

SECTION 12.

AUDIO SYNTHESIZER BOARD (A10)

12.1 DESCRIPTION

The Audio Synthesizer board generates and processes baseband signals, providing the composite modulating signal for RF-signal generation. The A10 board consists of an Audio Synthesizer that generates frequencies in the range of 5 to 19999.9 Hz, a digital private line (DPL) generator, and a fixed 1-kHz source. The A10 board provides external microphone and external audio inputs, and sums all modulation sources to form the composite modulation source.

A block diagram of the Audio Synthesizer board is shown at the end of this section in Figure 12-1, a schematic in Figure 12-2, and the printed wiring board assembly and parts list in Figure 12-3.

12.2 THEORY OF OPERATION

12.2.1 AUDIO SYNTHESIZER

12.2.1.1 General

Audio frequencies from 5 to 19999.9 Hz, in increments of 0.1 Hz, are synthesized using a phase-accumulative technique. Consider the 360 degrees in a cycle to be divided into 2^{20} pieces. A 20-bit digital accumulator, incrementing at some fixed rate, could then at any instant represent a fixed point in the 360-degree cycle. That is, if the accumulator were half full, it would represent the 180-degree point, and if totally full, would represent the 360-degree point. The number of times per second that the accumulator goes through a complete cycle determines the output frequency. If the increment rate is fixed, the time required to accumulate 2^{20} bits can be varied by changing the number of bits added at each time increment.

12.2.1.2 Clock Generator

The 104.8576-kHz clock generator (U6 and U7) provides the increment rate for the Audio Synthesizer. If only one bit were added each time, the time to complete one cycle would be 10 seconds. Processor-loaded control latches U40-U44 determine the number of bits to be added at each time increment and, thus, the final output frequency. A 20-bit adder (U26-U30) adds the control word to the current word in the 20-bit accumulator latch (U14-U18). At the next time increment, the adder output is latched, becoming the next input to the adder.

12.2.1.3 Digital-To-Analog Conversion

The linear digital output of the 20-bit latch accumulator is converted into a sinusoidal digital output by the decode EPROM (U11). Following the decode EPROM is a digital-to-analog converter (U3) which converts the sinusoidal information into a quantized sinewave with a period equal to the cycle time of the 20-bit accumulator latch.

12.2.1.4 Bandpass Filter

Bandpass filter U1 and U2, with a passband of 5 to 10 kHz, filters the quantized waveform to a sinewave having less than 1 percent distortion. The level of the sinewave is processor-controllable by a programmable attenuator (U23C and U23D) having dB settings of 0, 10, and 30.

12.2.2 DPL GENERATOR

12.2.2.1 General

The 23-bit digital private line (DPL) word is generated by the processor from the 3-digit code. The 23-bit word is then transferred to a serial shift register and clocked out at a rate of 133 Hz. Connecting the output of the shift register back to its input causes the 23-bit word to be continuously repeated.

12.2.2.2 Shift Register

There are two modes to the DPL generator. During the load mode, the shift-register control (U34 and U36) gates a control latch to the input of the shift register (U20 and U3). Twenty-three data bits and clock pulses are then provided by the processor to load the DPL word. At the completion of the load mode, the shift-register control switches back to the output mode, which cycles the DPL word through the shift register at a 133-Hz clock rate. The 133-Hz clock comes from one of the sinusoidal digital lines on the Audio Synthesizer (U4 PIN 15).

12.2.2.3 Bandpass Filter

Bandpass filter U8, with a 0.2 to 135-Hz bandpass, follows the shift-register output to remove the higher frequency components of the digital signal. For the DPL off-code (133-Hz tone), the processor switches the INT MOD line to the Audio Synthesizer's output, outputting a 133-Hz sinewave.

12.2.3 1-KHz TONE

A filtered, 1-kHz square wave provides the fixed, 1-kHz modulation source. The SYNTH 1 KHz signal from the Processor Interface board (A11) is filtered to less than 1 percent distortion by bandpass filter U46.

12.2.4 INTERNAL MODULATION

The internally generated modulation consists of the output of either the audio synthesizer or the DPL generator.

12.2.5 EXTERNAL MODULATION

External modulation can come from either the microphone input or the external modulation input port (Ext Mod In) on the front panel. An instantaneous deviation-control (IDC) circuit (U45) amplifies and limits the microphone signal (MIC IN) before summing it with the signal EXT MOD IN from the front panel's port. The resulting signal is the EXT MOD source.

12.2.6 MODULATION CONTROL

The three modulation sources, internal, external, and 1-kHz, are level-controlled by either the front panel controls or the IEEE Interface board (A13). The level-adjusted sources are then returned to the Audio Synthesizer board, where they are summed together

and dc-adjusted by U38 for 0 Vdc, forming the composite modulation audio. The composite signal is routed to four places: the modulation-select switch, the MOD CAL AUDIO line to the Scope/DVM Control board (A7), the F.P. MOD OUTPUT line to the front panel, and VOL CONTROL AUDIO line to the speaker (for generate modes only).

The modulation-select switch (U24) routes the composite modulation signal to any of the four modulators: to the double sideband-suppressed carrier modulator (DSBSC MOD) for sideband modulation, to the RF Synthesizer for frequency modulation (FM MOD), to the Duplex Generator for frequency modulation (OFFSET MOD), and to the RF output-leveling loop for amplitude modulation. U47 sums the signal for amplitude modulation with a 5-Vdc level and then routes it to the variable RF Level control on the front panel (5 VDC + AM MOD). At the RF Level control, the signal is attenuated according to the level setting to give the dc-plus-AM reference signal for the out-out-leveling loop.

