SECTION 13.
PROCESSOR INTERFACE BOARD (A11)

13.1 DESCRIPTION

The Processor Interface board contains the digital voltmeter (DVM), frequency counter, system timer, and the processor interface for the two system control busses: audio frequency (AF bus) and radio frequency (RF bus). The DVM can measure both dc and ac rms (root-mean-square) voltages. The frequency counter uses two different measuring techniques: the direct count and the reciprocal count.

A block diagram of the Processor Interface board is shown at the end of this section in Figure 13-1, a schematic in Figure 13-2, and the printed wiring board assembly and parts list in Figure 13-3.

13.2 THEORY OF OPERATION

13.2.1 SYSTEM CONTROL-BUS INTERFACE

13.2.1.1 General

Interface between the processor busses and the system is through peripheral-interface adapters (PIA). The PIA is a single integrated-circuit chip that provides 16 input/output latches (PA0-PA7 and PB0-PB7) which can either be read from or written into by the processor. The PIA also contains four control lines: two of these, CA1 and CB1, act as input-only lines for processor interrupts, and the other two, CA2 and CB2, act as output-only control lines. The two system control busses (AF and RF) use a single PIA (U1).

13.2.1.2 AF Control Bus

The AF control bus consists of eight lines split into four data lines (PB0-PB3) and four address lines (PB4-PB7). The address lines define the particular latch in which the data is to be stored, or the buffer from which data is to be obtained. One additional address line, the bus-enable line, is required to enable the address-decoding circuitry. The AF control bus has two bus-enable lines, AF BUS EN 1 and AF BUS EN 2, which provide a total control-bus capability of 128 bits. The AF BUS EN 2 line enables the address-decoder circuitry on the Front-Panel Interface board (A15) and the Processor Interface board (A11). The AF BUS EN 1 line, which comes from the Processor board (A14), enables the address-decoder circuitry on the Scope/DVM Control board (A7) and the Audio Synthesizer board (A10).

13.2.1.3 RF Control Bus

The RF control bus is a clocked serial bus which consists of five data lines (PA1, PA3-PA6), a data clock line (CA2), and a latch line (PA7). The data stream is 24 bits long. Four of these data lines (OFFSET DATA, 310-440 DATA, 24 DATA, and 60.5 DATA) program the phase-locked-loop (PLL) ICs on the Duplex Generator and the RF Synthesizer. These ICs disregard the first 5 bits of the serial data stream and latch-in the last 19 bits. The other data line, PA6 system control, controls the Receiver board (A8) and RF Synthesizer board (A9). The RF Synthesizer is programmed by the first 8 bits of the system-control data line, and the Receiver by the last 16 bits.

13.2.1.4 Timer

The timer (U35) provides interval timing to the processor for tone encoding and decoding and other functions. In the encode interval-timing mode, the processor programs the desired interval and initiates the timer with control words on the data lines and an enable pulse on the E line. The timer will interrupt the processor when the programmed interval is completed. In the decode interval-timing mode, the processor will start and stop the timer. The processor will then read the interval time from the timer. The timer reference frequency is the SYNTH 1 KHz, a 1-kHz square wave locked to the system's reference frequency.

13.2.2 DIGITAL VOLTMETER (DVM)

13.2.2.1 General

The DVM measures either the nine internal voltage points or the external voltages. The levels of the inputs to the DVM are auto-ranged for 3-digit accuracy. The DVM consists of an analog-to-digital (A/D) converter, a root-mean-square (rms) converter, and the DVM/FREQ COUNTER PIA which provides the interface between the DVM and the processor.

13.2.2.2 A/D Converter

The A/D converter (U29) converts positive dc voltages between 0 and 1023 mV into a 10-bit digital word. For negative voltages, the signal is converted to a positive voltage by the rms converter (U27), with the

polarity information detected by the SIGN DETECTOR (U34). The information bit for the sign detector is latched into the DVM/counter buffer (U20). The processor initiates an A/D conversion with a pulse on the start line (U29 PIN21). The A/D converter signals the processor that the conversion is complete by a pulse on the end line (U29 PIN23). The processor, in turn, enables the output drivers on the A/D, sets the DVM/COUNTER buffer to the DVM mode, and inputs the 10-bit word from the A/D and the sign bit.

