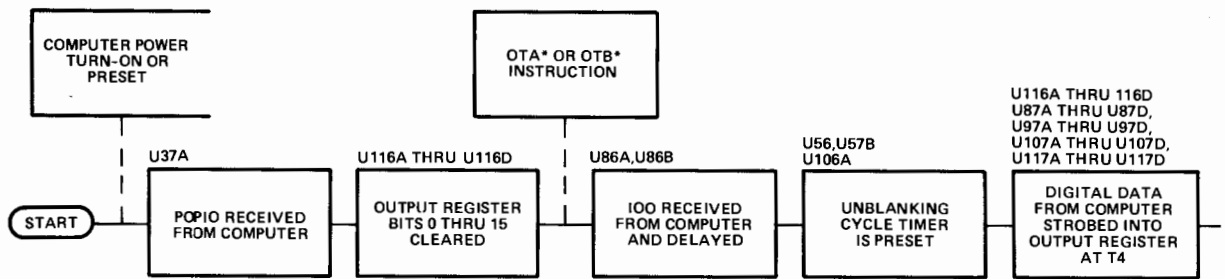


CONNECTION SYMBOL: BLACK
CIRCLES SHOW POINT OF
CONTINUED FLOW FROM ALL
WHITE CIRCLES WITH THE
SAME LETTER DESIGNATION.

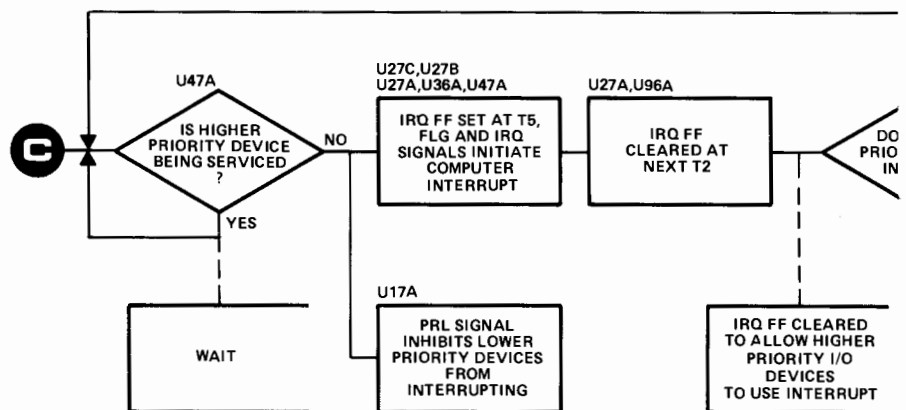
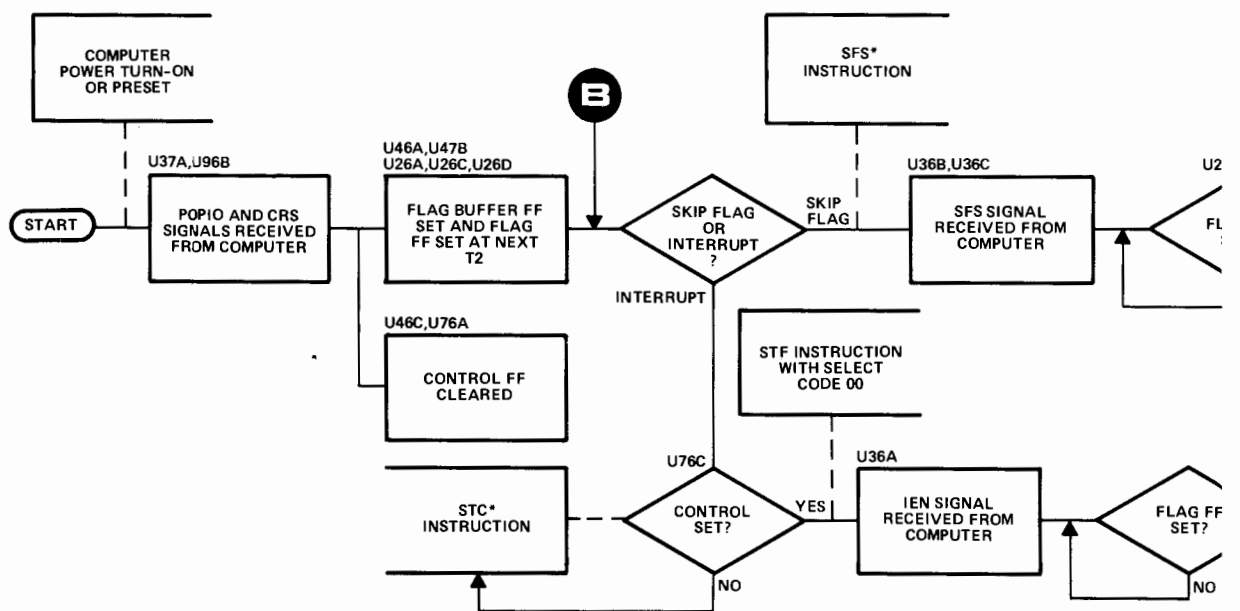
Figure 4-3. Operational Flow Diagram



DATA TRANSFER OPERATION



INTERRUPT OR SKIP FLAG CONTROL



SECTION V

MAINTENANCE



5-1. INTRODUCTION.

5-2. This section contains preventive maintenance and troubleshooting information for the DAC interface kit. Special instructions are included for replacing resistor R155 on the interface card (refer to paragraph 5-7). Tables and diagrams presented in this section are arranged in the following order:

- a. Interface card replaceable parts (table 5-1).
- b. Integrated circuit diagrams (figure 5-1).
- c. Integrated circuit characteristics (table 5-2).
- d. Interface card schematic diagram and parts location view (figure 5-2).

5-3. PREVENTIVE MAINTENANCE.

5-4. Preventive maintenance for the DAC interface kit should be performed when the preventive maintenance routines for the computer system are performed. Preventive maintenance consists of inspecting the interface card and cable assembly for burned or broken components, loose connections, and deteriorated insulating materials.

5-5. TROUBLESHOOTING.

5-6. Troubleshooting for the interface card is accomplished by performing the applicable assembly language program provided in Section III, or by performing any program where normal operation of the interface card has been verified. To isolate malfunctions, refer to the schematic diagram and parts location view in figure 5-2. Table 5-1 contains a list of parts in reference designation sequence. Logic and pin location diagrams for the integrated circuit used on the interface card are contained in figure 5-1. Table 5-2 gives the integrated circuit input levels, output levels, and delay times which correspond to the integrated circuit characteristic number shown below each diagram in figure

5-1. To perform continuity checks of the interconnecting cable assembly, refer to table 2-1 for connector pin functions at the interface card end of the cable. For information on cable fabrication, refer to paragraph 2-7.

5-7. REPLACING RESISTOR R155.

5-8. Resistor R155 is located at the output of the -10 volt regulated supply and is used to scale the precision voltage applied to the current summing network. To replace resistor R155, proceed as follows:

- a. Turn off power at computer and external analog device.
- b. Remove DAC interface card from computer and remove existing R155 from interface card.
- c. Install an extender card in the DAC interface card slot and then install the interface card in the extender card.
- d. Turn on power at computer and external analog device and the output 17777 to the interface card.
- e. Measure the voltage (V_o) between the base of Q1A and ground.
- f. Locate the value of V_o in table on figure 5-2 that is nearest to the value measured in step "e".
- g. Turn off power at computer and external analog device.
- h. Remove DAC interface card and extender card from computer.
- i. Install a new resistor R155, on the interface card, with a resistance value corresponding to the measured value of V_o .
- j. Install interface card in computer.

