MANUAL SUPPLEMENT

SWEEP OSCILLATOR

H26–8690B

USE THIS SUPPLEMENT WITH
MANUAL PART NO. 08690-90007
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GENERAL DESCRIPTION

The H26 modification to the 8690B Sweep Oscillator consists of a Digital Frequency Controller mounted on the rear panel of the sweep oscillator chassis. Figure 1 shows the rear view of the modified instrument. Although the modification is designed specifically for use with the 8542 series of Automatic Network Analyzers, the H26-8690B may be used in other applications requiring digital programming of the sweep oscillator frequency. The Digital Frequency Controller performs four main functions; digital-to-analog (D/A) conversion to allow computer selection of the oscillator output frequency, auto-manual mode selection, provision for external phase lock, and provision to interconnect several system functions between the 8542 Junction Box and the 8705A Signal Multiplexer. The controller receives twelve binary-coded-decimal (BCD) inputs from the computer and converts the BCD to an equivalent analog voltage for use by the helix amplifier circuits in the sweep oscillator. When the sweep oscillator operates in the auto mode, the output frequency is computer controlled and the sweep and AM functions are disabled. In the manual mode of operation, the D/A converter is disconnected and the instrument is connected to operate from the normal front panel controls. The phase lock circuits are associated with the 8542A system phase lock loop which allows the system signal source to be phase locked to a highly accurate and stable reference frequency. The through connections between the 8542 Junction Box and the 8705A are included as a matter of convenience and are not directly related to the other functions.

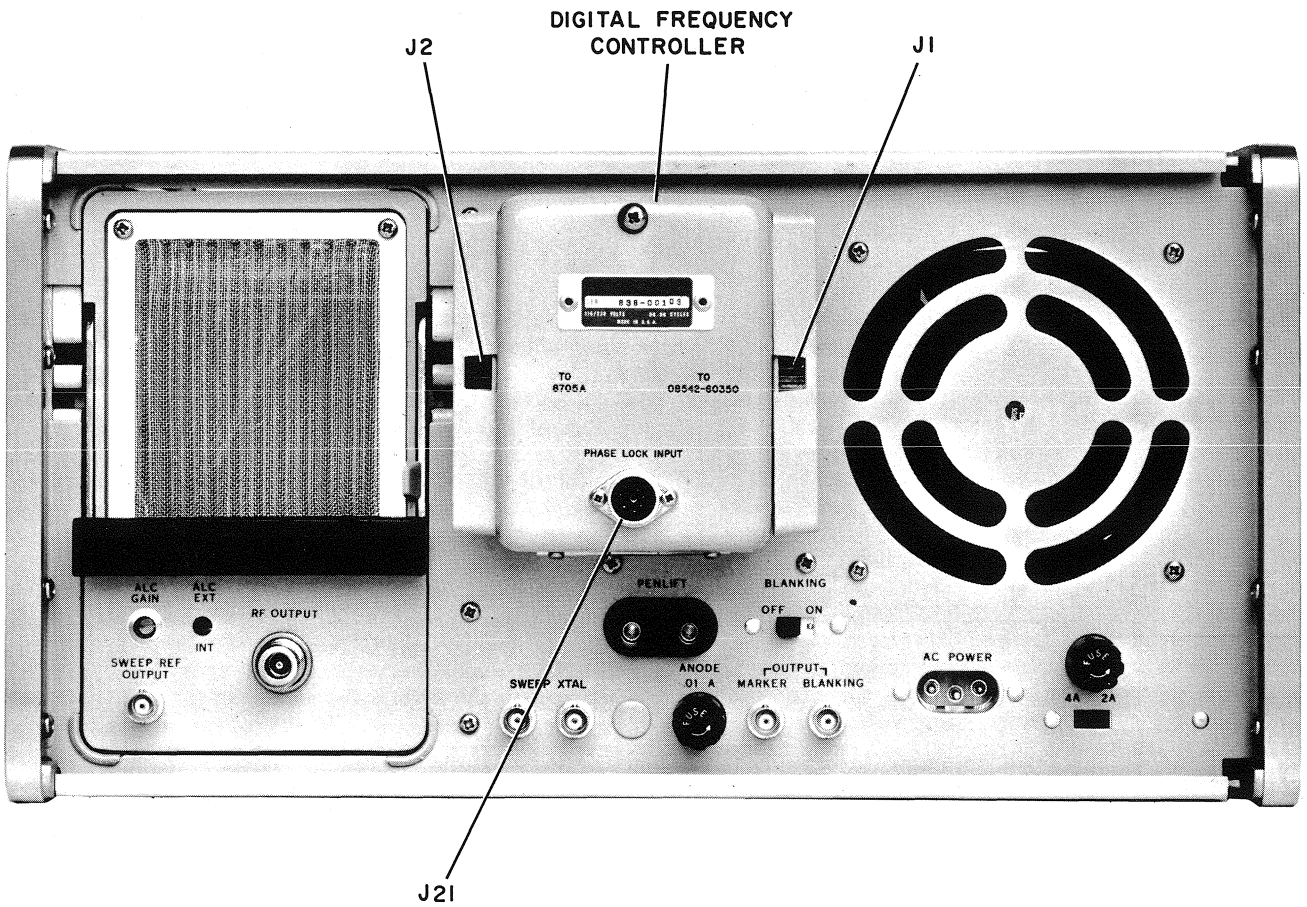

Figure 1. Model H26-8690B Rear View

OVERALL FUNCTIONAL DESCRIPTION

Figure 2 shows a simplified block diagram of the H26-8690B, a BWO RF Plug-In Unit, and system components in the phase-lock loop. When the system operates in the auto mode, the system computer supplies BCD data to the Digital Frequency Controller to coarse tune the frequency of the RF Plug-In to the desired value. The D/A Converter decodes the BCD data into an equivalent analog tuning voltage ranging from +3 volts to +73 volts. The use of 12 BCD inputs allows selection of 1000 discrete points across the frequency range of the RF Plug-In Unit. The D/A Converter output is routed to 8690B circuits which control the helix supply voltage. The operation of the unmodified 8690B circuits are covered in the Operating and Service Manual for the 8690B and should be referred to for a discussion of the unmodified circuitry. The output of the RF Plug-In connects to system components as shown in Figure 2. In the 8410 Network Analyzer, the output frequency is compared to harmonics of the H39-5105/8710 Reference Oscillator. If the RF Plug-In frequency is not properly phase-locked to the reference oscillator, the 8410 circuits supply an error signal to the phase lock amplifier in the Digital Frequency Controller. The error signal is combined with the feedback signal from the Frequency Shaping Assembly A2 and Voltage Follower A20 Q1-Q3 as shown in Figure 2. The combined signals connect to the feedback input of the Helix Differential Amplifier A4. The shaping assembly is a non-linear voltage divider feedback stick which causes an exponential helix voltage to be generated from a linear ramp input voltage. The error signal and feedback signal are essentially summed at the differential amplifier input. Voltage Follower A20 Q1-Q3 routes the voltage divider output to the differential amplifier and provides the proper high-frequency roll-off characteristics to prevent loop oscillation. A schematic diagram for A20 is included in Figure 8. The Digital Frequency controller also provides 10 direct through connections between the 8542 Junction Box and the 8705A Signal Multiplexer. These connections are not directly related to the H26-8690B and are covered in the 8542A System Manual. When the system operates in the manual mode, the auto/manual relay in the Digital Frequency Controller disconnects the D/A Converter and configures the 8690B to manual operation.

Figure 3 shows a phase-locked configuration using a YIG type of RF Plug-In Unit. Since an exponential drive is not required for YIG oscillators, the linear sweep ramp voltage is applied directly to YIG tuning circuits. A separate phase error output is provided by the 8410. The error signal feeds directly to the RF Plug-In and sums with the ramp voltage to correct the RF output frequency.

DIGITAL FREQUENCY CONTROLLER DESCRIPTION

The Digital Frequency Controller consists of Analog Assembly A21 and Digital Programming Assembly A22 both of which are located in the controller housing as shown in Figure 4. Figure 9 illustrates the schematic diagram for A21 and A22.

The controller serves as a D/A Converter, auto-manual control, and phase-lock interface between the 8690B and the system units. The digital input consists of 3 words in an 8-4-2-1 code corresponding to decimal 0 to 999. The D/A Converter provides an analog output ranging from +3 (decimal 0) to +73 volts (decimal 999). During the auto mode, the analog output drives the 8690B helix control circuits to change the BWO frequency. The analog output is linear over the 1000 bit range, so that each decimal selection corresponds to an analog output of 0.07 volt. As the analog output voltage increases, the BWO frequency increases proportionally. The frequency change per bit is 0.1% of the frequency range of the Plug-In Unit for the sweep oscillator. When an 8699B Plug-In Unit is used, the low frequency range is considered to be 0 to 2 GHz even though the unit can only generate a 0.1 to 2 GHz output. For 8699B frequency output calculations, the 0.1% per bit should be multiplied by a 0 to 2 GHz frequency range. The system auto-manual circuits are controlled by an open or ground signal from the system control panel. When a ground signal is received, the circuits switch to automatic and connect the D/A Converter output to the helix control circuits and also disable the sweep and AM functions. During the system manual mode, the control circuits enable the sweep and AM functions, disconnect the D/A Converter output, and connect the manual helix tuning voltage to the helix amplifier.