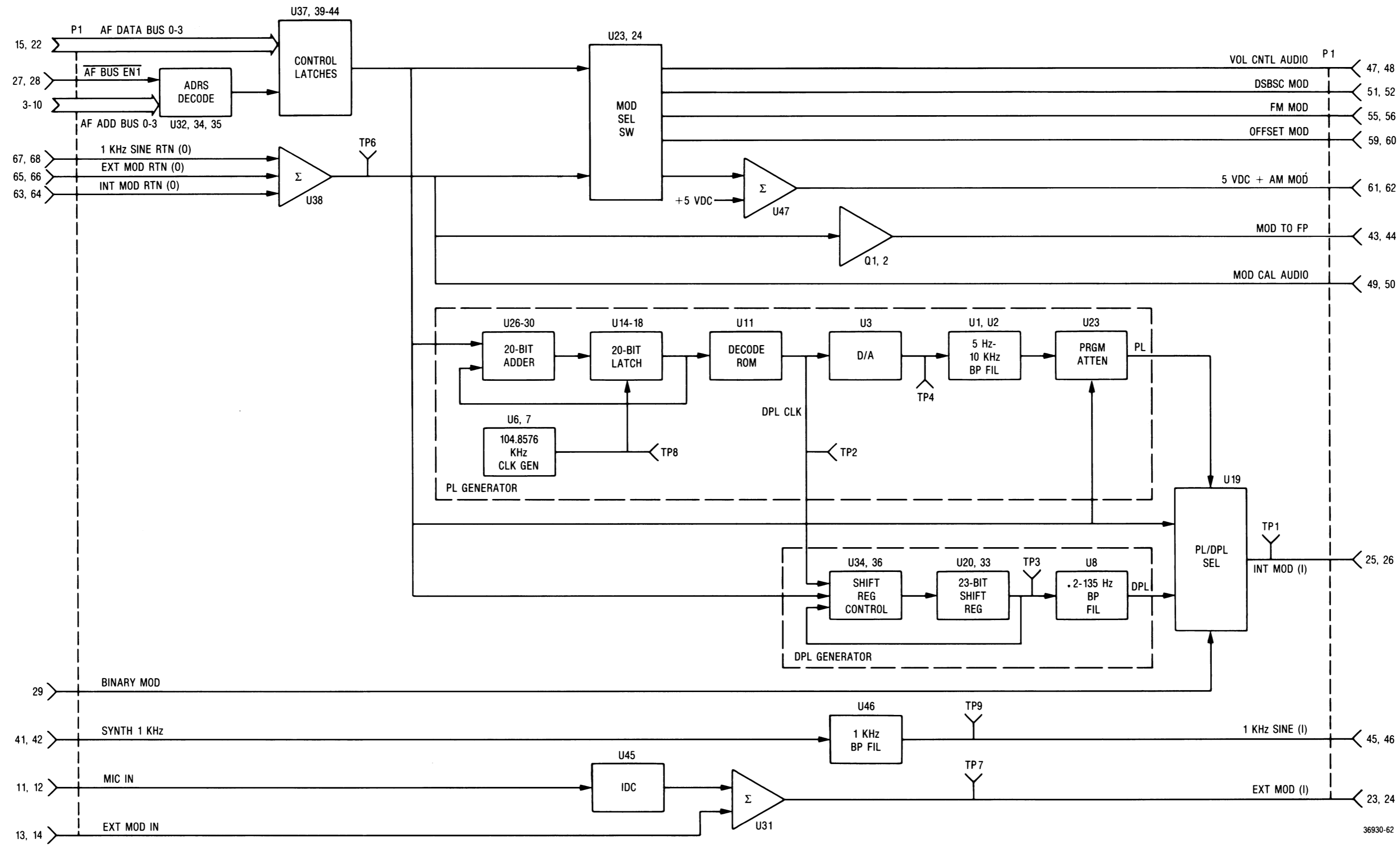
12.2.7 BOARD CONTROL

The AF bus provides all the control inputs for the Audio Synthesizer board. The 4-bit address bus (AF ADD BUS 0-3) is decoded by the address decoder (U35) to determine which control latch is to be accessed. Control data is transferred to the accessed latch on the 4-bit data bus (AF DATA BUS 0-3). Synchronization of the data transfer is the function of the AF BUS EN 1 signal line.