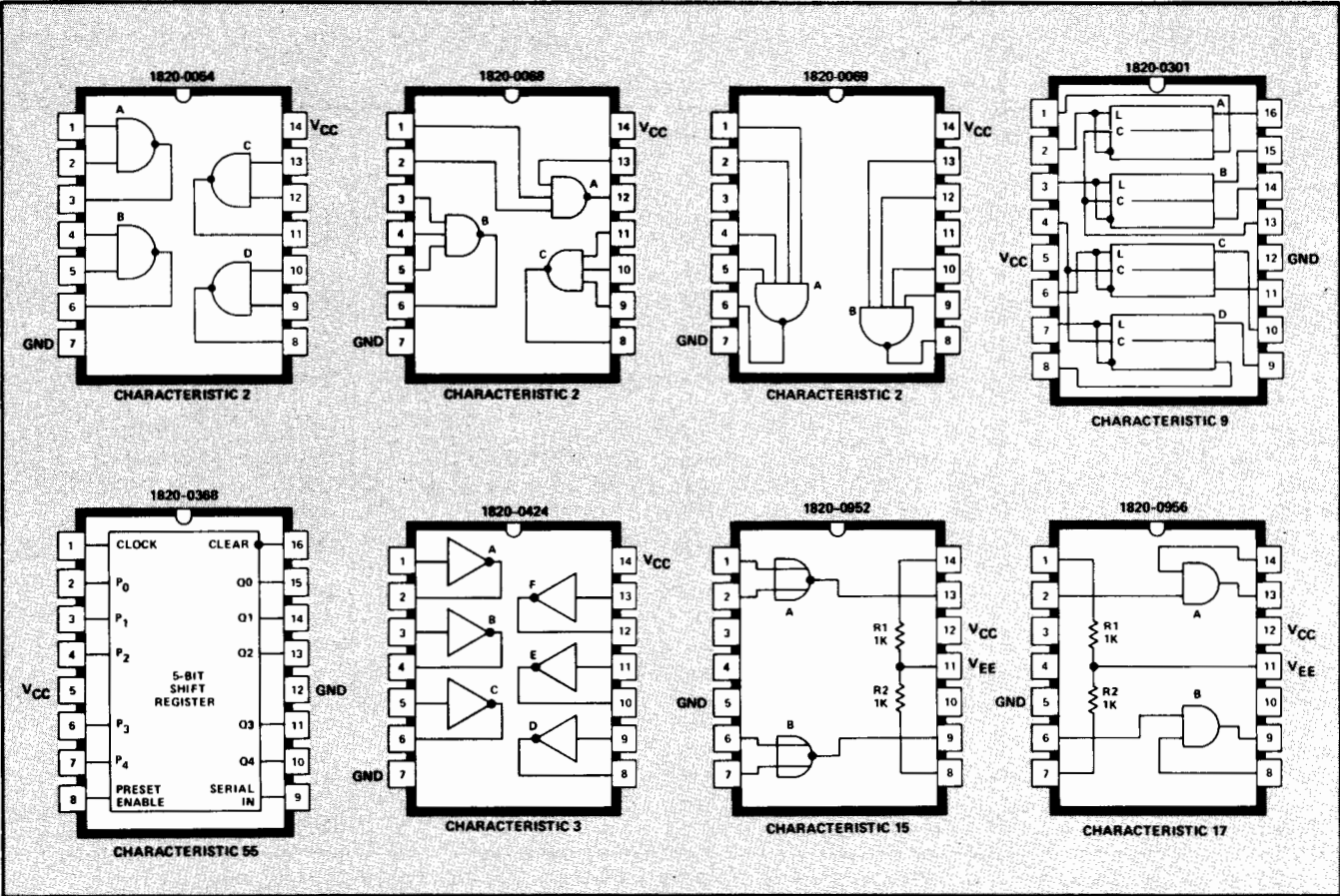
Table 5-1. DAC Interface Card Replaceable Parts

REFERENCE DESIGNATION	HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.
C1,4	0160-2307	Capacitor, Fxd, Mica, 47 pF, 5%, 300 VDCW	28480	0160-2307
C2	0160-0161	Capacitor, Fxd, My, 0.01 uF, 10%, 200 VDCW	56289	192P10392-PTS
C3	0180-0230	Capacitor, Fxd, Elect, 1.0 uF, 20%, 50 VDCW	56289	150D105X0050A2-DYS
C5,6	0180-0196	Capacitor, Fxd, Elect, 56 uF, 10%, 15 VDCW	28480	0180-0196
C7,11	0180-1747	Capacitor, Fxd, Elect, 150 uF, 20%, 15 VDCW	28480	0180-1747
C8,12	0180-1714	Capacitor, Fxd, Elect, 330 uF, 10%, 6 VDCW	28480	0180-1714
C9*,20,21	0180-0161	Capacitor, Fxd, Elect, 3.3 uF, 20%, 35 VDCW	56289	150D335X0035B2-DYS
C10, C13 thru C18	0180-0291	Capacitor, Fxd, Elect, 1.0 uF, 10%, 35 VDCW	56289	150D105X9035A2-DYS
C19	0160-0134	Capacitor, Fxd, Mica, 220 pF, 5%, 300 VDCW	14655	RDM15F221J3C
CR1	1901-0048	Diode, Breakdown, 6.81V, 5%	04713	SZ10939-134
CR2 thru CR35, CR37 thru CR39, 43,44	1901-0040	Diode, Si, 30 mA, 30 WV	07263	FDG1088
CR36	1902-3103	Diode, Breakdown, 5.62V, 10%	28480	1902-3103
CR40	1902-0777	Diode, Breakdown, 6.2V, 5%	04713	IN825
CR41	1901-0460	Diode, Si, 3-junction stabistor	03508	STB523
CR42	1901-0025	Diode, Si, 100 mA, 1.0V	07263	FD2387
E5,6	1205-0037	Heat Sink, Transistor	28480	1205-0037
Q1,6,46	1854-0221	Transistor, Si, NPN	28480	1854-0221
Q2,5	1853-0281	Transistor, Si, PNP	05292	2N2907A
Q3,4, Q23 thru Q38,47	1853-0036	Transistor, Si, PNP	80131	2N3906
Q7 thru Q22	1854-0246	Transistor, Si, NPN	80131	2N3643
Q39 thru Q43	1854-0215	Transistor, Si, NPN	80131	2N3904
Q44,45	1853-0058	Transistor, Si, PNP	80131	2N3644
Q48	1854-0072	Transistor, Si, NPN	80131	2N3054
R1,14	0757-0159	Resistor, Fxd, Flm, 1k, 1%, 1/2W	28480	0757-0159
R2,16	0757-0438	Resistor, Fxd, Flm, 5.11k, 1%, 1/8W	28480	0757-0438
R3,15,30,37	0698-6670	Resistor, Fxd, Flm, 1k, 0.5%, 1/8W	28480	0698-6670
R4,11,13	0757-0398	Resistor, Fxd, Flm, 75 ohms, 1%, 1/8W	28480	0757-0398
R5,146,149,157	0698-0085	Resistor, Fxd, Flm, 2.61k, 1%, 1/8W	28480	0698-0085
R6	0757-0278	Resistor, Fxd, Flm, 1.78k, 1%, 1/8W	28480	0757-0278
R7,12	0757-0290	Resistor, Fxd, Flm, 6.19k, 1%, 1/8W	28480	0757-0290
R8	0757-0838	Resistor, Fxd, Flm, 9.09k, 1%, 1/2W	28480	0757-0838
R9,51,53,55,57,59,61,63,65,67, 69,71,73,75,77,79,81	0757-0399	Resistor, Fxd, Flm, 82.5 ohms, 1%, 1/8W	28480	0757-0399
R10	0757-0817	Resistor, Fxd, Flm, 750 ohms, 1%, 1/2W	28480	0757-0817
R17,19,21,23,25,27,40,42,44,46, 48,50, R134 thru R138,147,154	0757-0280	Resistor, Fxd, Flm, 1k, 1%, 1/8W	28480	0757-0280
R18,49	0698-6675	Resistor, Fxd, Flm, 255k, 1%, 1/8W	28480	0698-6675
R20,47	0698-6674	Resistor, Fxd, Flm, 127k, 1%, 1/8W	28480	0698-6674
R22,45	0698-6673	Resistor, Fxd, Flm, 63k, 1%, 1/8W	28480	0698-6673
R24,43	0698-6672	Resistor, Fxd, Flm, 31k, 1%, 1/8W	28480	0698-6672
R26,41	0698-6678	Resistor, Fxd, Flm, 15k, 0.5%, 1/8W	28480	0698-6678
R28,39	0698-6671	Resistor, Fxd, Flm, 7k, 0.25%, 1/8W	28480	0698-6671
R29,38	0698-6676	Resistor, Fxd, Flm, 3k, 1%, 1/8W	28480	0698-6676
R31,32,35,36	0698-6677	Resistor, Fxd, Flm, 1k, 0.05%, 3/20W	28480	0698-6677
R33,34	0757-0200	Resistor, Fxd, Flm, 5.62k, 1%, 1/8W	28480	0757-0200
R52,54,56,58,60,62,64,66,68,70, 72,74,76,78,80,82	0757-0178†	Resistor, Fxd, Flm, 100 ohms, 1%, 1/4W	28480	0757-0178
R83,86,89,92,95,98,101,104, 107,110,113,116,119,122, 125,128,133,141	0698-3155	Resistor, Fxd, Flm, 4.64k, 1%, 1/8W	28480	0698-3155
R84,87,90,93,96,99,102,105, 108,111,114,117,120,123, 126,129	0698-3132	Resistor, Fxd, Flm, 261 ohms, 1%, 1/8W	28480	0698-3132
R131*, R151	0757-0401	Resistor, Fxd, Flm, 100 ohms, 1%, 1/8W	28480	0757-0401