Digital Assembly A22 contains diode logic stages which accept the 3-word input from the computer. As an example of operation, assume that the computer supplies a BCD output corresponding to decimal 972. In BCD form, the input decoder receives a 1001-0111-0010 so that grounds are applied to the following input lines; X800, X100, X40, X20, X10, and X2 (see Figure 9, sheet 1). For an example of diode logic operation, consider the operation of CR1 and CR2 when a 0 bit is applied to the X800 line. With a 0 bit (open) on the X800 input, CR1 conducts. Since R13 is considerably larger than R1, CR2 is reverse biased to disconnect R13 from the summing point input of IC1. With a 1 bit (ground) applied to the X800 input line, CR1 cuts off, CR2 conducts and R13 connects to the input of IC1. The potential at the summing point input to IC1 will be held to +3 volts by the feedback action of the operational amplifier. The relative weighting of the bits for the 12 input lines is determined by the resistor values and the applied voltage; either -300 volts or voltage Y (-9.12 volts). Voltage Y is derived from A21-Q5 and determines the relative weighting of the lower bits (X1 to X80). Voltage X is approximately +9.4 as determined by A21-Q1. Amplifier A22 Q1-Q2 provides a means to phase lock the 8690B frequency to the H39-5105/8710 Reference Oscillator. Phase error signals are received at J21-5 and applied to common base amplifier A22-Q2. A22-Q2 provides the proper impedance match for a current source input. The phase lock output connects through A21 and back through an interlock connection on J21. The interlock prevents the voltage at the junction of A22-Q1 and Q2 from being applied to the helix feedback line when the phase lock signal is disconnected from J21. Assembly A22 also contains 19 through connections as shown in sheet 2 of Figure 9. Nine of the through connections are not used and are

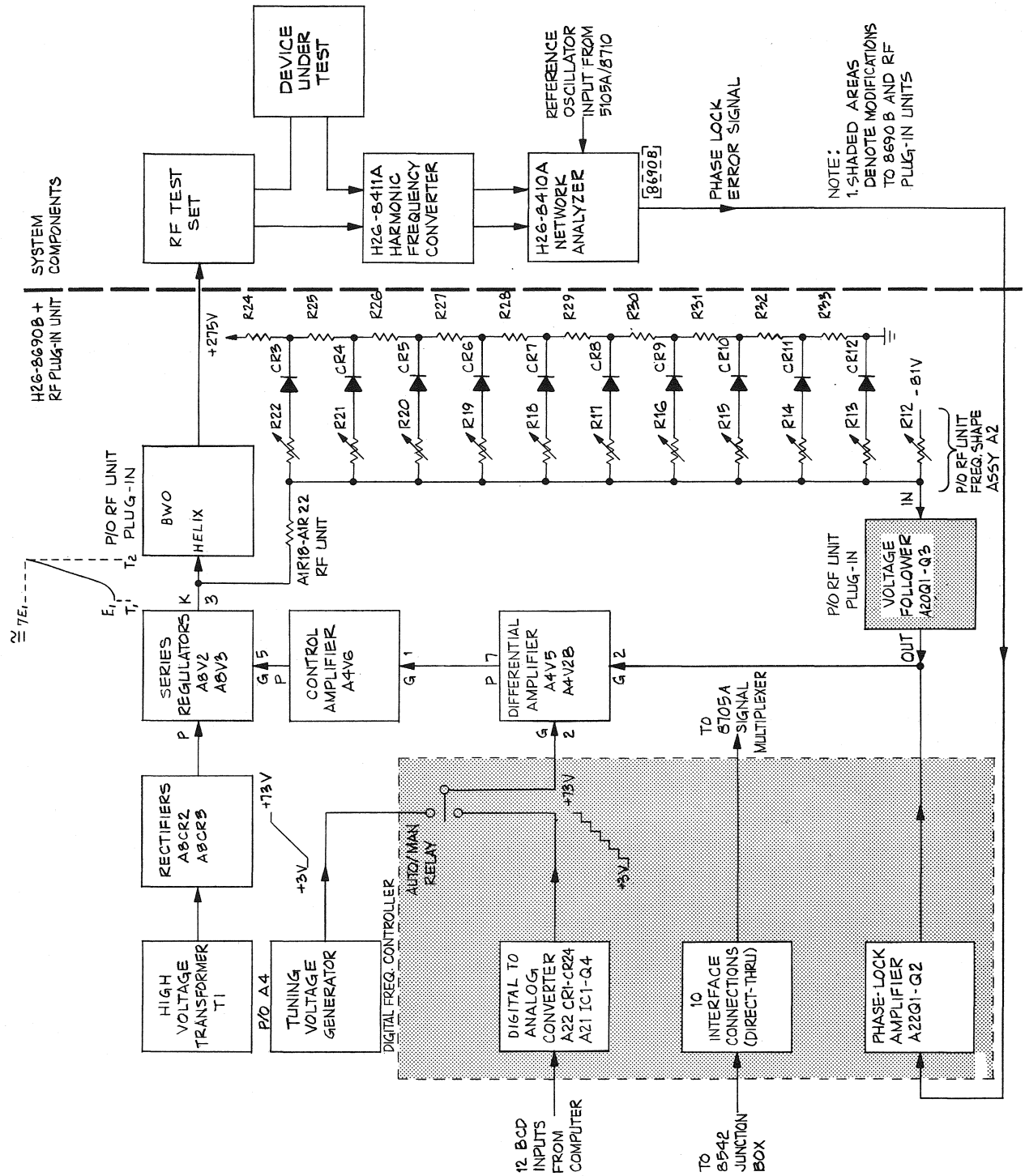

Figure 2. H26-8690B Block Diagram

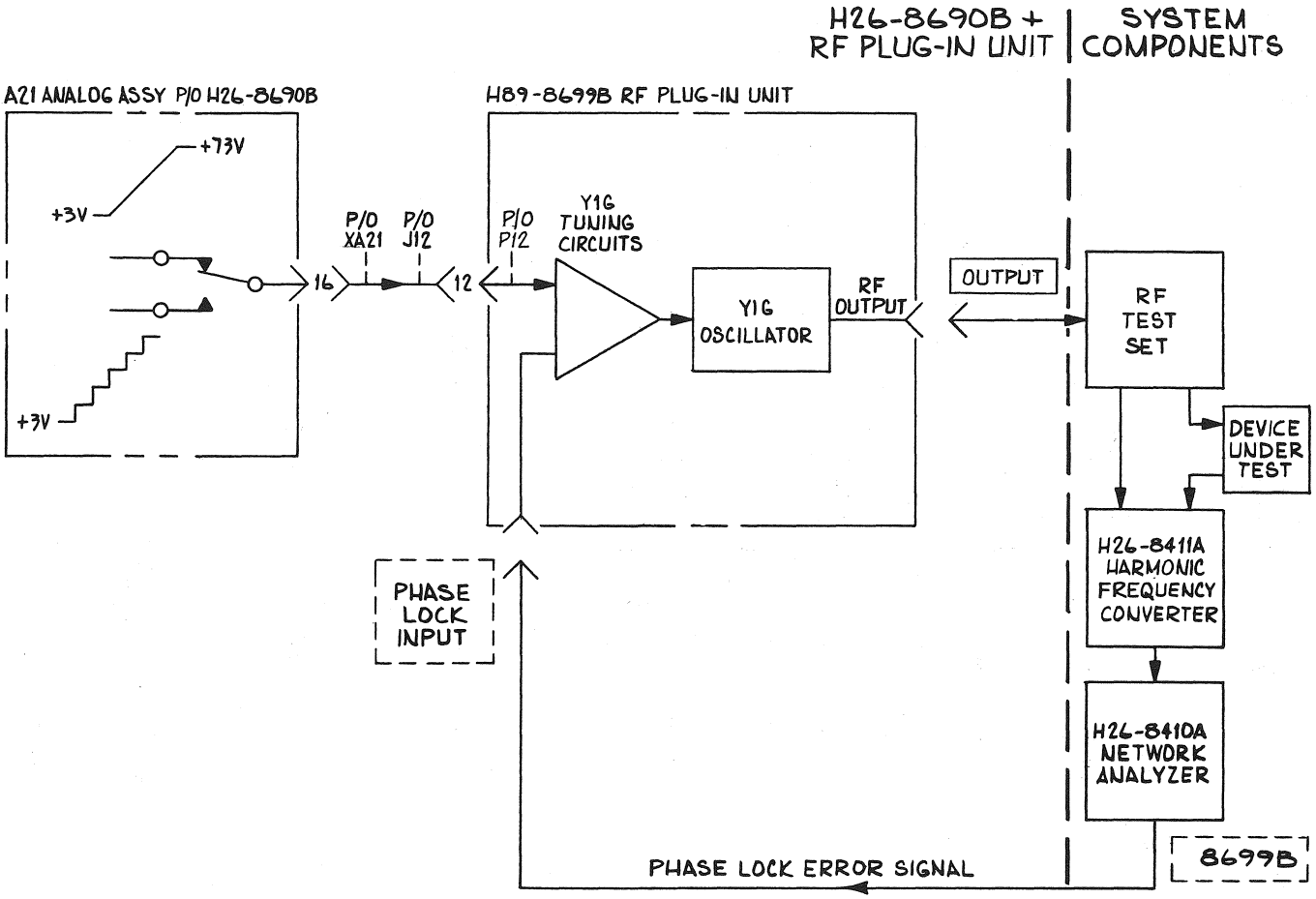

Figure 3. H89-8699B Phase-Lock Loop Functional Block Diagram

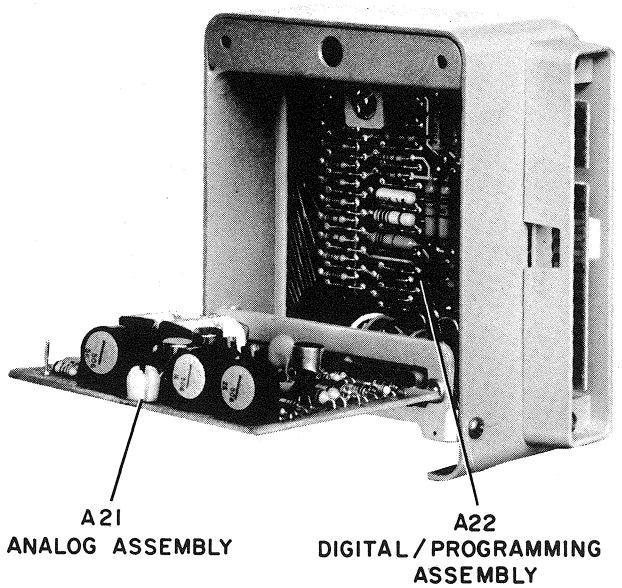

Figure 4. Digital Frequency Controller Interior View

provided as spares. The remaining ten through connections provide interconnections between the 8542 Junction Box and the 8705A Signal Multiplexer. The functions, pin numbers, and wire color codes are shown in Figure 9, sheet 2.