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Figure 12-1. Block Diagram



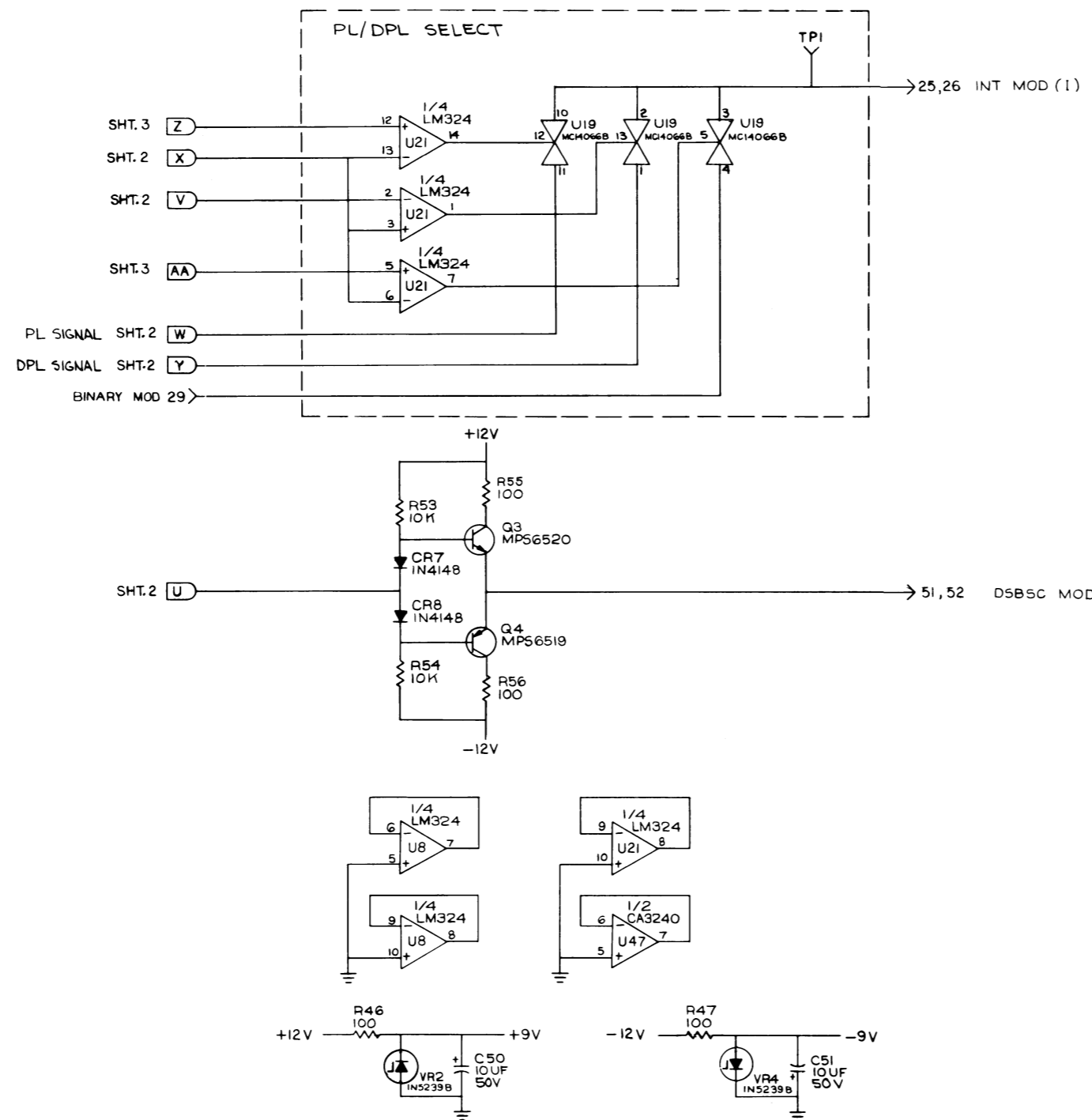
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Figure 12-2a. Schematic (Sheet 1 of 3)

- NOTES:
- PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH 1A6.
 - FOR REFERENCE DRAWINGS REFER TO ASSY. NO. 01-P0026N.
 - UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS ± 5% PCT, 1/4 WATT(S).
ALL CAPACITORS ARE IN UF.
ALL INDUCTORS ARE IN LH.
ALL VOLTAGES ARE IN DC.



REF DES	DEVICE TYPE	GND	+5V	-5V	+12V	-12V	NO CONN
U1	CA3240E	3			8	4	
U2	CA3240E	5			8	4	
U3	MC1408PB	1,2	13			3,16	
U4	MC14175BCP	8	16			3,6,11,14	
U5	MC14175BCP	8	16			3,6,11,14	
U6	SN74LS90N	2,3,6,7,10	5			4,8,9,13	
U7	SN74LS04N	7	14,9,11			8,10	
U8	MLM324N	5,10	4	11			
U9							
U10							
U11	MM2716 Q	12,18,20	21,24				
U12							
U13							
U14	MC14175BCP	8	16			3,6,11,14	
U15	MC14175BCP	8	16			3,6,11,14	
U16	MC14175BCP	8	16			3,6,11,14	
U17	MC14175BCP	8	16			3,6,11,14	
U18	MC14175BCP	8	16			3,6,11,14	
U19	MC14066BCP		14	6,7		8,9	
U20	MC14006BCP	7	14			12,5,6,8,9,10,11,13	
U21	MLM324N	10	4	11			
U22	LM324N					14, *9/4, -9/11	
U23	MC14066BCP	9,10				12, *9/4, -9/7, 13	
U24	MC14066BCP					+9V/14, -9V/7	
U25	LM324N					+9/4, -9/11	
U26	MC14008BCP	8	16				
U27	MC14008BCP	1,3,8	16			14	
U28	MC14008BCP	8	16				
U29	MC14008BCP	8	16				
U30	MC14008BCP	8,9	16				
U31	CA3140E	3			7	4	5,8
U32	MC14011BCP	1,2,5,7	14				3,4,6
U33	MC14006BCP	7	14				2,8,11
U34	MC14011BCP	7	1,2,14				3
U35	MC14028BCP	8	16				5,9
U36	MC14011BCP	7	14				
U37	MC14042BCP	8	16			3,9,12,15	
U38	CA3240E	5			8	4	
U39	MC14042BCP	8	16			3,9,12,15	
U40	MC14042BCP	8	16			3,9,12,15	
U41	MC14042BCP	8	16			3,9,15	
U42	MC14042BCP	8	16			3,9,12,15	
U43	MC14042BCP	8	16			3,9,12,15	
U44	MC14042BCP	8	16			3,9,12,15	
U45	IDC	3					2
U46	CA3240E	3,5			8	4	
U47	CA3240E	5			8	4	
U48	MC14042BCP	8	16			2,3,9,10,11,12,15	