Table 5-1. DAC Interface Card Replaceable Parts (Continued)

REFERENCE DESIGNATION	HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.
R85,88,91,94,97,100,103,106, 109,112,115,118,121,124, 127,130,156	0757-0274	Resistor, Fxd, Flm, 1.21k, 1%, 1/8W	28480	0757-0274
R132	0698-3444	Resistor, Fxd, Flm, 316 ohms, 1%, 1/8W	28480	0698-3444
R139	0757-0442	Resistor, Fxd, Flm, 10k, 1%, 1/8W	28480	0757-0442
R140,148,159	0757-0416	Resistor, Fxd, Flm, 511 ohms, 1%, 1/8W	28480	0757-0416
R142,144,150	0698-0082	Resistor, Fxd, Flm, 464 ohms, 1%, 1/8W	28480	0698-0082
R152	0757-0444	Resistor, Fxd, Flm, 12.1k, 1%, 1/8W	28480	0757-0444
R153	0757-0419	Resistor, Fxd, Flm, 681 ohms, 1%, 1/8W	28480	0757-0419
R155	refer to para. 5-7	Resistor, Fxd, Flm, Selected Value, 1%, 1/8W	28480	refer to para. 5-7
R158	0757-0418	Resistor, Fxd, Flm, 619 ohms, 1%, 1/8W	28480	0757-0418
R160 thru R164	1810-0020	Resistor, Network, 1.5k (7 fxd flm resistors)	28480	1810-0020
R165	0698-0084	Resistor, Fxd, Flm, 2.15k, 1%, 1/8W	28480	0698-0084
R166,167	0757-0424	Resistor, Fxd, Flm, 1.10k, 1%, 1/8W	28480	0757-0424
R168,169	0698-7219	Resistor, Fxd, Flm, 196 ohms, 2%, 1/8W	28480	0698-7219
U16,17,77	1820-0956	Integrated Circuit, CTL	07263	U6A995679X
U26,27,37,76,96,116	1820-0054	Integrated Circuit, TTL	01295	SN7400N
U36,46,106	1820-0068	Integrated Circuit, TTL	01295	SN7410N
U47	1820-0069	Integrated Circuit, TTL	01295	SN7420N
U56	1820-0368	Integrated Circuit, TTL	01295	SN7496N
U57	1820-0424	Integrated Circuit, TTL	01295	SN74H04N
U86	1820-0952	Integrated Circuit, CTL	07263	U6A995279X
U87,97,107,117	1820-0301	Integrated Circuit, TTL	01295	SN7475N
W2 thru W4	8159-0005	Jumper Wire	28480	8159-0005

*When used with storage-type devices, the value of C9 and R131 may be changed to increase the Erase signal pulse width.
†Part no. 0757-0178 first used on card rev. 1138. Card rev. 1101 uses 1/8W resistor, part no. 0757-0401.