Analog Assembly A21 consists of an operational amplifier and driver - IC1 and Q4, an auto-manual control stage - Q2 and Q3, an X voltage emitter follower Q1, and a Y voltage emitter follower Q5.

Figure 5 shows a basic operational amplifier connected as a dc multiplier. IC1 is a dc amplifier containing 22 stages with an open loop gain of approximately 100 dB. The ratio of Zin to Zf determines the amplifier closed loop gain so that basically Eo = Ein(Zf/Zin). The operational amplifier used in the Analog Assembly has a variable value of Zin. The value of Zin is digitally switched as determined by the input decoder. Since the resistance values on the digital board are weighted in proportion to the BCD inputs, Eo will vary as a function of the BCD input code. In another sense, the digital assembly switches different values of resistance to vary the current input to the operational amplifier. The current input is determined by the resistance value, and the applied voltage Ein which is either -300 or Y volts.

With a constant value of Ein, a range of 800 to 1 would be required for Zin. To reduce the range to a more practical value, Ein for the lower bits is reduced to voltage Y (= 9.12V) thereby, allowing a resistance range of only 80 to 1.

In the Analog Assembly, the operational amplifier is used as a dc amplifier with A21-R6 and R7 providing feedback for the circuit. The minus input of IC1 connects to a +3 volt reference established by voltage divider R1 through R3. With no input (decimal 0) applied to IC1, R2 is adjusted for a +3.000 volt output at testpoint (CV). The positive input of IC1 connects to the output of Digital Assembly A22. With an input signal equivalent to decimal 999 applied to IC1, R6 is adjusted for a +73.000 volt output at test point (CV). Capacitor C4 suppresses noise spikes and transient voltages. The analog output voltage of Q4 connects to contacts of K2 for further routing to the helix amplifier when the system is in the auto mode. The Y voltage emitter follower Q5 provides the proper operating voltage for the X1 through X80 circuits. With the X80 input grounded, R17 is adjusted for a +8.6 volt output at test point (CV).

The auto-manual control circuits consist of A21-Q2, A21-Q3, and relays K1 and K2. The input line at A22J1-H connects to the system control panel and receives a ground for system auto mode and an open for the manual mode. When A22J1-H is grounded, the bias applied to Q3 will be negative, thus Q3 cuts off, Q2 conducts, K1 de-energizes, and K2 energizes. The level of the ground signal can range from zero to +4 volts before Q3 will conduct, thereby protecting the stage against noise peaks on the auto-manual control line. When K1 de-energizes the AM circuits are disabled and the manual helix tuning voltage is disconnected from the helix amplifier. When K2 energizes, the D/A converter output connects to the helix amplifier, and R24 is used to disable the 8690B sweep circuits. When the auto-manual line is open, the potential at the junction of R19 and R20 rises to +8 volts and Q3 conducts to energize K1.

PHASE-LOCK LOOP FUNCTIONAL DESCRIPTION

Two different configurations are used for the phase lock loop, dependent upon the type of RF Plug-In Unit to be phase-locked to the Reference Oscillator. For RF Plug-Ins using BWO's, the loop configuration is shown by the functional schematic diagram in Figure 7. When an H89-8699B RF Plug-In is used, the block diagram in Figure 3 illustrates the proper method to connect the phase-lock loop. The loop is designed to lock the output frequency of the RF Plug-In to a harmonic of the H39-5105A/8710 Reference Oscillator. The 8410 contains phase comparator circuits which detect phase errors between the RF Plug-In frequency and the proper harmonic of the Reference Oscillator. If the frequency of the RF Plug-In is too high, the 8410 supplies a positive going error signal to A22-pin 10 on the Digital Frequency Controller. A22 Q1-Q2 comprise a drift compensated common base amplifier and provides impedance matching between the 8410 and 8690B circuits. The interlock on

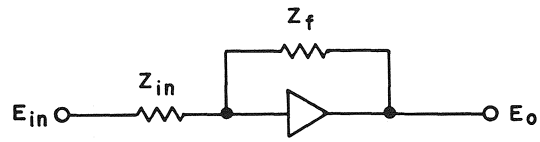

Figure 5. Basic Operational Amplifier

J21 provides a means to disconnect the phase-lock loop when the H26-8690B is used in a non-phase lock system. Differential amplifier A4V2B-A4V5 receives the tuning signal and error signal and provides an output proportional to the difference of the two inputs. In the example described previously, with the frequency error of the RF Plug-In above the Reference Oscillator Harmonic, A4V2B grid is driven positive. When A4V2B grid goes positive, A4V5 plate goes positive, A4V6 plate potential drops, and the series regulators (A8V2-V3) drive the helix voltage lower. This action will cause the RF Units frequency to decrease and lock on the proper Reference Oscillator harmonic. Voltage follower assembly A20 in the BWO type of RF Plug-In Units, provides a feedback path from the non-linear voltage divider output back to the differential amplifier. The non-linear voltage divider serves to change the amount of feedback voltage to the differential amplifier so as to convert the linear tuning ramp (A4V5 grid signal) to an exponential helix driver voltage. This is necessary to produce a linear change in BWO frequency since the BWO frequency varies linearly as the helix voltage varies exponentially. Voltage follower 20 provides impedance matching in the feedback path and has the proper high-frequency roll-off characteristics to prevent loop oscillations. The Helix Amplifier and voltage follower circuits are not used in an H89-8699B since this unit uses a YIG oscillator instead of a BWO.

DIGITAL FREQUENCY CONTROLLER CALIBRATION

Three potentiometer adjustments are required to calibrate the Digital Frequency Controller. All three potentiometers are located on Assembly A21 as shown on Figure 6. To calibrate the controller, disconnect P1 of cable 08542-60053 from the Digital Frequency Controller and proceed as follows:

a. Select decimal 0 input for A22 (all BCD inputs open).

b. Using a digital voltmeter (DVM), monitor the D/A Converter output at (CV) (see Figure 6).

c. Adjust R2 (LOW potentiometer) until DVM indicates 3.000 volts (+1 millivolt).

d. Ground pins 1, B, 3, D, 5, and F on A22J1 to obtain a BCD input of 999.

e. Adjust R6 (HIGH potentiometer) until DVM indicates 73.00 volts (±10 millivolts).

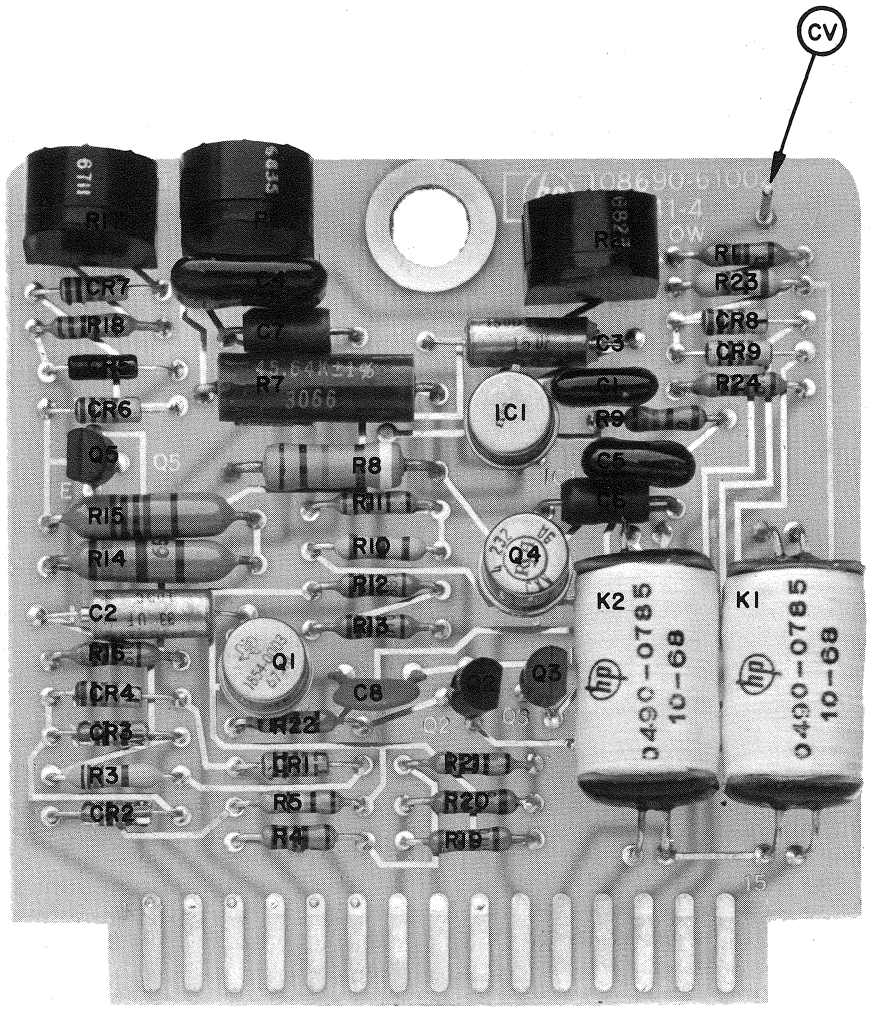

Figure 6. Analog Assembly A21 Component Identification

f. Repeat steps a through e until no further adjustments are necessary for R2 and R6.

g. At A22J1, disconnect grounds and ground pin 3 (X80 input grounded).

h. Adjust R17 (X80 ADJ) until DVM indicates 8.6 volts (±10 millivolts). Record DVM reading.

i. Refer to Table 1 and ground each pin separately and record each DVM reading. All readings should be within ±60 millivolts. If errors are predominantly high or low, adjust R6 and R17 to minimize the errors over the entire bit range.