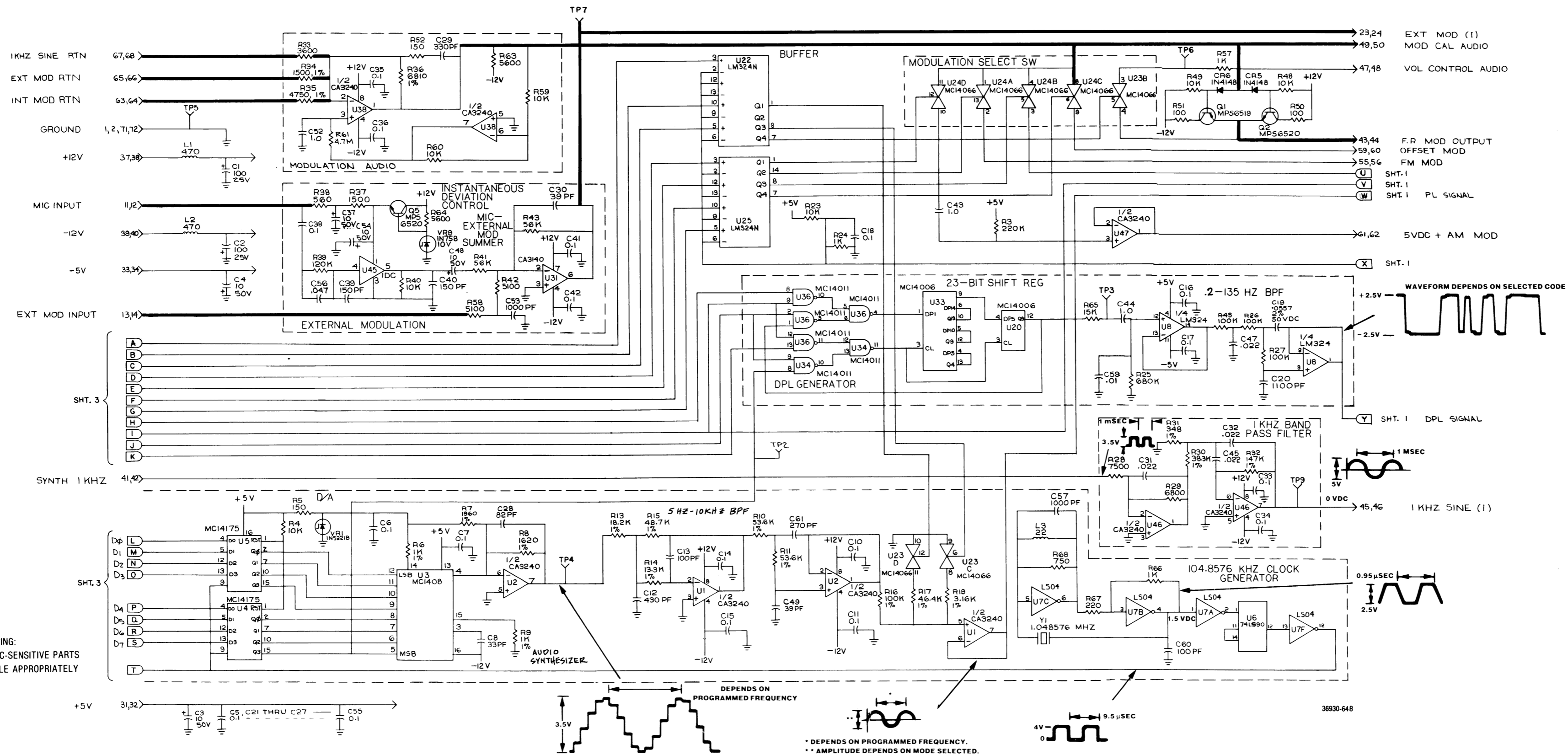
LAST USED	NOT USED
C61	C46, C58
CR8	CR1, CR2, CR3, CR4
L3	
Q5	
R68	R12, R18, R20, R21, R22, R44, R61
U48	U9, U10, U12, U13
VR9	VR3, VR5, VR6, VR7, VR8
Y1	

 WARNING:
STATIC-SENSITIVE PARTS
HANDLE APPROPRIATELY

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Figure 12-2b. Schematic (Sheet 2 of 3)