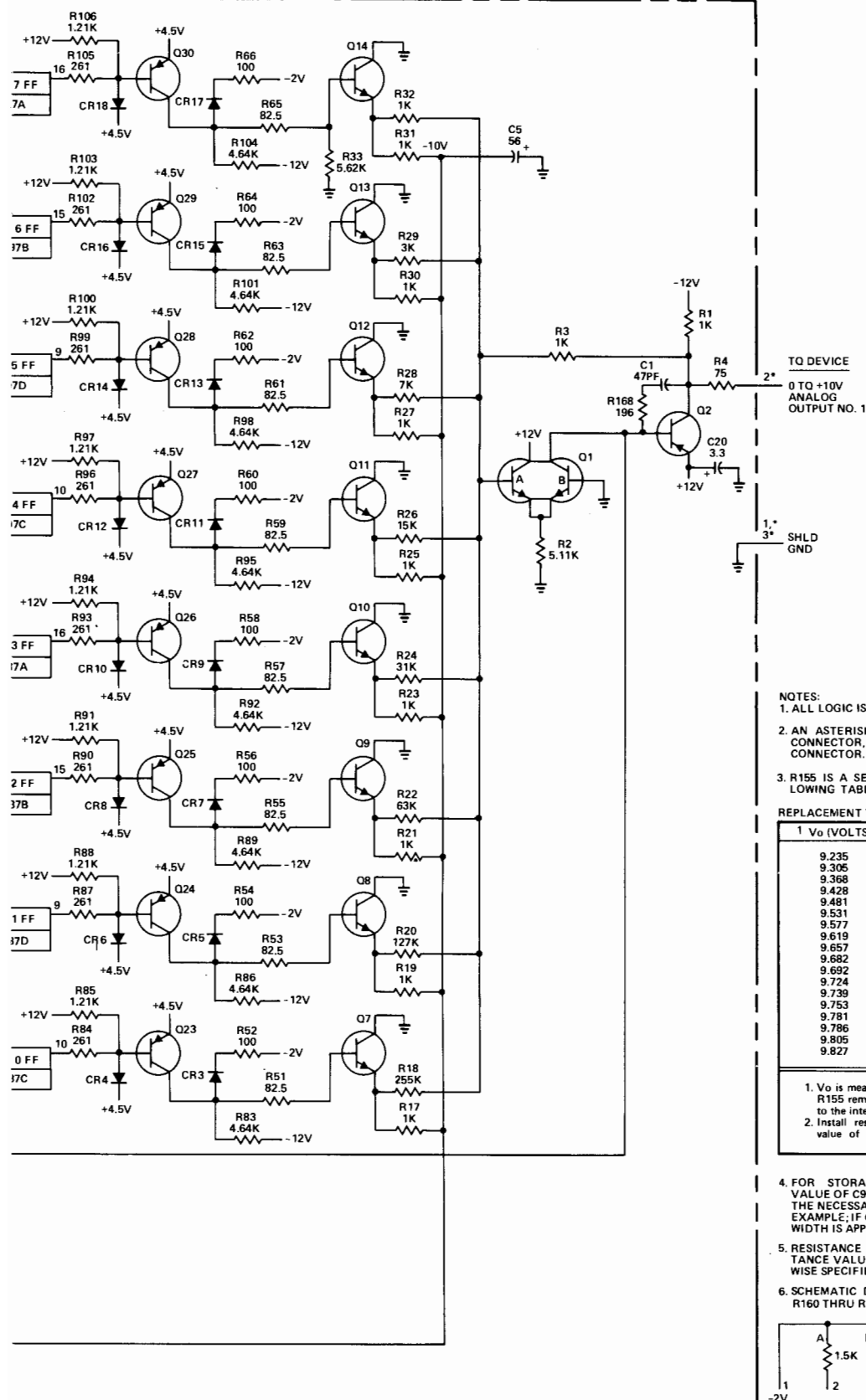


2151-7

Figure 5-1. Integrated Circuit Diagrams

Table 5-2. Integrated Circuit Characteristics

CHARACTERISTIC	INPUT LEVEL		OUTPUT LEVEL		OPEN INPUT ACTS AS:	MAXIMUM PROPAGATION DELAY	
	LOGIC 1 (VOLTS, MIN)	LOGIC 0 (VOLTS, MAX)	LOGIC 1 (VOLTS, MIN)	LOGIC 0 (VOLTS, MAX)		TO LOGIC 1 (NANOSECONDS)	TO LOGIC 0 (NANOSECONDS)
2	+2.0	+0.8	+2.4	+0.4	Logic 1	29	15
3	+2.0	+0.8	+2.4	+0.4	Logic 1	12	10
9	+2.0	+0.8	+2.4	+0.4	Logic 1	40	25
15	+1.25	+0.5	+2.35	-0.5	Logic 0	14	12
17	+1.25	+0.5	+2.25	-0.36	Logic 0	18	18
55	+2.0	+0.8	+2.4	+0.4	Logic 1	25	25



NOTES:

1. ALL LOGIC IS POSITIVE TRUE.
2. AN ASTERISK (*) DENOTES PINS ON THE 48-PIN CONNECTOR, ALL OTHER PINS ARE ON THE 86-PIN CONNECTOR.
3. R155 IS A SELECTED PART, REFER TO THE FOLLOWING TABLE.

REPLACEMENT VALUES FOR RESISTOR R155

1 Vo (VOLTS)	2 RESISTANCE	HP PART NO.
9.235	4.64K	0698-3155
9.305	5.11K	0757-0438
9.368	5.62K	0757-0200
9.428	6.19K	0757-0290
9.481	6.81K	0757-0439
9.531	7.50K	0757-0440
9.577	8.25K	0757-0441
9.619	9.09K	0757-0228
9.657	10.0K	0757-0442
9.682	10.7K	0698-4478
9.692	11.0K	0757-0443
9.724	12.1K	0757-0444
9.739	12.7K	0698-3357
9.753	13.3K	0757-0287
9.781	14.7K	0698-3156
9.786	15.0K	0757-0446
9.805	16.2K	0757-0447
9.827	17.8K	0698-3136

1. Vo is measured between Q1A-BASE and ground with R155 removed and an output of 17777 programmed to the interface card.
2. Install resistance value corresponding to measured value of Vo. Resistors are Fxd, Fim, 1%, 1/8W.

4. FOR STORAGE OSCILLOSCOPES, CHANGE THE VALUE OF C9 AND R131 AS REQUIRED TO PROVIDE THE NECESSARY ERASE SIGNAL PULSE WIDTH. FOR EXAMPLE, IF C9 IS CHANGED TO 100 MF, THE PULSE WIDTH IS APPROXIMATELY 0.5 SECOND.