DIGITAL FREQUENCY CONTROLLER TROUBLESHOOTING PROCEDURE

Troubleshooting for the Digital Frequency Controller is accomplished by grounding each of the inputs listed in Table 1 and checking test point (CV) with a digital voltmeter for corresponding output.

Table 1. Digital Frequency Controller Troubleshooting Data

Ground on A22J1	Function	DVM Indication at (CV) in Volts
None	0	3.00 ± 60 mV
F	X1	3.07
6	X2	3.14
E	X4	3.28
5	X8	3.56
D	X10	3.7
4	X20	4.4
C	X40	5.8
3	X80	8.6
B	X100	10.0
2	X200	17.0
A	X400	31.0
1	X800	59.0

PHASE-LOCK LOOP TROUBLESHOOTING

Troubleshooting for the phase-lock loop can be accomplished by operating the equipment across all frequency bands in its various modes including system auto, system manual, phase-lock, and non-phase lock. Based upon symptoms observed during normal operation or during system checkout procedures, the following table will aid in locating faults in the equipment.

Table 2. Phase-Lock Loop Troubleshooting

Symptoms	Probable Cause
No phase lock on any band, other modes proper.	Check 8410 and 8710 for proper operation, then check A22 Q1-Q2 in Digital Frequency Controller.
No phase lock on one band, manual mode proper.	Check 8410 and 8710 for proper operation, then check voltage follower A20 Q1-Q3 in RF Plug-In Unit.
Phase Lock Loop Oscillates.	Check voltage follower A20 Q1-Q3 in RF Plug-In Unit.
During auto mode, coarse frequency set is improper on all bands, operation normal in manual mode.	Check for proper computer BCD inputs, then check Digital Frequency Controller.
During manual mode, coarse frequency set is improper on all bands, operation normal in auto mode.	Check tuning voltage generator in 8690B.
In both auto and manual, coarse frequency set is improper on all bands.	Check 8690B circuits. See Operating and Service Manual.

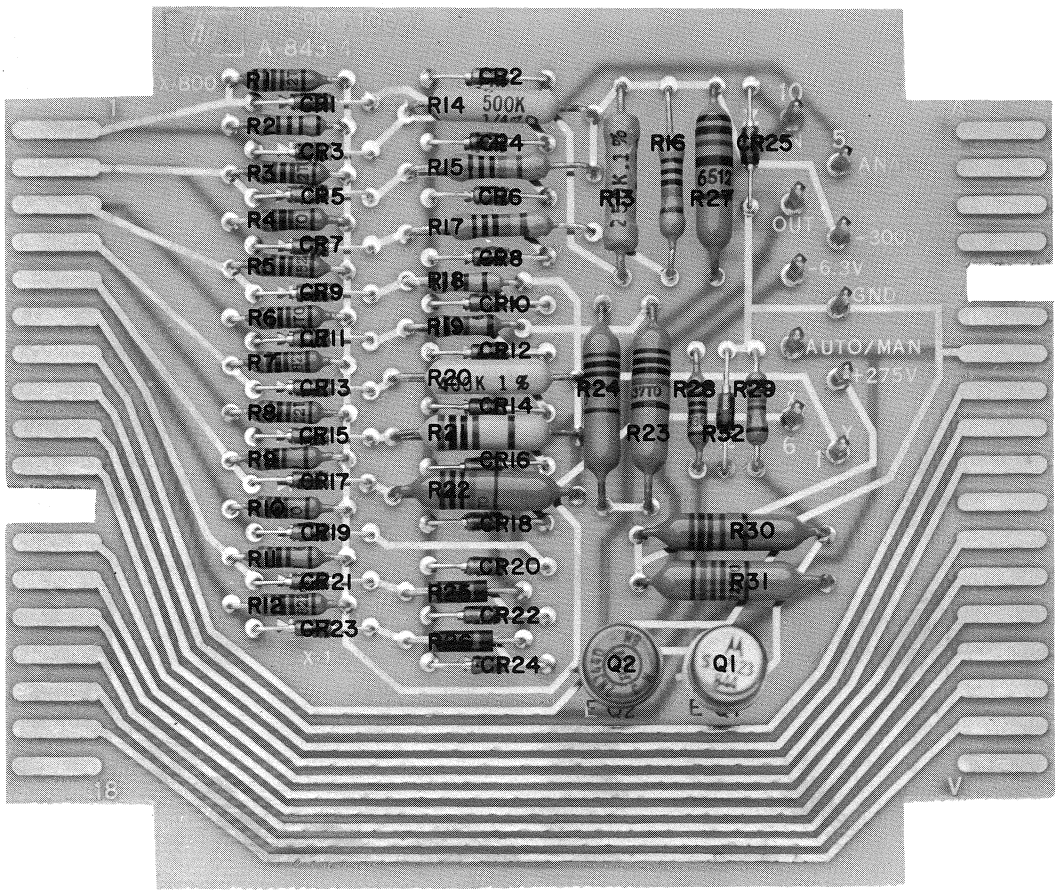

Figure 7. Digital Programming Assembly A22 Component Identification

REPLACEABLE PARTS

INTRODUCTION. Parts for the H26-8690B modification are listed in Tables 4 and 5. Table 4 lists the parts in alpha-numerical order by reference designation together with their HP stock numbers and descriptions. Miscellaneous parts that are not indexed by reference designation are listed at the end of the table. Table 5 lists the parts in alpha-numerical order by HP stock number and provides the following information on each part:

a. Description of the part. (Refer to list of abbreviations in Table 3).

b. Typical manufacturer of the part in a five digit code. (Refer to code list of manufacturers in Table 6).

c. Manufacturer's part number.

d. Total quantity used in the modification (TQ column).

Table 3 lists reference designators and abbreviations used in Tables 4 and 5.

ORDERING INFORMATION. When ordering a replaceable part listed in Tables 4 and 5.

a. Quote the Hewlett-Packard stock number for the part.

b. Address the order or inquiry to the nearest Hewlett-Packard sales and service office listed at the rear of this manual.

To order a part not listed in the tables:

a. Give a complete description of the part including its function and location.

b. Give the instrument model number and complete serial number.

c. Address the order or inquiry to the nearest Hewlett-Packard sales and service office listed at the rear of this manual.

Table 3. Reference Designators and Abbreviations Used in Replaceable Parts List

A = assembly	F = fuse	MP = mechanical part	V = vacuum, tube, neon bulb, photocell, etc.
B = motor	FL = filter	P = plug	VR = voltage regulator
BT = battery	IC = integrated circuit	Q = transistor	W = cable
C = capacitor	J = jack	R = resistor	X = socket
CP = coupler	K = relay	RT = thermistor	Y = crystal
CR = diode	L = inductor	S = switch	Z = tuned cavity, network
DL = delay line	LS = loud speaker	T = transformer	
DS = device signaling (lamp)	M = meter	TB = terminal board	
E = misc electronic part	MK = microphone	TP = test point	

ABBREVIATIONS

A = amperes	H = henries	N/O = normally open	RMO = rack mount only
AFC = automatic frequency control	HDW = hardware	NPO = negative positive zero (zero temperature coefficient)	RMS = root-mean square
AMPL = amplifier	HEX = hexagonal		RWV = reverse working voltage
	HG = mercury		
BFO = beat frequency oscillator	HR = hour(s)	NPN = negative-positive-negative	S-B = slow-blow
BE CU = beryllium copper	HZ = hertz		SCR = screw
BH = binder head	IF = intermediate freq	NRFR = not recommended for field replacement	SE = selenium
BP = bandpass	IMPG = impregnated		SECT = section(s)
BRS = brass	INCD = incandescent	NSR = not separately replaceable	SEMICON = semiconductor
BWO = backward wave oscillator	INCL = include(s)		SI = silicon
	INS = insulation(ed)		SIL = silver
CCW = counter-clockwise	INT = internal	OBD = order by description	SL = slide
CER = ceramic		OH = oval head	SPG = spring
CMO = cabinet mount only	K = kilo = 1000	OX = oxide	SPL = special
COEF = coefficient			SST = stainless steel
COM = common	LH = left hand	P = peak	SR = split ring
COMP = composition	LIN = linear taper	PC = printed circuit	STL = steel
COMPL = complete	LK WASH = lock washer	PF = picofarads = 10^{-12} farads	
CONN = connector	LOG = logarithmic taper		TA = tantalum
CP = cadmium plate	LPF = low pass filter	PH BRZ = phosphor bronze	TD = time delay
CRT = cathode-ray tube		PHL = Phillips	TGL = toggle
CW = clockwise	M = milli = 10^{-3}	PIV = peak inverse voltage	THD = thread
	MEG = meg = 10^{6}	PNP = positive-negative-positive	TI = titanium
DEPC = deposited carbon	MET FLM = metal film		TOL = tolerance
DR = drive	MET OX = metallic oxide	P/O = part of	TRIM = trimmer
	MFR = manufacturer	POLY = polystyrene	TWT = traveling wave tube
ELECT = electrolytic	MHZ = mega hertz	PORC = porcelain	
ENCAP = encapsulated	MINAT = miniature	POS = position(s)	U = micro = 10^{-6}
EXT = external	MOM = momentary	POT = potentiometer	
	MTG = mounting	PP = peak-to-peak	VAR = variable
F = farads	MY = "mylar"	PT = point	VDCW = dc working volts
FH = flat head		PWV = peak working voltage	
FIL H = fillister head	N = nano (10^{-9})		W/ = with
FXD = fixed	N/C = normally closed	RECT = rectifier	W = watts
	NE = neon	RF = radio frequency	WIV = working inverse voltage
G = giga (10^{9})	NI PL = nickel plate	RH = round head or right hand	
GE = germanium			WW = wirewound
GL = glass			W/O = without
GRD = ground(ed)			