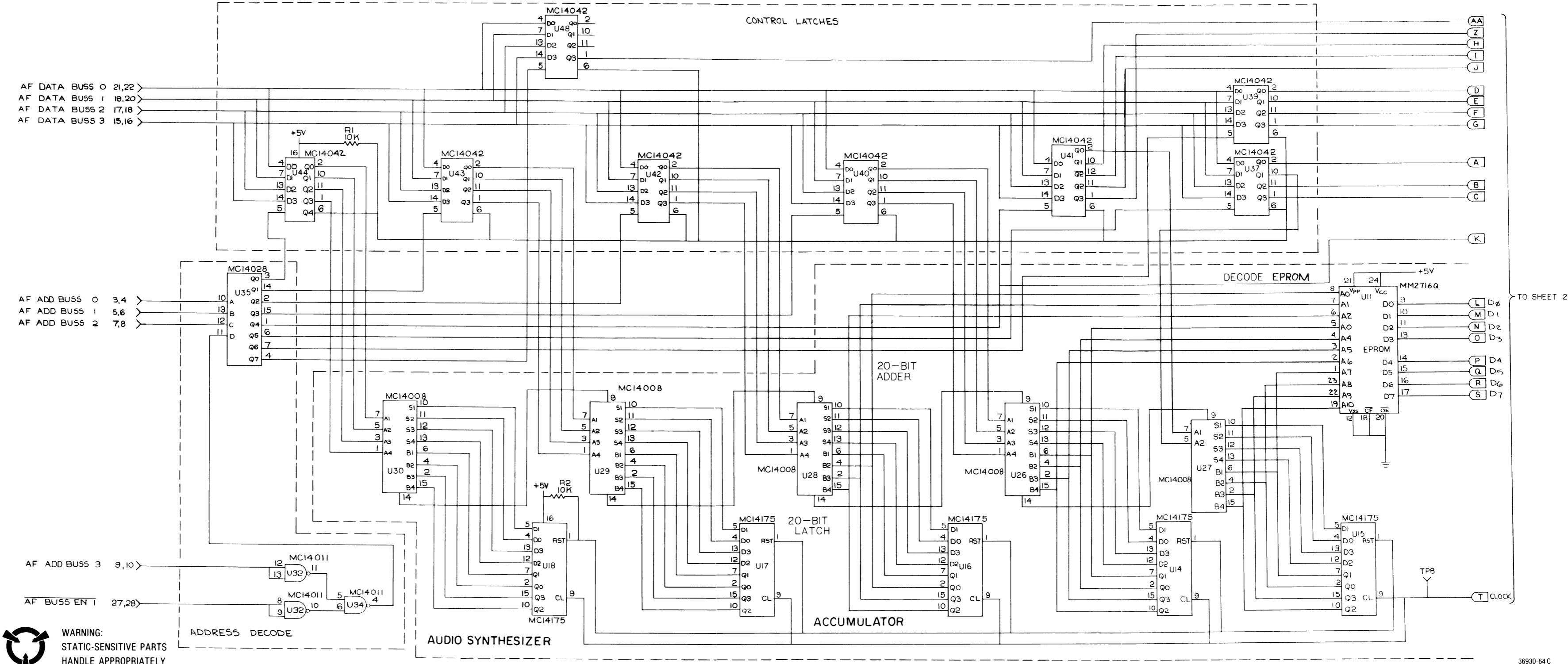
WARNING:
STATIC-SENSITIVE PARTS
HANDLE APPROPRIATELY


* DEPENDS ON PROGRAMMED FREQUENCY.
** AMPLITUDE DEPENDS ON MODE SELECTED.

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Figure 12-2c. Schematic (Sheet 3 of 3)



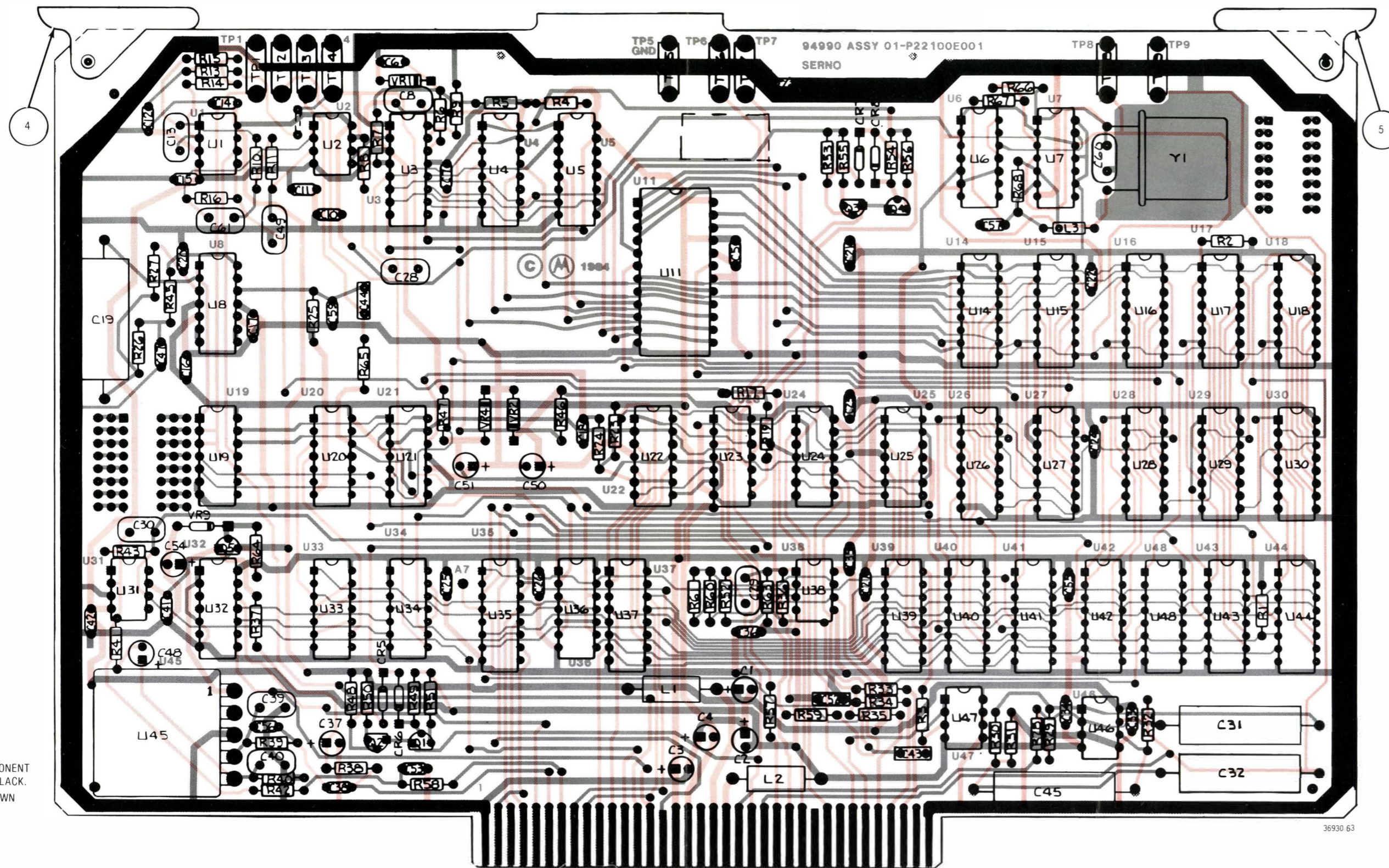
 **WARNING:**
STATIC-SENSITIVE PARTS
HANDLE APPROPRIATELY