13.2.2.3 Internal DVM

Internal DVM voltages in the System Analyzer are all positive and proportional to certain parameters in the system. (See Section 9, Scope/DVM Control board A7, paragraph 9.2.8.2.) These signals are auto-ranged over two decades to a 0 to 1-Vdc range on the A7 board and routed to the INT DVM TO A/D input on the A11 board. The processor makes an internal measurement by selecting the internal path which routes the signal directly to the A/D converter for conversion, as described in paragraph 13.2.2.2.

13.2.2.4 External DVM

13.2.2.4.1 General

In the external DVM mode, voltages applied to the input jack on the front panel are auto-ranged on the Front-Panel Interface board (A15) to provide four full-scale displays of 1, 10, 100, and 300V. From A15, the signal is passed directly through the A7 board to the EXT DVM TO A/D input on the A11 board. The resulting dynamic voltage range at the EXT DVM TO A/D input is 0 to 1 Vrms. This signal is amplified at U28 by a voltage gain of 3.5 and applied to the rms-to-dc converter. The resulting output is applied to attenuator R22 with a voltage gain of 1/3.5. The amplifier and attenuator allow the rms-to-dc converter to work with larger signal levels. This provides a net increase in conversion speed. The output of the attenuator is then routed to the A/D converter for conversion, as described in paragraph 13.2.2.2.

13.2.2.4.2 DC/AC Mode

In the dc mode, inputs are low-pass filtered in the A15 board before entering the A11 board. The rms-to-dc converter reads true rms; therefore, the output for a dc input is the positive square root of the input square — that is, the absolute value of the input voltage. The polarity of the signal is determined by the sign detector, U34. In the ac mode, inputs are capacitor-coupled in the A15 board. Therefore, only the rms voltage of the ac component is measured.

13.2.2.5 Distortion Reading

In the distortion-measurement mode, the 1-kHz fundamental of the input is filtered out by a notch filter on the A7 board. The distortion products are routed to the EXT DVM TO A/D input of the A11 board for input to the processor by the A/D converter. The input to the notch filter is rectified and averaged on the A7 board and then routed through the internal DVM circuitry for measurement. To obtain the percent of distortion for a 1-kHz input signal, the processor divides the rms output voltage of the notch filter by the average rectified input voltage to the notch filter.

13.2.3 FREQUENCY COUNTER

13.2.3.1 General

The frequency counter uses two methods to determine frequency: direct counting and reciprocal counting. In this manual the direct method will be called "frequency counter" and the reciprocal method will be called "period counter."

In the direct method, the counter counts cycles of the unknown signal for a precisely known length of time, called a gate time. The resolution of the measured signal is directly proportional to the gate time, one Hertz in one second. The reciprocal method measures frequency by counting the number of internal clock cycles per one period of the unknown signal. This technique makes the resolution of the measured frequency proportional to the frequency of the internal clock. For a 1-MHz internal clock, the measurement of a 1-kHz signal would take 1 msec and provide a resolution of 1 Hz.

Three possible signal sources are available to the frequency counter for frequency determination. The desired signal is selected and sent to the counter by select switch U8. For external inputs, the EXTERNAL COUNTER lines from the Front-Panel Interface board (A15) provide the input which is buffered by U3B, Q4 and Q5 on the A11 board. The signal for off-the-air tone-sequence decode is DEMOD CAL AUDIO, which is routed through the A7 board to the INT SCOPE TO RNG SW line. This signal is connected to A15, where it is routed through the range switch to the EXTERNAL COUNTER input. Monitor frequency error is determined from the IF/BFO FREQ line by comparing that frequency to 700 kHz.

13.2.3.2 Frequency Counter

The frequency counter consists of a gate-time generator (U9-U13), an accumulator (U18, U19), a buffer (DVM/COUNTER BUFFER U20-U22), a PIA (U2, as described in paragraph 13.2.1.1), and control circuitry

(U15, U16, U17B). The control circuitry and the gate-time generator are sequentially gated by a 1-kHz clock. A measurement cycle for the frequency counter begins with a START pulse from PIA line CA2. This pulse resets the gate-time generator and clears the accumulator via the control circuitry (U16A and U16B). On the next cycle of the 1-kHz clock, the accumulator input gate (U17B) is enabled by the control circuitry (U15A). The accumulator will total the cycles of the unknown signal until the time-out of the gate timer or until an accumulator overflow is detected by U8D, U17A, and U17C. This will disable the accumulator input and signal the processor (via the PIA pin, CA1) that the count is complete. The processor, in turn, disables the A/D output drivers, switches the DVM/COUNTER BUFFER to the counter mode, and inputs the 16-bit accumulator information.