Table 4. Reference Designation Index

Reference Designation	℗ Part No.	Description #	Note
A21	08690-61002	BOARD ASSY:ANALOG	
	08690-21002	BOARD:BLANK PC	
A21C1	0140-0193	C:FXD MICA 82 PF 5%	
A21C2	0180-0229	C:FXD ELECT 33 UF 10% 10VDCW	
A21C3	0180-1746	C:FXD ELECT 15 UF 10% 20VDCW	
A21C4	0160-2213	C:FXD MICA 620 PF 5% 300VDCW	
A21C5	0160-0939	C: FXD MICA 430 PF 5% 300 VDCW	
A21C6	0160-0154	C:FXD MYLAR 2200PF 10%	
A21C7	0160-0154	C:FXD MYLAR 2200PF 10%	
A21C8	0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	
A21CR1	1901-0044	DIODE:SILICON 20MA/1V	
A21CR2	1902-0041	DIODE:BREAKDOWN 5.11V 5% 400MW	
A21CR3	1902-0041	DIODE:BREAKDOWN 5.11V 5% 400MW	
A21CR4	1901-0044	DIODE:SILICON 20MA/1V	
A21CR5	1902-3256	DIODE:BREAKDOWN SILICON 23.7V 5%	
A21CR6	1901-0044	DIODE:SILICON 20MA/1V	
A21CR7	1901-0044	DIODE:SILICON 20MA/1V	
A21CR8	1901-0044	DIODE:SILICON 20MA/1V	
A21CR9	1901-0044	DIODE:SILICON 20MA/1V	
A21IC1	1820-0104	INTEGRATED CIRCUIT	
A21K1	0490-0785	RELAY:REED, DUAL FORM A	
A21K2	0490-0785	RELAY:REED, DUAL FORM A	
A21Q1	1854-0003	TRANSISTOR:NPN SILICON	
A21Q2	1854-0071	TRANSISTOR:SILICON NPN	
A21Q3	1854-0071	TRANSISTOR:SILICON NPN	
A21Q4	1854-0232	TRANSISTOR:SILICON NPN	
A21Q5	1853-0020	TRANSISTOR:SILICON PNP	
A21R1	0757-0461	R:FXD MET FLM 68.1K OHM 1% 1/8W	
A21R2	2100-1760	R:VAR WW 5K OHM 10% LIN 1/2W	
A21R3	0698-3519	R:FXD MET FLM 12.4K OHM 1% 1/8W	
A21R4	0757-0402	R:FXD MET FLM 110 OHM 1% 1/8W	
A21R5	0757-0422	R:FXD MET FLM 909 OHM 1% 1/8W	
A21R6	2100-1758	R:VAR WW 1K OHM 10% LIN 1/2W	
A21R7	0811-2111	R:FXD WW 45.64K OHM 1% 1/2W	
A21R8	0764-0047	R:FXD MET OX 82K OHM 5% 2W	
A21R9	0757-0278	R:FXD MET FLM 1.78K OHM 1% 1/8W	
A21R10	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A21R11	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A21R12	0757-0442	R:FXD MET FLM 10.0K OHM 1% 1/8W	
A21R13	0757-0442	R:FXD MET FLM 10.0K OHM 1% 1/8W	
A21R14	0757-0195	R:FXD MET FLM 348K OHM 1% 1/2W	
A21R15	0757-0135	R:FXD MET FLM 511K OHM 1% 1/2W	

 # See introduction to this section for ordering information

Table 4. Reference Designation Index (Cont.)

Reference Designation	℗ Part No.	Description #	Note
A21R16	0698-3450	R:FXD MET FLM 42.2K OHM 1% 1/8W	
A21R17	2100-1759	R:VAR WW 2K OHM 10% LIN 1/2W	
A21R18	0757-0446	R:FXD MET FLM 15.0K OHM 1% 1/8W	
A21R19	0757-0200	R:FXD MET FLM 5.62K OHM 1% 1/8W	
A21R20	0757-0200	R:FXD MET FLM 5.62K OHM 1% 1/8W	
A21R21	0757-0443	R:FXD MET FLM 11.0K OHM 1% 1/8W	
A21R22	0757-0465	R:FXD MET FLM 100K OHM 1% 1/8W	
A21R23	0698-3444	R:FXD MET FLM 316 OHM 1% 1/8W	
A21R24	0698-3460	R:FXD MET FLM 422K OHM 1% 1/8W	
A22	08690-61003	BOARD ASSY:DIGITAL	
	08690-21003	BOARD:BLANK PC	
A22CR1	1901-0044	DIODE:SILICON 20MA/1V	
A22CR2	1901-0044	DIODE:SILICON 20MA/1V	
A22CR3	1901-0044	DIODE:SILICON 20MA/1V	
A22CR4	1901-0044	DIODE:SILICON 20MA/1V	
A22CR5	1901-0044	DIODE:SILICON 20MA/1V	
A22CR6	1901-0044	DIODE:SILICON 20MA/1V	
A22CR7	1901-0044	DIODE:SILICON 20MA/1V	
A22CR8	1901-0044	DIODE:SILICON 20MA/1V	
A22CR9	1901-0044	DIODE:SILICON 20MA/1V	
A22CR10	1901-0044	DIODE:SILICON 20MA/1V	
A22CR11	1901-0044	DIODE:SILICON 20MA/1V	
A22CR12	1901-0044	DIODE:SILICON 20MA/1V	
A22CR13	1901-0044	DIODE:SILICON 20MA/1V	
A22CR14	1901-0044	DIODE:SILICON 20MA/1V	
A22CR15	1901-0044	DIODE:SILICON 20MA/1V	
A22CR16	1901-0044	DIODE:SILICON 20MA/1V	
A22CR17	1901-0044	DIODE:SILICON 20MA/1V	
A22CR18	1901-0044	DIODE:SILICON 20MA/1V	
A22CR19	1901-0044	DIODE:SILICON 20MA/1V	
A22CR20	1901-0044	DIODE:SILICON 20MA/1V	
A22CR21	1901-0044	DIODE:SILICON 20MA/1V	
A22CR22	1901-0044	DIODE:SILICON 20MA/1V	
A22CR23	1901-0044	DIODE:SILICON 20MA/1V	
A22CR24	1901-0044	DIODE:SILICON 20MA/1V	
A22CR25	1901-0044	DIODE:SILICON 20MA/1V	
A22Q1	1853-0038	TRANSISTOR:SILICON PNP	
A22Q2	1854-0234	TRANSISTOR:SILICON NPN 2N3440	
A22R1	0698-0084	R:FXD MET FLM 2.15K OHM 1% 1/8W	
A22R2	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A22R3	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R4	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R5	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	

 # See introduction to this section for ordering information

Table 4. Reference Designation Index (Cont.)

Reference Designation	ℌ Part No.	Description #	Note
A22R6	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R7	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R8	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R9	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R10	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R11	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R12	0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	
A22R13	0698-7083	R:FXD MET FLM 250K OHM 0.1% 1/2W	
A22R14	0698-5157	R:FXD MET FLM 500K OHM 0.25% 1/4W	
A22R15	0698-5159	R:FXD MET FLM 1 MEGOHM 0.5% 1/4W	
A22R16	0698-5159	R:FXD MET FLM 1 MEGOHM 0.5% 1/4W	
A22R17	0698-5159	R:FXD MET FLM 1 MEGOHM 0.5% 1/4W	
A22R18	0757-0465	R:FXD MET FLM 100K OHM 1% 1/8W	
A22R19	0757-0472	R:FXD MET FLM 200K OHM 1% 1/8W	
A22R20	0698-5699	R:FXD MET FLM 400K OHM 1% 1/4W	
A22R21	0698-6654	R:FXD MET FLM 800K OHM 1% 1/4W	
A22R22	0757-0059	R:FXD MET FLM 1 MEGOHM 1% 1/2W	
A22R23	0757-0059	R:FXD MET FLM 1 MEGOHM 1% 1/2W	
A22R24	0757-0059	R:FXD MET FLM 1 MEGOHM 1% 1/2W	
A22R25	0698-5844	R:FXD COMP 4.3 MEGOHM 5% 1/4W	
A22R26	0683-8255	R:FXD COMP 8.2 MEGOHM 5% 1/4W	
A22R27	0698-3424	R:FXD MET FLM 237K OHM 1% 1/2W	
A22R28	0757-0442	R:FXD MET FLM 10.0K OHM 1% 1/8W	
A22R29	0698-3266	R:FXD MET FLM 237K OHM 1% 1/8W	
A22R30	0757-0135	R:FXD MET FLM 511K OHM 1% 1/2W	
A22R31	0698-3175	R:FXD MET FLM 147K OHM 1% 1/2W	
A22R32	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	
		MISCELLANEOUS	
	08690-21006	BEARING	
	08690-21005	BOX	
	08690-01002	BRACKET:HINGE	
	08690-01003	BRACKET:ROTARY	
	0403-0003	BUMPER:GROMMET TYPE, RUBBER	
	1251-0159	CONNECTOR:2X15 CONTACT	
	08690-21008	EXTENSION:PLUNGER	
	1390-0105	GROMMET:PANEL FASTENER,POLYCARBONATE	
	08690-21007	HINGE	
	1251-2205	KEY:POLARIZING FOR PC CONNECTORS	
	1251-1865	PLUG:5 MALE CONTACTS	
	1390-0033	PLUNGER:PANEL FASTENER,NYLON	
	08690-21009	PLUNGER:MOD.	
	0362-0063	TERMINATION:CRIMP LUG FOR 0.046SQ PIN	
	08690-21012	SPRING	
	08690-21004	SOCKET:MODIFIED	
	1251-1864	SOCKET:5 FEMALE CONTACTS	
	08690-21011	SQUARE PIN:MOD.	