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Figure 12-3. Printed Wiring Board Assembly and Parts List



COMPONENTS AND COMPONENT SIDE TRACK SHOWN IN BLACK. SOLDER-SIDE TRACK SHOWN IN ORANGE

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
004	1	45-80339B28	CARD EJECTOR	MARKED
005	1	45-80339B29	CARD EJECTOR	MARKED
C 001	1	23-84665F03	CAPACITOR	100UF-20-25
C 002	1	23-84665F03	CAPACITOR	100UF-20-25
C 003	1	23-80341B15	CAPACITOR	10UF-20-50
C 004	1	23-80341B15	CAPACITOR	10UF-20-50
C 005	1	21-80342B10	CAPACITOR	1UF-20-50
C 006	1	21-80342B10	CAPACITOR	1UF-20-50
C 007	1	21-80342B10	CAPACITOR	1UF-20-50
C 008	1	21-80369A90	CAPACITOR	33PF-5-500
C 010	1	21-80342B10	CAPACITOR	1UF-20-50
C 011	1	21-80342B10	CAPACITOR	1UF-20-50
C 012	1	21-80341B80	CAPACITOR	430PF-5-50
C 013	1	21-00850118	CAPACITOR	100PF-5-500
C 014	1	21-80342B10	CAPACITOR	1UF-20-50
C 015	1	21-80342B10	CAPACITOR	1UF-20-50
C 016	1	21-80342B10	CAPACITOR	1UF-20-50
C 017	1	21-80342B10	CAPACITOR	1UF-20-50
C 018	1	21-80342B10	CAPACITOR	1UF-20-50
C 019	1	08-84326A27	CAPACITOR	0557UF-2-50
C 020	1	21-80341B47	CAPACITOR	1100PF-5-50
C 021	1	21-80342B10	CAPACITOR	1UF-20-50
C 022	1	21-80342B10	CAPACITOR	1UF-20-50
C 023	1	21-80342B10	CAPACITOR	1UF-20-50
C 024	1	21-80342B10	CAPACITOR	1UF-20-50
C 025	1	21-80342B10	CAPACITOR	1UF-20-50
C 026	1	21-80342B10	CAPACITOR	1UF-20-50
C 027	1	21-80342B10	CAPACITOR	1UF-20-50
C 028	1	21-80339B18	CAPACITOR	82PF-5-500
C 029	1	21-80339B19	CAPACITOR	330PF-5-100
C 030	1	21-80339B15	CAPACITOR	39PF-5-500
C 031	1	08-84326A48	CAPACITOR	022UF-1-50
C 032	1	08-84326A48	CAPACITOR	022UF-1-50
C 033	1	21-80342B10	CAPACITOR	1UF-20-50
C 034	1	21-80342B10	CAPACITOR	1UF-20-50
C 035	1	21-80342B10	CAPACITOR	1UF-20-50
C 036	1	21-80342B10	CAPACITOR	1UF-20-50
C 037	1	23-80341B15	CAPACITOR	10UF-20-50
C 038	1	21-80342B10	CAPACITOR	1UF-20-50
C 039	1	21-80369A94	CAPACITOR	150PF-5-500
C 040	1	21-80369A94	CAPACITOR	150PF-5-500
C 041	1	21-80342B10	CAPACITOR	1UF-20-50
C 042	1	21-80342B10	CAPACITOR	1UF-20-50
C 043	1	21-80342B46	CAPACITOR	1UF-20-50
C 044	1	21-80342B46	CAPACITOR	1UF-20-50
C 045	1	08-84326A48	CAPACITOR	022UF-1-50
C 047	1	21-80342B01	CAPACITOR	022UF-10-100
C 048	1	23-80341B15	CAPACITOR	10UF-20-50
C 049	1	21-80339B15	CAPACITOR	39PF-5-500
C 050	1	23-80341B15	CAPACITOR	10UF-20-50
C 051	1	23-80341B15	CAPACITOR	10UF-20-50
C 052	1	21-80342B46	CAPACITOR	1UF-20-50
C 053	1	21-80341B92	CAPACITOR	1000PF-10-100
C 054	1	23-80341B15	CAPACITOR	10UF-20-50
C 055	1	21-80342B10	CAPACITOR	1UF-20-50
C 056	1	21-80342B13	CAPACITOR	047UF-20-50
C 057	1	21-80341B46	CAPACITOR	1000PF-5-50
C 059	1	21-80341B95	CAPACITOR	01UF-20-100
C 060	1	21-00850118	CAPACITOR	100PF-5-500
C 061	1	21-80339B22	CAPACITOR	270PF-5-300
CR005	1	48-84463K02	DIODE	
CR006	1	48-84463K02	DIODE	
CR007	1	48-84463K02	DIODE	
CR008	1	48-84463K02	DIODE	
L 001	1	24-80348A83	COIL	470UH
L 002	1	24-80348A83	COIL	470UH
L 003	1	24-80369A31	COIL	22UH
Q 001	1	48-80340B85	TRANSISTOR	MPS6519
Q 002	1	48-80340B86	TRANSISTOR	MPS6520
Q 003	1	48-80340B86	TRANSISTOR	MPS6520
Q 004	1	48-80340B85	TRANSISTOR	MPS6519
Q 005	1	48-80340B86	TRANSISTOR	MPS6520
R 001	1	06-11009C73	RESISTOR	10K-5-1/4
R 002	1	06-11009C73	RESISTOR	10K-5-1/4
R 003	1	06-11009D06	RESISTOR	220K-5-1/4
R 004	1	06-11009C73	RESISTOR	10K-5-1/4
R 005	1	06-11009C29	RESISTOR	150-5-1/4
R 006	1	06-10621B94	RESISTOR	1K-1-1/4
R 007	1	06-10621C23	RESISTOR	1.96K-1-1/4
R 008	1	06-10621C15	RESISTOR	1.62K-1-1/4
R 009	1	06-10621B94	RESISTOR	1K-1-1/4
R 010	1	06-10621D62	RESISTOR	53.6K-1-1/4
R 011	1	06-10621D62	RESISTOR	53.6K-1-1/4