5. RESISTANCE VALUES ARE IN OHMS AND CAPACITANCE VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

6. SCHEMATIC DIAGRAM FOR RESISTOR NETWORKS R160 THRU R164:

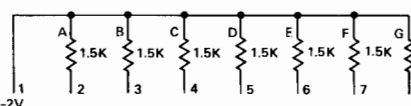
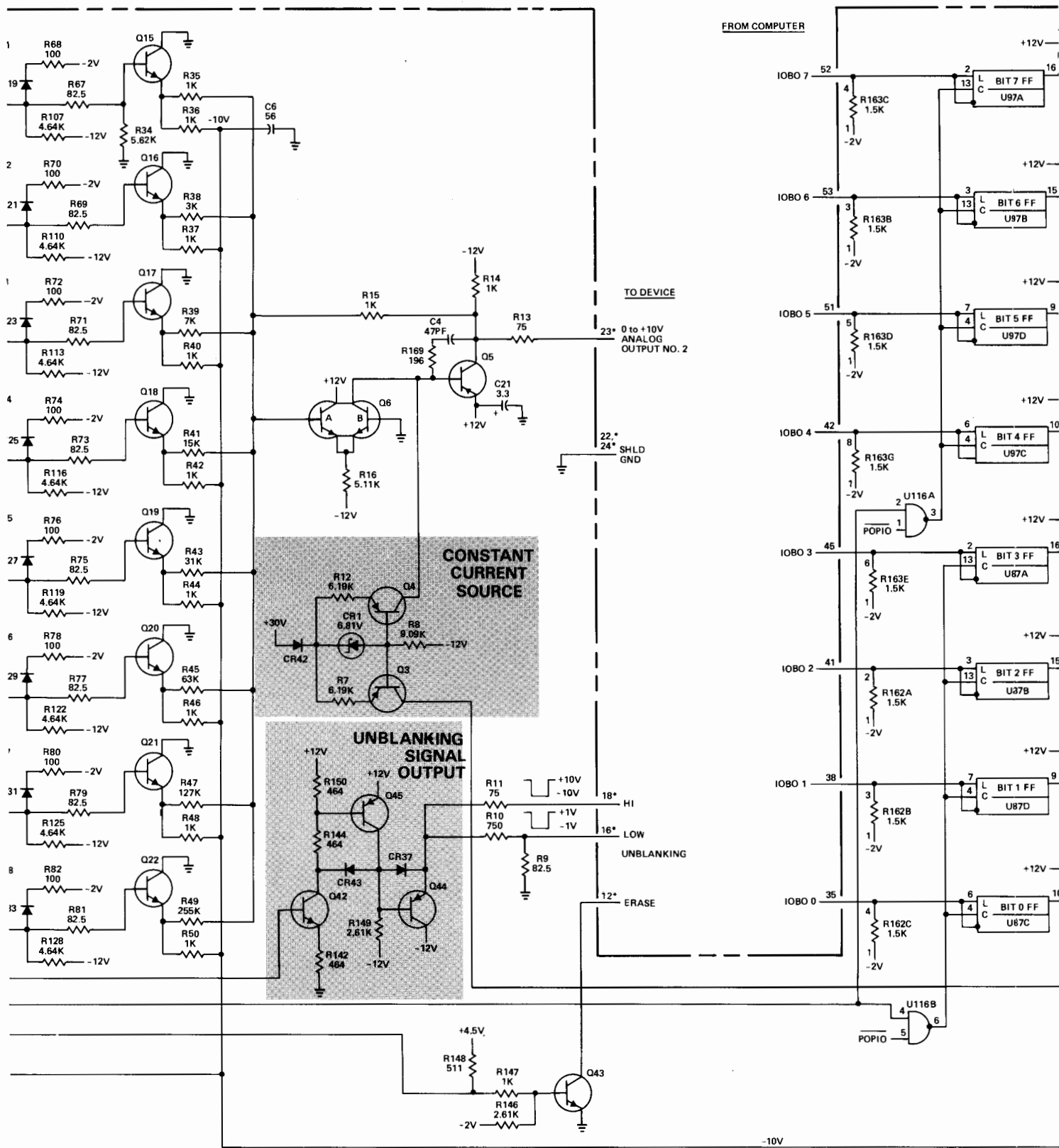
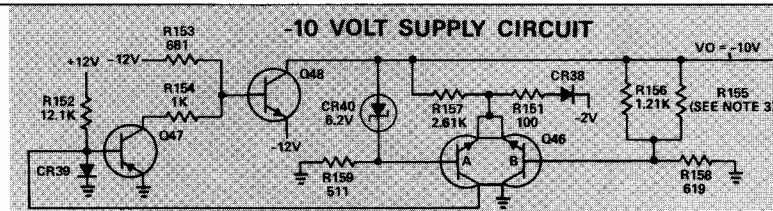
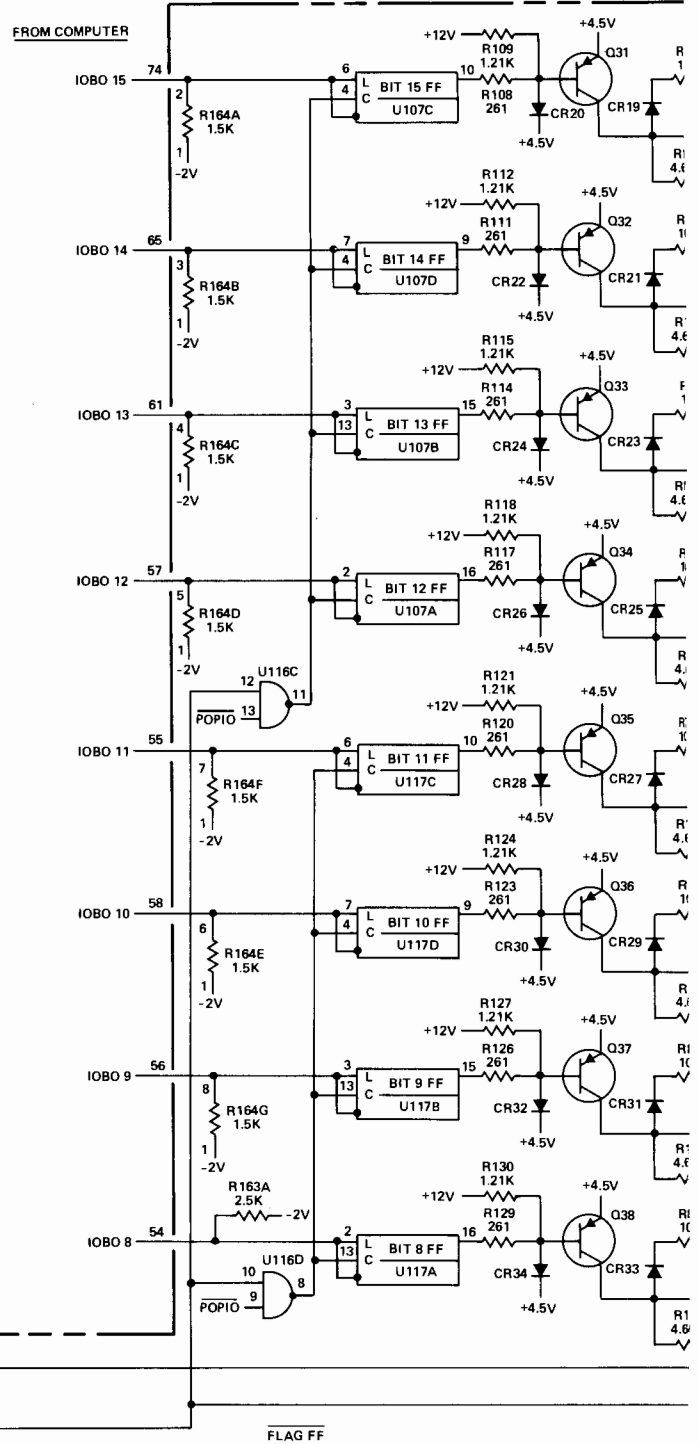
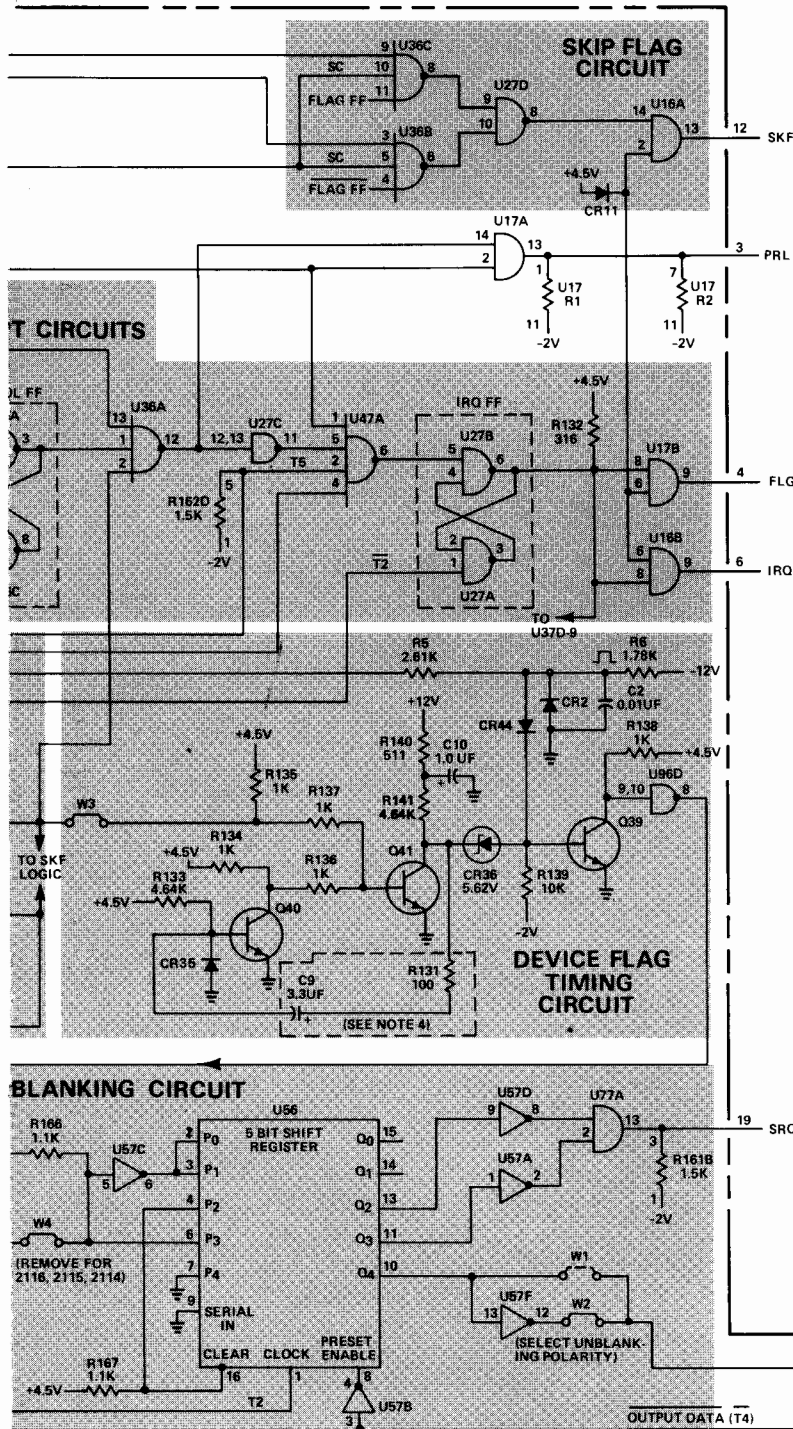
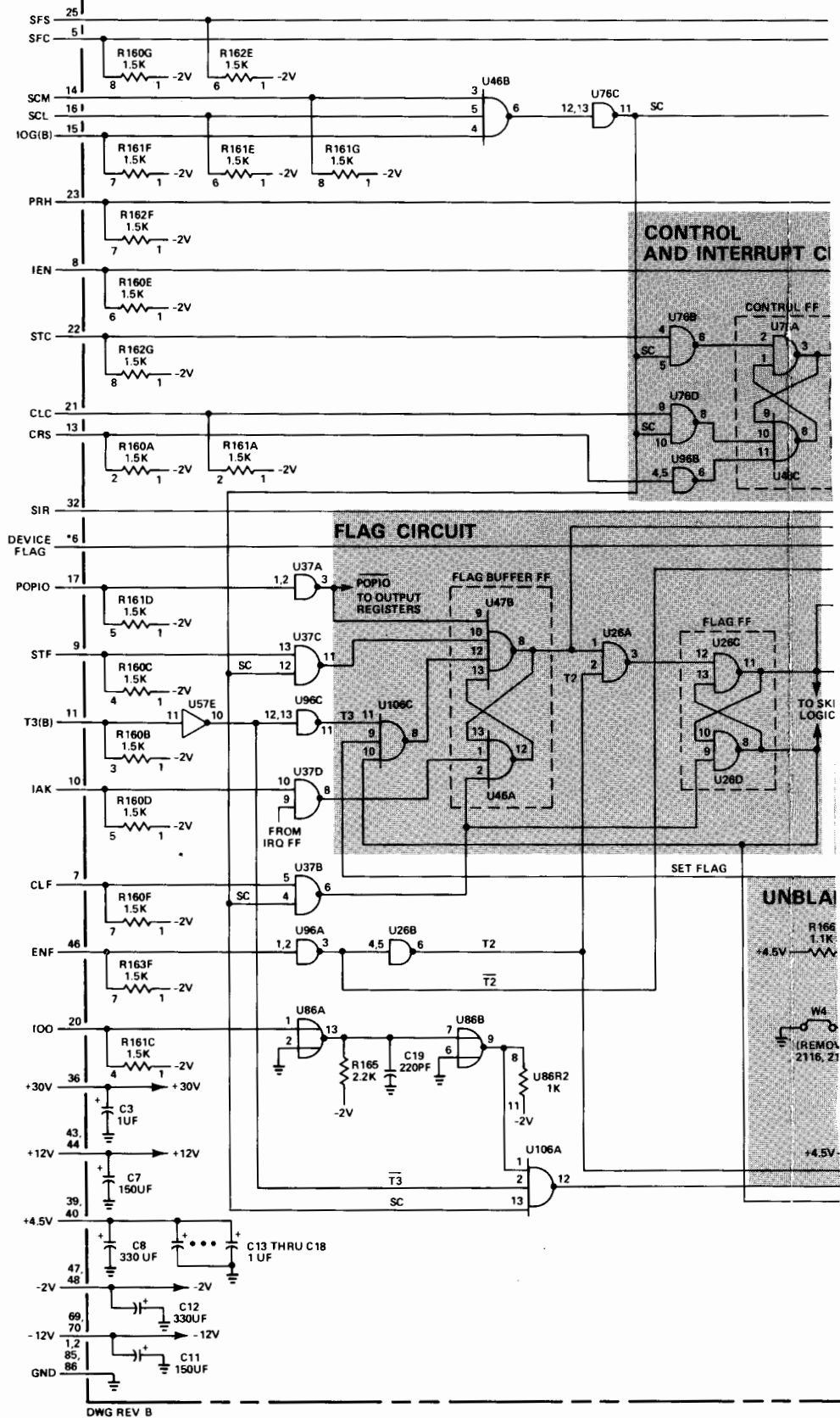