 # See introduction to this section for ordering information

Table 5. Replaceable Parts

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
0140-0193	C:FXD MICA 82 PF 5%	28480	0140-0193	1
0160-0154	C:FXD MYLAR 2200PF 10%	28480	0160-0154	2
0160-0939	C: FXD MICA 430 PF 5% 300 VDCW	28480	0160-0939	1
0160-2213	C:FXD MICA 620 PF 5% 300VDCW	28480	0160-2213	1
0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA	1
0180-0229	C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229	1
0180-1746	C:FXD ELECT 15 UF 10% 20VDCW	56289	150D156X9020B2	1
0362-0063	TERMINATION:CRIMP LUG FOR 0.046SQ PIN	00000	OBD	10
0403-0003	BUMPER:GROMMET TYPE, RUBBER	70485	1165	2
0490-0785	RELAY:REED, DUAL FORM A	28480	0490-0785	2
0683-8255	R:FXD COMP 8.2 MEGOHM 5% 1/4W	01121	CB 8255	1
0698-0084	R:FXD MET FLM 2.15K OHM 1% 1/8W	28480	0698-0084	1
0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	28480	0698-0085	1
0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	28480	0698-3154	1
0698-3175	R:FXD MET FLM 147K OHM 1% 1/2W	28480	0698-3175	1
0698-3266	R:FXD MET FLM 237K OHM 1% 1/8W	28480	0698-3266	1
0698-3424	R:FXD MET FLM 237K OHM 1% 1/2W	28480	0698-3424	1
0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440	1
0698-3444	R:FXD MET FLM 316 OHM 1% 1/8W	28480	0698-3444	1
0698-3450	R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450	1
0698-3460	R:FXD MET FLM 422K OHM 1% 1/8W	28480	0698-3460	1
0698-3519	R:FXD MET FLM 12.4K OHM 1% 1/8W	28480	0698-3519	1
0698-5157	R:FXD MET FLM 500K OHM 0.25% 1/4W	28480	0698-5157	1
0698-5159	R:FXD MET FLM 1 MEGOHM 0.5% 1/4W	28480	0698-5159	3
0698-5699	R:FXD MET FLM 400K OHM 1% 1/4W	28480	0698-5699	1
0698-5844	R:FXD COMP 4.3 MEGOHM 5% 1/4W	28480	0698-5844	1
0698-6654	R:FXD MET FLM 800K OHM 1% 1/4W	28480	0698-6654	1
0698-7083	R:FXD MET FLM 250K OHM 0.1% 1/2W	28480	0698-7083	1
0757-0059	R:FXD MET FLM 1 MEGOHM 1% 1/2W	28480	0757-0059	3
0757-0135	R:FXD MET FLM 511K OHM 1% 1/2W	28480	0757-0135	2
0757-0195	R:FXD MET FLM 348K OHM 1% 1/2W	28480	0757-0195	1
0757-0200	R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200	2
0757-0278	R:FXD MET FLM 1.78K OHM 1% 1/8W	28480	0757-0278	1
0757-0402	R:FXD MET FLM 110 OHM 1% 1/8W	28480	0757-0402	1
0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416	1
0757-0422	R:FXD MET FLM 909 OHM 1% 1/8W	28480	0757-0422	1
0757-0440	R:FXD MET FLM 7.50K OHM 1% 1/8W	28480	0757-0440	10
0757-0442	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442	3
0757-0443	R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443	1
0757-0446	R:FXD MET FLM 15.0K OHM 1% 1/8W	28480	0757-0446	1
0757-0461	R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461	1
0757-0465	R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465	2
0757-0472	R:FXD MET FLM 200K OHM 1% 1/8W	28480	0757-0472	1
0764-0047	R:FXD MET OX 82K OHM 5% 2W	28480	0764-0047	1
0811-2111	R:FXD WW 45.64K OHM 1% 1/2W	28480	0811-2111	1
1251-0159	CONNECTOR:2X15 CONTACT	28480	1251-0159	1
1251-1864	SOCKET:5 FEMALE CONTACTS	82389	61HA5F	1
1251-1865	PLUG:5 MALE CONTACTS	82389	12CL5M	1
1251-2205	KEY:POLARIZING FOR PC CONNECTORS	71785	OBD	2
1390-0033	PLUNGER:PANEL FASTENER,NYLON	83014	H323-3-3-2	1
1390-0105	GROMMET:PANEL FASTENER,POLYCARBONATE	83014	H559-3-2	2
1820-0104	INTEGRATED CIRCUIT	28480	1820-0104	1
1853-0020	TRANSISTOR:SILICON PNP	28480	1853-0020	1
1853-0038	TRANSISTOR:SILICON PNP	28480	1853-0038	1
1854-0003	TRANSISTOR:NPN SILICON	28480	1854-0003	1

 # See introduction to this section for ordering information

Table 5. Replaceable Parts (Cont.)

Part No.	Description #	Mfr.	Mfr. Part No.	TQ
1854-0071	TRANSISTOR:SILICON NPN	28480	1854-0071	2
1854-0232	TRANSISTOR:SILICON NPN	28480	1854-0232	1
1854-0234	TRANSISTOR:SILICON NPN 2N3440	02735	2N3440	1
1901-0044	DIODE:SILICON 20MA/1V	28480	1901-0044	31
1902-0041	DIODE:BREAKDOWN 5.11V 5% 400MW	28480	1902-0041	2
1902-3256	DIODE:BREAKDOWN SILICON 23.7V 5%	28480	1902-3256	1
2100-1758	R:VAR WW 1K OHM 10% LIN 1/2W	28480	2100-1758	1
2100-1759	R:VAR WW 2K OHM 10% LIN 1/2W	28480	2100-1759	1
2100-1760	R:VAR WW 5K OHM 10% LIN 1/2W	28480	2100-1760	1
C8690-01002	BRACKET:HINGE	28480	08690-01002	1
08690-01003	BRACKET:ROTARY	28480	08690-01003	1
C8690-21002	BOARD:BLANK PC	28480	08690-21002	1
C8690-21003	BOARD:BLANK PC	28480	08690-21003	1
08690-21004	SOCKET:MODIFIED	28480	08690-21004	2
08690-21005	BOX	28480	08690-21005	1
08690-21006	BEARING	28480	08690-21006	2
C8690-21007	HINGE	28480	08690-21007	1
C8690-21008	EXTENSION:PLUNGER	28480	08690-21008	1
C8690-21009	PLUNGER:MOD.	28480	08690-21009	1
08690-21011	SQUARE PIN:MOD.	28480	08690-21011	1
C8690-21012	SPRING	28480	08690-21012	2
08690-61002	BOARD ASSY:ANALOG	28480	08690-61002	1
08690-61003	BOARD ASSY:DIGITAL	28480	08690-61003	1

 # See introduction to this section for ordering information

Table 6. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die	Newark, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.

From: FSC. Handbook Supplements
H4-1 Dated AUGUST 1966

Table 6. Code List of Manufacturers (Cont.)

Code No.	Manufacturer	Address
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.

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Table 6. Code List of Manufacturers (Cont.)

Code No.	Manufacturer	Address
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N,J,
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

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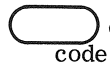
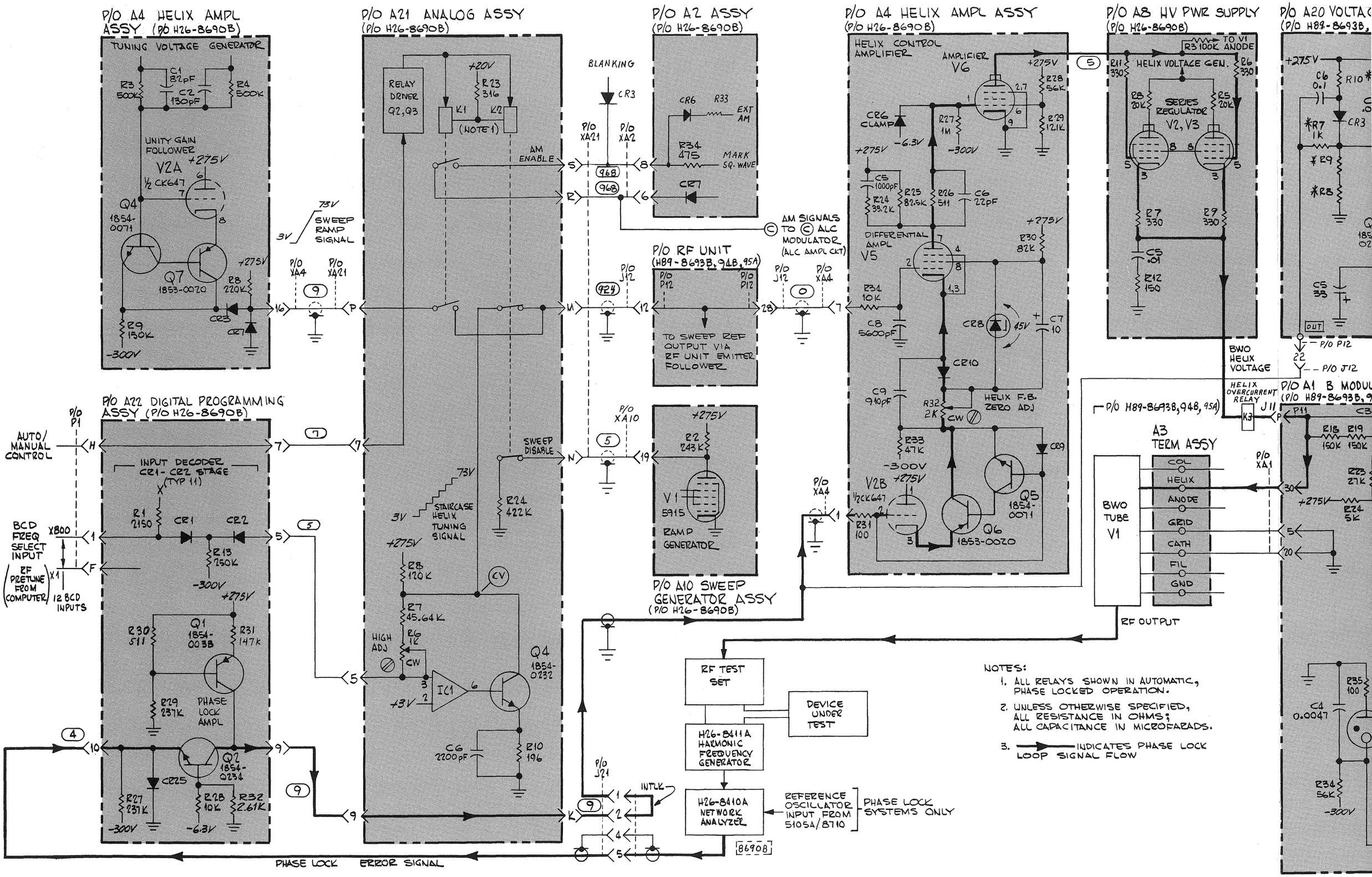
SCHEMATIC DIAGRAMS

Schematic presentations in this manual show electrical circuit operation and are not intended to serve as wiring diagrams. Notes that apply to the schematic diagrams are listed below. Reference designations within assemblies are abbreviated. The full designation includes the assembly on which the component is mounted, and the individual component designation.