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Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
R 013	1	06-10621D17	RESISTOR	18.2K-1-1/4
R 014	1	06-10621D04	RESISTOR	13.3K-1-1/4
R 015	1	06-10621D58	RESISTOR	48.7K-1-1/4
R 016	1	06-10621D88	RESISTOR	100K-1-1/4
R 017	1	06-10621D56	RESISTOR	46.4K-1-1/4
R 019	1	06-10621C43	RESISTOR	3.16K-1-1/4
R 023	1	06-11009C73	RESISTOR	10K-5-1/4
R 024	1	06-11009C49	RESISTOR	1K-5-1/4
R 025	1	06-11009D18	RESISTOR	880K-5-1/4
R 026	1	06-11009C97	RESISTOR	100K-5-1/4
R 027	1	06-11009C97	RESISTOR	100K-5-1/4
R 028	1	06-11009C70	RESISTOR	7.5K-5-1/4
R 029	1	06-11009C69	RESISTOR	6.8K-5-1/4
R 030	1	06-10621D48	RESISTOR	38.3K-1-1/4
R 031	1	06-10621B50	RESISTOR	348-1-1/4
R 032	1	06-10621E05	RESISTOR	147K-1-1/4
R 033	1	06-11009C62	RESISTOR	3.6K-5-1/4
R 034	1	06-10621C12	RESISTOR	1.5K-1-1/4
R 035	1	06-10621C60	RESISTOR	4.75K-1-1/4
R 036	1	06-10621C75	RESISTOR	6.81K-1-1/4
R 037	1	06-11009C53	RESISTOR	1.5K-5-1/4
R 038	1	06-11009C43	RESISTOR	560-5-1/4
R 039	1	06-11009C99	RESISTOR	120K-5-1/4
R 040	1	06-11009C73	RESISTOR	10K-5-1/4
R 041	1	06-11009C91	RESISTOR	56K-5-1/4
R 042	1	06-11009C66	RESISTOR	5.1K-5-1/4
R 043	1	06-11009C91	RESISTOR	56K-5-1/4
R 045	1	06-11009C97	RESISTOR	100K-5-1/4
R 046	1	06-11009C25	RESISTOR	100-5-1/4
R 047	1	06-11009C25	RESISTOR	100-5-1/4
R 048	1	06-11009C73	RESISTOR	10K-5-1/4
R 049	1	06-11009C73	RESISTOR	10K-5-1/4
R 050	1	06-11009C25	RESISTOR	100-5-1/4
R 051	1	06-11009C25	RESISTOR	100-5-1/4
R 052	1	06-11009C29	RESISTOR	150-5-1/4
R 053	1	06-11009C73	RESISTOR	10K-5-1/4
R 054	1	06-11009C73	RESISTOR	10K-5-1/4
R 055	1	06-11009C25	RESISTOR	100-5-1/4
R 056	1	06-11009C25	RESISTOR	100-5-1/4
R 057	1	06-11009C49	RESISTOR	1K-5-1/4
R 058	1	06-11009C66	RESISTOR	5.1K-5-1/4
R 059	1	06-11009C73	RESISTOR	10K-5-1/4
R 060	1	06-11009C73	RESISTOR	10K-5-1/4
R 061	1	06-00124B38	RESISTOR	4.7M-5-1/4
R 063	1	06-11009C67	RESISTOR	5.6K-5-1/4
R 064	1	06-11009C67	RESISTOR	5.6K-5-1/4
R 065	1	06-11009C77	RESISTOR	15K-5-1/4
R 066	1	06-11009C49	RESISTOR	1K-5-1/4
R 067	1	06-11009C33	RESISTOR	220-5-1/4
R 068	1	06-11009C46	RESISTOR	750-5-1/4
TP001	1	09-80331A88	JACK	WHITE
TP002	1	09-80331A88	JACK	WHITE
TP003	1	09-80331A88	JACK	WHITE
TP004	1	09-80331A88	JACK	WHITE
TP005	1	09-80331A88	JACK	WHITE
TP006	1	09-80331A88	JACK	WHITE
TP007	1	09-80331A88	JACK	WHITE
TP008	1	09-80331A88	JACK	WHITE
TP009	1	09-80331A88	JACK	WHITE
U 001	1	51-80345A04	INTEGRATED CIRCUIT	CA3240E SCREENED
U 002	1	51-80345A04	INTEGRATED CIRCUIT	CA3240E SCREENED
U 003	1	51-80340B17	INTEGRATED CIRCUIT	
U 004	1	51-84887K30	INTEGRATED CIRCUIT	
U 005	1	51-84887K30	INTEGRATED CIRCUIT	
U 006	1	51-84561L10	INTEGRATED CIRCUIT	SCREENED
U 007	1	51-84561L03	INTEGRATED CIRCUIT	
U 008	1	51-80396A16	INTEGRATED CIRCUIT	LM324N SCREENED
U 011	1	51-82609M11	INTEGRATED CIRCUIT	
U 014	1	51-84887K30	INTEGRATED CIRCUIT	
U 015	1	51-84887K30	INTEGRATED CIRCUIT	
U 016	1	51-84887K30	INTEGRATED CIRCUIT	
U 017	1	51-84887K30	INTEGRATED CIRCUIT	
U 018	1	51-84887K30	INTEGRATED CIRCUIT	
U 019	1	51-82884L71	INTEGRATED CIRCUIT	
U 020	1	51-05596E21	INTEGRATED CIRCUIT	
U 021	1	51-80396A16	INTEGRATED CIRCUIT	LM324N SCREENED
U 022	1	51-80396A16	INTEGRATED CIRCUIT	LM324N SCREENED
U 023	1	51-82884L71	INTEGRATED CIRCUIT	
U 024	1	51-82884L71	INTEGRATED CIRCUIT	
U 025	1	51-80396A16	INTEGRATED CIRCUIT	LM324N SCREENED
U 026	1	51-82884L23	INTEGRATED CIRCUIT	
U 027	1	51-82884L23	INTEGRATED CIRCUIT	
U 028	1	51-82884L23	INTEGRATED CIRCUIT	