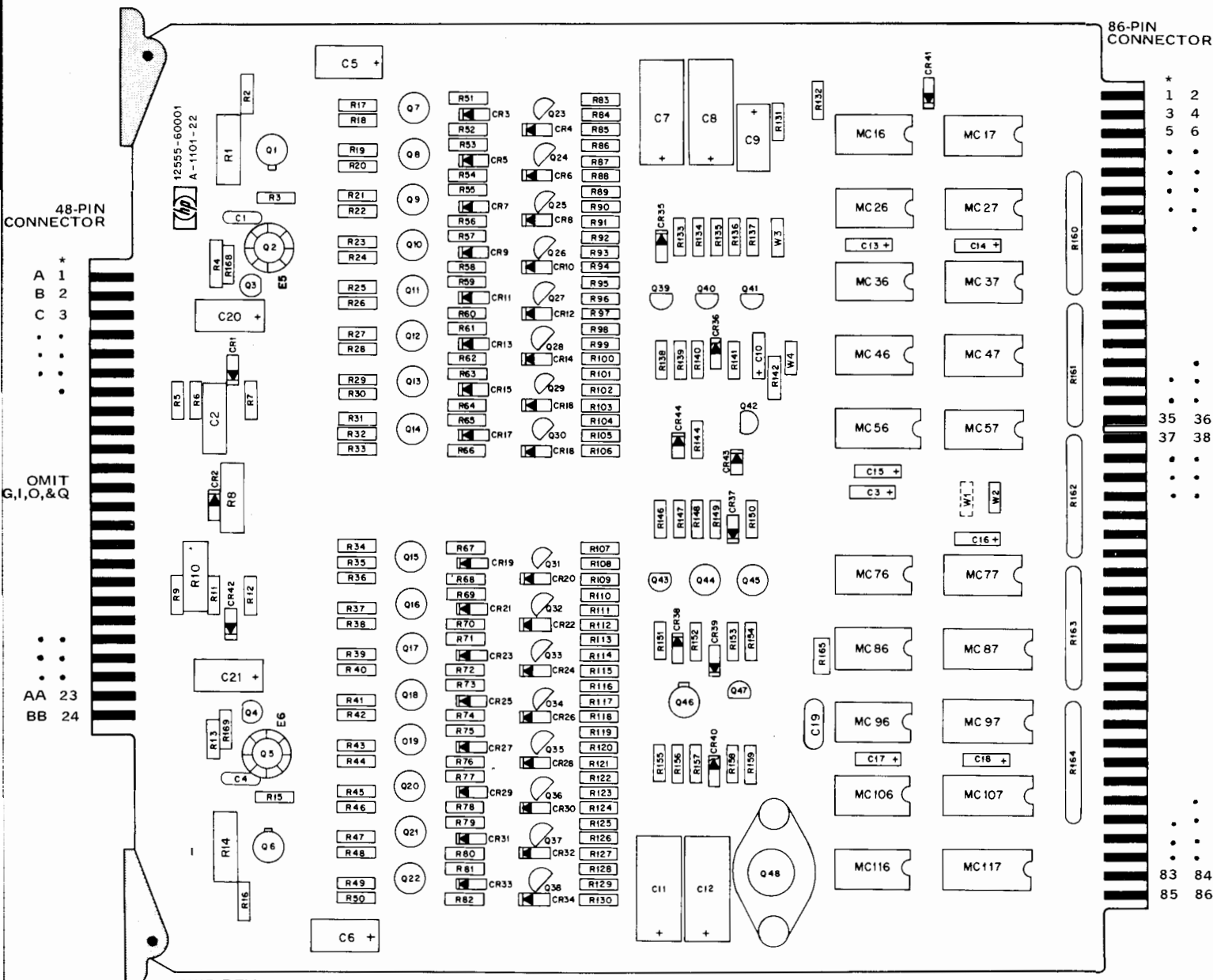
Figure 5-2. Digital-to-Analog Converter Interface Card
Schematic Diagram and Parts Location View