For example, resistor R1 mounted on Assembly A1 has a complete reference designation of A1R1. Certain parts are not included on assemblies, and are classified as chassis parts. Chassis parts are assigned only the reference designation shown on the schematic diagram. Component procurement information and specific component descriptions are given on page 9. Refer to page 8 for information on how to order parts.

SCHEMATIC DIAGRAM NOTES

1. Unless otherwise specified, resistance in ohms and capacitance in microfarads.
2.  encloses front panel designation or PC lettering/numerals.
3.  encloses rear panel designation.
4.  screwdriver adjustment.
5.  wiper moves toward CW with clockwise rotation of control.
6. — - - - — etched circuit borderline.
7.  path and direction of main signal.
8.  path and direction of feedback.
9.  test point, number or letters in circle matches TP designating on circuit board illustrations.
10.  Voltage regulator (breakdown) diode.
11.  encloses wire color code. Wire color code (MIL-STD-681) same as resistor color code. First number identifies ground color, second number identifies wide stripe, third number identifies narrow stripe; e.g., 947 denotes white ground, yellow wide stripe, and violet narrow stripe.
12. P/O = Part of.
13. * denotes factory-selected value.



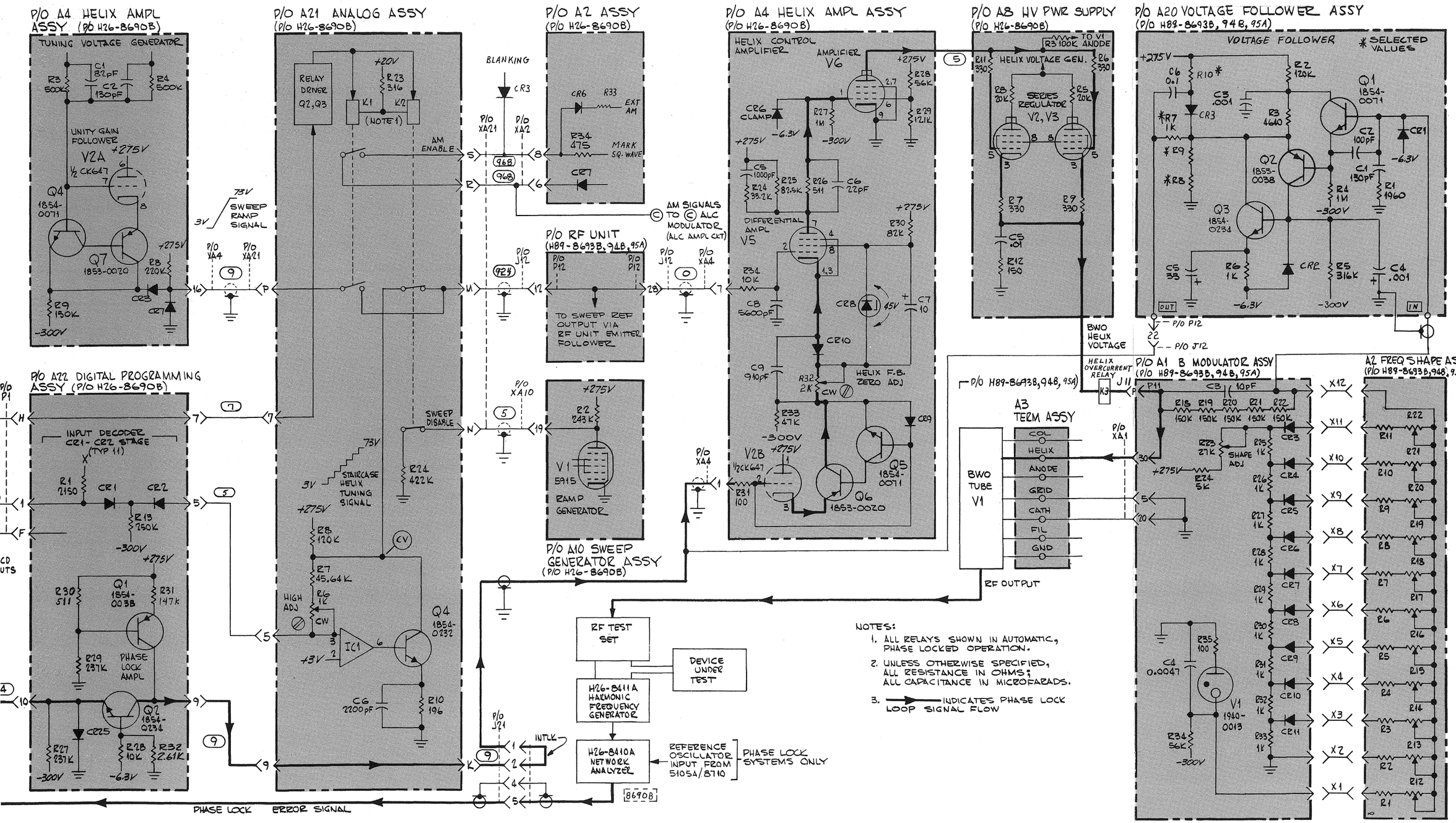
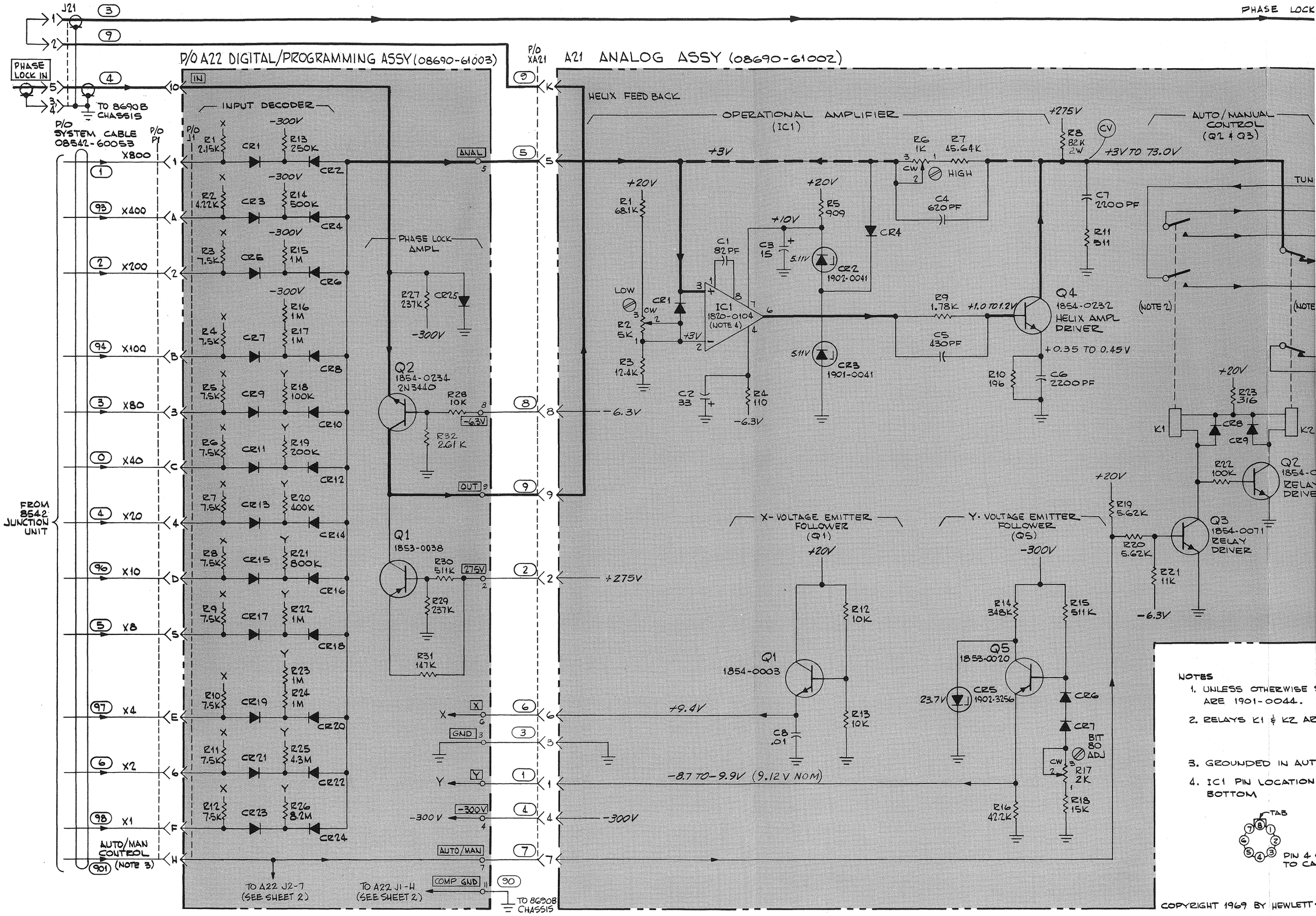
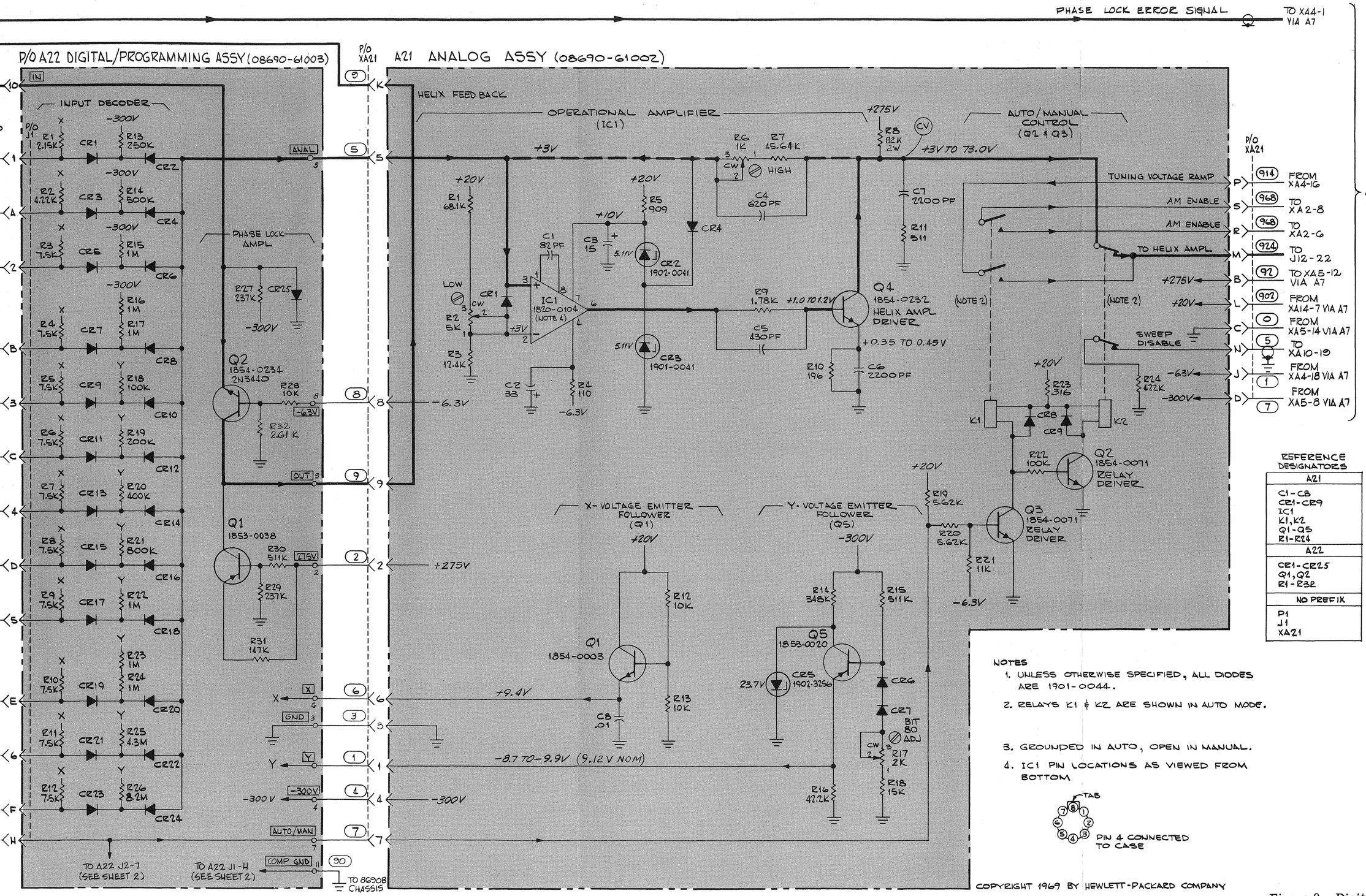