The gate-time generator provides gate times of 0.001, 0.01, 0.1, 1, and 10 seconds, which translate to resolutions of 1000, 100, 10, 1, and 0.1 Hz. These gate times are user-selectable or can be auto-selected by the processor to give a 5-digit frequency display with a resolution of 0.1 Hz.

13.2.3.3 Period Counter

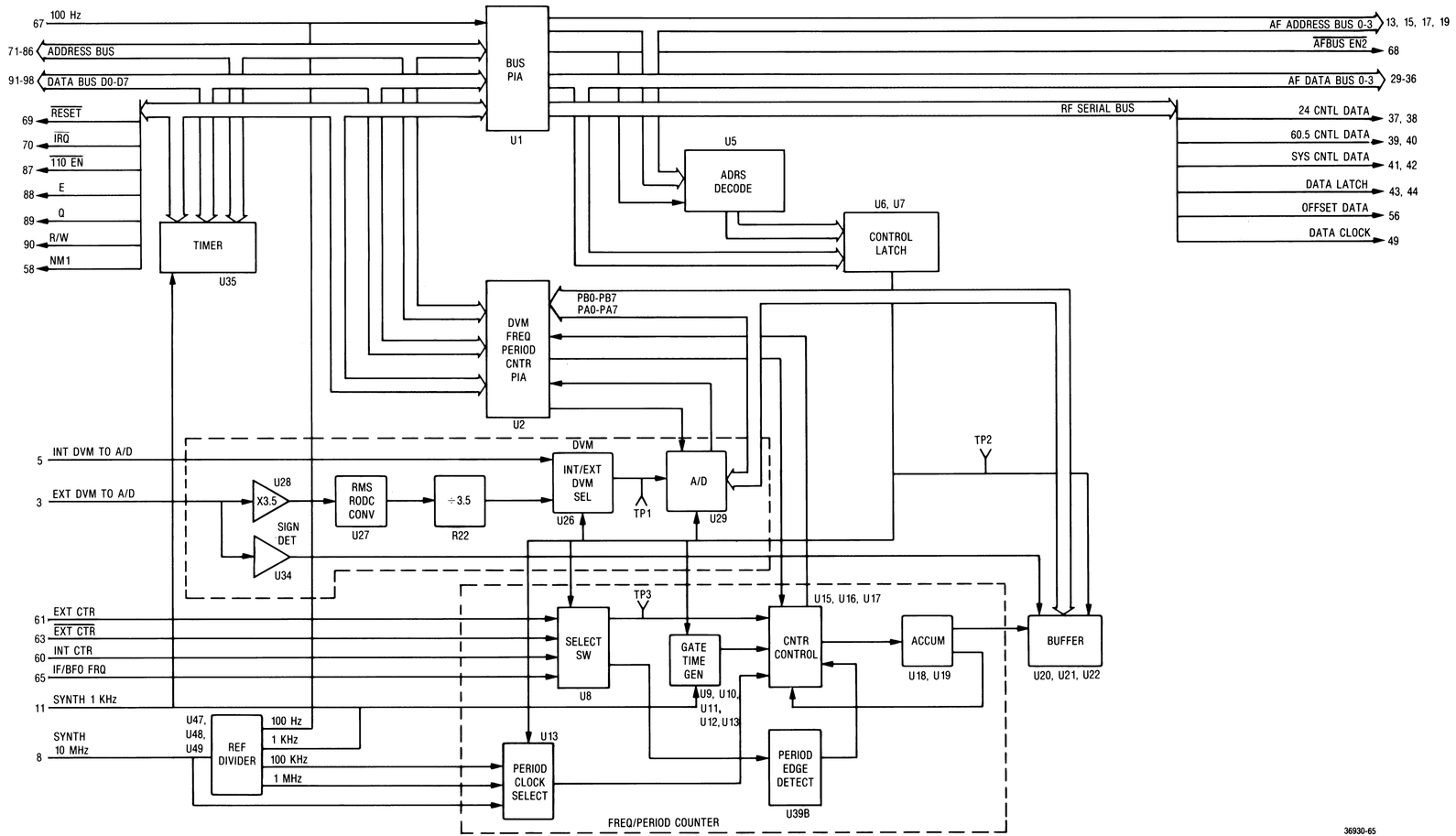
The period counter consists of a clock generator (U46-U49), a positive-edge detector (U39B), control circuitry (U36-40), and the same accumulator, buffer, and PIA as the frequency counter. The control circuitry is sequentially gated at the same rate as the clock generator. A period-counter measurement begins with a START pulse from PIA line CA2. This pulse clears the accumulator (U18, U19) and control circuitry (U38, U39A). The period counter then waits for U39B to detect a positive rising edge of the unknown signal. When a positive edge is detected, the control circuitry will enable the accumulator input gate (U40B). The accumulator will count the cycles of the period-counter clock until the next positive rising edge of one period of the unknown signals. This will disable the accumulator input and signal the processor (via PIA pin CA1) that the count is complete. The processor will then input the data as described above for the frequency counter.