DIGITAL-TO-ANALOG CONVERTER INTERFACE CARD (12555-60001, REV. 1101 AND 11





* DENOTES COMPONENT SIDE OF CARD FOR 48 AND 86-PIN CONNECTOR DESIGNATIONS.
THIS DIAGRAM ALSO APPLIES TO CARD REV. A-1138-22

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section provides information for ordering replacement parts for the HP 12555B Digital-to-Analog Converter Interface Kit. Table 6-1 lists parts in alpha-numeric order by HP part numbers and gives the total quantity for each replaceable part in the interface kit. A replaceable parts list (table 5-1) and parts location diagram (figure 5-2) for the interface card are provided in Section V of this manual.

6-3. Tables 5-1 and 6-1 provide the following information for each replaceable part:

a. Reference designation of the part (table 5-1 only). (Refer to table 6-3 for an explanation of the abbreviations used in the REFERENCE DESIGNATION column.)

b. Hewlett-Packard part number.

c. Description of the part. (Refer to table 6-3 for an explanation of the abbreviations used in the DESCRIPTION column.)

d. A five digit code identifying the manufacturer of the part. (Refer to table 6-2 for a code list of manufacturers.)

e. Manufacturer's part number.

f. Total quantity (TQ) of each part used in the kit or assembly (table 6-1 only).

6-4. ORDERING INFORMATION.

6-5. To order replacement parts, address the order or inquiry to the nearest Hewlett-Packard Sales and Service Office. Refer to the list at the back of this manual for addresses. Specify the following information for each part ordered:

a. Identification of the instrument, kit, or assembly containing the part.

b. Hewlett-Packard part number for each part.

c. Description of each part.

d. Circuit reference designation for each part (if applicable).

Table 6-1. DAC Interface Kit Numerical Listing of Replaceable Parts

HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	TQ
0160-0134	Capacitor, Fxd, Mica, 220 pF, 5%, 300 VDCW	14655	RDM15F221J3C	1
0160-0161	Capacitor, Fxd, My, 0.01 uF, 10%, 200 VDCW	56289	192P10392-PTS	1
0160-2307	Capacitor, Fxd, Mica, 47 pF, 5%	28480	0160-2307	2
0180-0161	Capacitor, Elect, 3.3 uF, 20%, 35 VDCW (Note 2)	56289	150D335X0035B2-DYS	3
0180-0196	Capacitor, Fxd, Elect, 56 uF, 10%, 15 VDCW	28480	0180-0196	2
0180-0230	Capacitor, Fxd, Elect, 1.0 uF, 20%, 50 VDCW	56289	150D105X0050A2-DYS	1
0180-0291	Capacitor, Fxd, Elect, 1.0 uF, 10%, 35 VDCW	56289	150D105X9035A2-DYS	7
0180-1714	Capacitor, Fxd, Elect, 330 uF, 10%, 6 VDCW	28480	0180-1714	2
0180-1747	Capacitor, Fxd, Elect, 150 uF, 20%, 15 VDCW	28480	0180-1747	2
0698-0082	Resistor, Fxd, Flm, 464 ohms, 1%, 1/8W	28480	0698-0082	3
0698-0084	Resistor, Fxd, Flm, 2.15k, 1%, 1/8W	28480	0698-0084	1
0698-0085	Resistor, Fxd, Flm, 2.61k, 1%, 1/8W	28480	0698-0085	4
0698-3132	Resistor, Fxd, Flm, 261 ohms, 1%, 1/8W	28480	0698-3132	16
0698-3155	Resistor, Fxd, Flm, 4.64k, 1%, 1/8W	28480	0698-3155	18
0698-3444	Resistor, Fxd, Flm, 316 ohms, 1%, 1/8W	28480	0698-3444	1
0698-6670	Resistor, Fxd, Flm, 1k, 0.5%, 1/8W	28480	0698-6670	4
0698-6671	Resistor, Fxd, Flm, 7k, 0.25%, 1/8W	28480	0698-6671	2
0698-6672	Resistor, Fxd, Flm, 31k, 1%, 1/8W	28480	0698-6672	2
0698-6673	Resistor, Fxd, Flm, 63k, 1%, 1/8W	28480	0698-6673	2
0698-6674	Resistor, Fxd, Flm, 127k, 1%, 1/8W	28480	0698-6674	2
0698-6675	Resistor, Fxd, Flm, 255k, 1%, 1/8W	28480	0698-6675	2
0698-6676	Resistor, Fxd, Flm, 3k, 1%, 1/8W	28480	0698-6676	2
0698-6677	Resistor, Fxd, Flm, 1k, 0.05%, 3/20W	28480	0698-6677	4
0698-6678	Resistor, Fxd, Flm, 15k, 0.5%, 1/8W	28480	0698-6678	2
0698-7219	Resistor, Fxd, Flm, 196 ohms, 2%, 1/8W	28480	0698-7219	2
0757-0159	Resistor, Fxd, Flm, 1k, 1%, 1/2W	28480	0757-0159	2
0757-0178	Resistor, Fxd, Flm, 100 ohms, 1%, 1/4W	28480	0757-0178	(NOTE 3)
0757-0200	Resistor, Fxd, Flm, 5.62k, 1%, 1/8W	28480	0757-0200	2
0757-0274	Resistor, Fxd, Flm, 1.21k, 1%, 1/8W	28480	0757-0274	17
0757-0278	Resistor, Fxd, Flm, 1.78k, 1%, 1/8W	28480	0757-0278	1
0757-0280	Resistor, Fxd, Flm, 1k, 1%, 1/8W	28480	0757-0280	19
0757-0290	Resistor, Fxd, Flm, 6.19k, 1%, 1/8W	28480	0757-0290	2
0757-0398	Resistor, Fxd, Flm, 75 ohms, 1%, 1/8W	28480	0757-0398	3
0757-0399	Resistor, Fxd, Flm, 82.5 ohms, 1%, 1/8W	28480	0757-0399	17
0757-0401	Resistor, Fxd, Flm, 100 ohms, 1%, 1/8W (Note 2)	28480	0757-0401	(NOTE 4)
0757-0416	Resistor, Fxd, Flm, 511 ohms, 1%, 1/8W	28480	0757-0416	3
0757-0418	Resistor, Fxd, Flm, 619 ohms, 1%, 1/8W	28480	0757-0418	1
0757-0419	Resistor, Fxd, Flm, 681 ohms, 1%, 1/8W	28480	0757-0419	1
0757-0424	Resistor, Fxd, Flm, 1.10k, 1%, 1/8W	28480	0757-0424	2
0757-0438	Resistor, Fxd, Flm, 75 ohms, 1%, 1/8W	28480	0757-0438	2
0757-0442	Resistor, Fxd, Flm, 10k, 1%, 1/8W	28480	0757-0442	1
0757-0444	Resistor, Fxd, Flm, 12.1k, 1%, 1/8W	28480	0757-0444	1
0757-0817	Resistor, Fxd, Flm, 750 ohms, 1%, 1/2W	28480	0757-0817	1
0757-0838	Resistor, Fxd, Flm, 9.09k, 1%, 1/2W	28480	0757-0838	1
1205-0037	Heat Sink, Transistor	28480	1205-0037	2
1810-0020	Resistor Network, 1.5k (7 fxd flm resistors)	28480	1810-0020	5
1820-0054	Integrated Circuit, TTL	01295	SN7500N	6
1820-0068	Integrated Circuit, TTL	01295	SN7410N	3
1820-0069	Integrated Circuit, TTL	01295	SN7420N	1
1820-0424	Integrated Circuit, TTL	01295	SN74H04N	1
1820-0301	Integrated Circuit, TTL	01295	SN7475N	4