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
U 029	1	51-82884L23	INTEGRATED CIRCUIT	
U 030	1	51-82884L23	INTEGRATED CIRCUIT	
U 031	1	51-80345A01	INTEGRATED CIRCUIT	CA3140E SCREENED
U 032	1	51-05596E46	INTEGRATED CIRCUIT	
U 033	1	51-05596E21	INTEGRATED CIRCUIT	
U 034	1	51-05596E46	INTEGRATED CIRCUIT	
U 035	1	51-82884L09	INTEGRATED CIRCUIT	
U 036	1	51-05596E46	INTEGRATED CIRCUIT	
U 037	1	51-82884L15	INTEGRATED CIRCUIT	
U 038	1	51-80345A04	INTEGRATED CIRCUIT	CA3240E SCREENED
U 039	1	51-82884L15	INTEGRATED CIRCUIT	
U 040	1	51-82884L15	INTEGRATED CIRCUIT	
U 041	1	51-82884L15	INTEGRATED CIRCUIT	
U 042	1	51-82884L15	INTEGRATED CIRCUIT	
U 043	1	51-82884L15	INTEGRATED CIRCUIT	
U 044	1	51-82884L15	INTEGRATED CIRCUIT	
U 045	1	01-80714B64	INTEGRATED CIRCUIT	
U 046	1	51-80345A04	INTEGRATED CIRCUIT	CA3240E SCREENED
U 047	1	51-80345A04	INTEGRATED CIRCUIT	CA3240E SCREENED
U 048	1	51-82884L15	INTEGRATED CIRCUIT	
VR001	1	48-80345A80	DIODE,ZENER	2.4V-5.5
VR002	1	48-80345A81	DIODE,ZENER	9.1V-5.5
VR004	1	48-80345A81	DIODE,ZENER	9.1V-5.5
VR009	1	48-82256C11	DIODE,ZENER	10V-5.4
Y 001	1	48-80346A07	CRYSTAL	1.048576MHZ