Figure 8. BWO Phase-Lock Loop Functional Block


P/O A22 DIGITAL/PROGRAMMING ASSY (08690-61003)
A21 ANALOG ASSY (08690-61002)
PHASE LOCK IN
TO 8690B CHASSIS
P/O SYSTEM CABLE 08542-60053
INPUT DECODER
PHASE LOCK AMPL
HELIX FEED BACK
OPERATIONAL AMPLIFIER (IC1)
AUTO/MANUAL CONTROL (Q2 & Q3)
X- VOLTAGE EMITTER FOLLOWER (Q1)
Y- VOLTAGE EMITTER FOLLOWER (Q5)
Q4 1854-0232 HELIX AMPL DRIVER
Q2 1854-0234 2N3440
Q1 1853-0038
Q1 1854-0003
Q5 1853-0020
Q3 1854-0071 RELAY DRIVER
IC1 1820-0104 (NOTE 4)
FROM 8542 JUNCTION UNIT
AUTO/MAN CONTROL (NOTE 3)
TO A22 J2-7 (SEE SHEET 2)
TO A22 J1-H (SEE SHEET 2)
TO 8690B CHASSIS
+275V
+3V TO 73.0V
+0.35 TO 0.45V
+1.0 TO 1.2V
-6.3V
+9.4V
-8.7 TO -9.9V (9.12 V NOM)
NOTES
1. UNLESS OTHERWISE
ARE 1901-0044.
2. RELAYS K1 & K2 AR
3. GROUNDED IN AUT
4. IC1 PIN LOCATION
BOTTOM
TAB
PIN 4
TO CA
COPYRIGHT 1969 BY HEWLETT



REFERENCE DESIGNATORS

A21
C1-C8 CR1-CR9 IC1 K1, K2 Q1-Q5 R1-R24
A22
CR1-CR25 Q1, Q2 R1-R32
NO PREFIX
P1 J1 XA21

NOTES

1. UNLESS OTHERWISE SPECIFIED, ALL DIODES ARE 1901-0044.
2. RELAYS K1 & K2 ARE SHOWN IN AUTO MODE.
3. GROUNDED IN AUTO, OPEN IN MANUAL.
4. IC1 PIN LOCATIONS AS VIEWED FROM BOTTOM

Figure 9. Digital Frequency Controller Schematic Diagram (sheet 1)

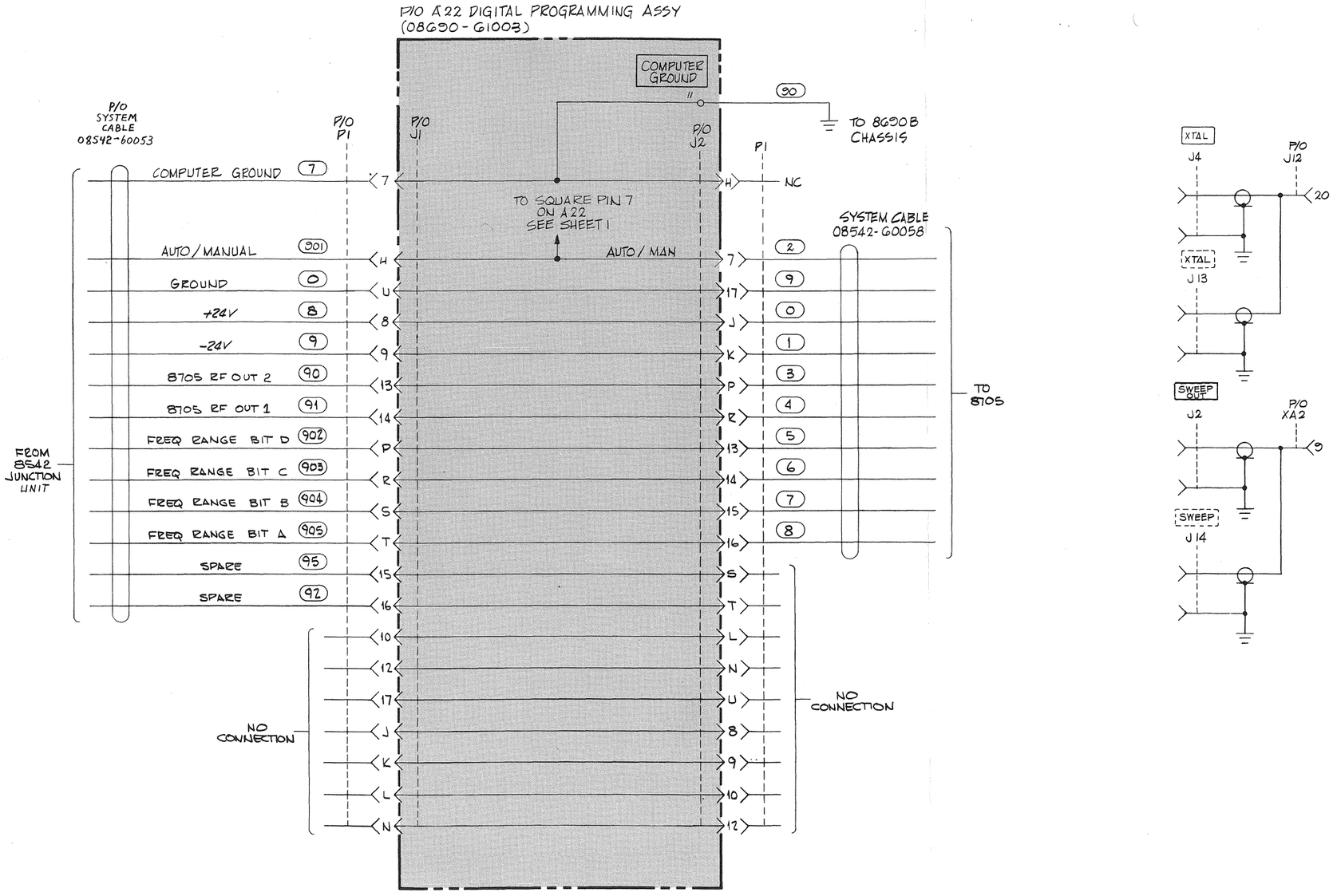


Figure 9. Digital Frequency Controller Schematic Diagram (sheet 2)