Table 6-1. DAC Interface Kit Numerical Listing of Replaceable Parts (Continued)

HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	TQ
1820-0368	Integrated Circuit, TTL	01295	SN7496N	1
1820-0952	Integrated Circuit, CTL	02763	U6A995279X	1
1820-0956	Integrated Circuit, CTL	07263	U6A995679X	3
1853-0036	Transistor, Si, PNP	80131	2N3906	19
1853-0058	Transistor, Si, PNP	80131	2N3644	2
1853-0281	Transistor, Si, PNP	05292	2N2907A	2
1854-0072	Transistor, Si, NPN	80131	2N3054	1
1854-0215	Transistor, Si, NPN	80131	2N3904	5
1854-0221	Transistor, Dual, Si, NPN	21845	1854-0221	3
1854-0246	Transistor, Si, NPN	80131	2N3643	16
1901-0025	Diode, Si, 100 mA, 1.0V	07263	FD2387	1
1901-0040	Diode, Si, 30 mA, 30WV	07263	FDG1088	39
1901-0460	Diode, Si, 3-Junction Stabistor	03508	STB523	1
1902-0048	Diode, Breakdown, 6.81V, 5%	04713	SZ10939-134	1
1902-0777	Diode, Breakdown, 6.2V, 5%	04713	1N825	1
1902-3103	Diode, Breakdown, 5.62V, 10%	28480	1902-3103	1
8159-0005	Jumper Wire	28480	8159-0005	3
5060-8340	Connector Kit	28480	5060-8318	1
12555-60001	Digital-to-Analog Converter Interface Card	28480	12555-60001	1
12555-90063	Operating and Service Manual	28480	12555-90063	1

NOTES:

1. Resistor R155 is listed separately on figure 5-2.
2. Capacitor C9 (0180-0161) and resistor R131 (0757-0401) may have different values and part numbers when this interface kit is used with storage-type devices.
3. TQ is 16 for card rev. 1138 and subsequent; 0 for card rev. 1101.
4. TQ is 2 for card rev. 1138 and subsequent; 18 for card rev. 1101.

Table 6-2. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 and H4-2, and the latest supplements.					
Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
01295	Texas Instruments, Inc., Semiconductor-Components Division	Dallas, Texas	07263	Fairchild Camera & Instrument Corp., Semiconductor Division	Mountain View, Calif.
03508	General Electric Company, Semiconductor Products Dept.	Syracuse, N.Y.	14655	Cornell-Dubilier Electric Corp.	Newark, N.J.
04713	Motorola Semiconductor Products, Inc.	Phoenix, Ariz.	21845	Soliton Devices, Incorporated	
05292	International Telephone and Telegraph Corp. Components Division	Clifton, N.J.	28480	Transistor Division	Riviera Beach, Fla.
			56289	Hewlett-Packard Company	Palo Alto, Calif.
			80131	Sprague Electric Company	North Adams, Mass.
				Electronic Industries Asso.	Washington, D.C.

Table 6-3. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS		
A = assembly B = motor, synchro BT = battery C = capacitor CB = circuit breaker CR = diode DL = delay line DS = indicator E = Misc electrical parts F = fuse FL = filter J = receptacle connector	K = relay L = inductor M = meter MC = microcircuit P = plug connector Q = semiconductor device other than diode or microcircuit R = resistor RT = thermistor S = switch T = transformer	TB = terminal board TP = test point U = integrated circuit, non-repairable assembly V = vacuum tube, photocell, etc. VR = voltage regulator W = cable, jumper X = socket Y = crystal Z = tuned cavity, network
ABBREVIATIONS		
A = amperes ac = alternating current ad = anode Al = aluminum AR = as required adj = adjust assy = assembly B = base bp = bandpass blk = black blu = blue brn = brown brs = brass Btu = British thermal unit Be Cu = beryllium copper C = collector cw = clockwise ccw = counterclockwise cer = ceramic cmo = cabinet mount only com = common crt = cathode-ray tube CTL = complementary-transistor logic cath = cathode cd pl = cadmium plate Comp = composition conn = connector compl = complete dc = direct current dr = drive DTL = diode-transistor logic depc = deposited carbon dpdt = double-pole, double-throw dpst = double-pole, single-throw E = emitter ECL = emitter-coupled logic ext = external encap = encapsulated elctlt = electrolytic F = farads FF = flip-flop flh = flat head Fim = film Fxd = fixed filh = fillister head G = giga (10^9) Ge = germanium gl = glass gnd = ground(ed)	gra = gray grn = green H = henries Hg = mercury hr = hour(s) Hz = hertz hdw = hardware hex = hexagon, hexagonal ID = inside diameter IF = intermediate frequency in. = inch, inches I/O = input/output int = internal incl = include(s) insul = insulation, insulated impgrg = impregnated incand = incandescent k = kilo (10^3), kilohm lp = low pass m = milli (10^{-3}) M = mega (10^6), megohm My = Mylar mfr = manufacturer mom = momentary mtg = mounting misc = miscellaneous Met Ox = metal oxide mintr = miniature n = nano (10^{-9}) n.c. = normally closed or no connection Ne = neon no. = number n.o. = normally open np. = nickel plated NPN = negative-positive-negative NPO = negative-positive zero (zero temperature coefficient) NSR = not separately replaceable NRFR = not recommended for field replacement OD = outside diameter OBD = order by description orn = orange ovh = oval head oxd = oxide p = pico (10^{-12}) PC = printed circuit	ph = Phillips head pk = peak p-p = peak-to-peak pt = point PIV = peak inverse voltage PNP = positive-negative-positive PWV = peak working voltage porc = porcelain posn = position(s) pozi = pozidrive rf = radio frequency rdh = round head rmo = rack mount only rms = root-mean-square RWV = reverse working voltage rect = rectifier r/min = revolutions per minute RTL = resistor-transistor logic s = second SB = slow blow Se = selenium Si = silicon scr = silicon controlled rectifier sil = silver sst = stainless steel stl = steel spcl = special spdt = single-pole, double-throw spst = single-pole, single-throw semicond = semiconductor Ta = tantalum td = time delay Ti = titanium tgl = toggle thd = thread tol = tolerance TTL = transistor transistor logic U(μ) = micro (10^{-6}) V = volt(s) var = variable vio = violet VDCW = direct current working volts W = watts WW = wirewound wht = white WIV = working inverse voltage yel = yellow

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.



MANUAL PART NO. 12555-90063
MICROFICHE PART NO. 12555-90066

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