The period-counter clock generator (U47-U49) takes the RF Synthesizer's 10-MHz signal and divides it down to 1 MHz and 100 kHz. These three signals (10 MHz, 1 MHz, and 100 kHz) are selected and sent to the counter by switch U46. These clock rates produce period-counter resolutions of 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, and 1 kHz. The resolutions are user-selectable or can be auto-selected by the processor.

13.2.4 BOARD CONTROL

The processor on the AF control bus controls this board. The 4-bit address (AF ADD BUS 0-3) is decoded by the address decoder (U5, U33, U43) to determine in which control latch (U6, U7, or U42) the control data is to be stored. The four data bits (AF DATA BUS 0-3) are then stored in the selected control latch by a pulse on the AF BUS EN 2 line.

Figure 13-1. Block Diagram



PROCESSOR INTERFACE BOARD (A11)

(RTC-1009A)

Figure 13-2a. Schematic (Sheet 1 of 3)

NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH 1A11.
2. UNLESS OTHERWISE SPECIFIED
   ALL RESISTORS ARE IN OHMS ± 5% PCT, 1/4 WATT(S).
   ALL CAPACITORS ARE IN UF.
   ALL INDUCTORS ARE IN MH.
   ALL VOLTAGES ARE IN DC.

REF DES	DEVICE	+5V	-5V	GND	+12V	-12V	ASSOC CAPS
U1	MC6821	20		1			
U2	MC6821	20		1			C20
U3	MC10116	16		8			C77
U4							
U5	MC14073	14		7			C61
U6	MC14077	16		8			C63
U7	MC14042	16		8			C66
U8	74LS00	14		7			C68
U9	MC14518	16		8			C55
U10	MC14518	16		8			C60
U11	MC14081	14		7			C56
U12	MC14081	14		7			C62
U13	MC14512	16		8			C69
U14							
U15	74LS74	14		7			C53
U16	MC14027	16		8			C58
U17	74LS11	14		7			C52
U18	74LS197	14		7			C54
U19	MC14040	16		8			
U20	MC14503	16		8			C51
U21	MC14503	16		8			C21
U22	MC14503	16		8			C22
U23	74LS86	14		7			C48
U24							
U25							
U26	H1201-5			5	13	9	C11,C12
U27	AD536AKH			2	3	5	
U28	LF356N				7	9	
U29	B704	19	18	20			
U30	LM308A				7	9	C36
U31	MC1403						
U32							
U33	MC14069	14		7			C67
U34	LF356N				7	9	
U35	MC6840C	19		1			C65
U36	74LS10	14		7			C19
U37	74LS00	14		7			C71
U38	74LS74	14		7			C74
U39	74LS74	14		7			C73
U40	74LS08	14		7			C23
U41	74LS245	20		10			C76
U42	MC14042	16		8			C75
U43	MC14073	14		7			C72
U44	74LS27	14		7			
U45	74LS08	14		7			C15
U46	74LS54	14		7			C27
U47	74LS390	16		8			C49
U48	74LS390	16		8			
U49	74LS390	16		8			C50

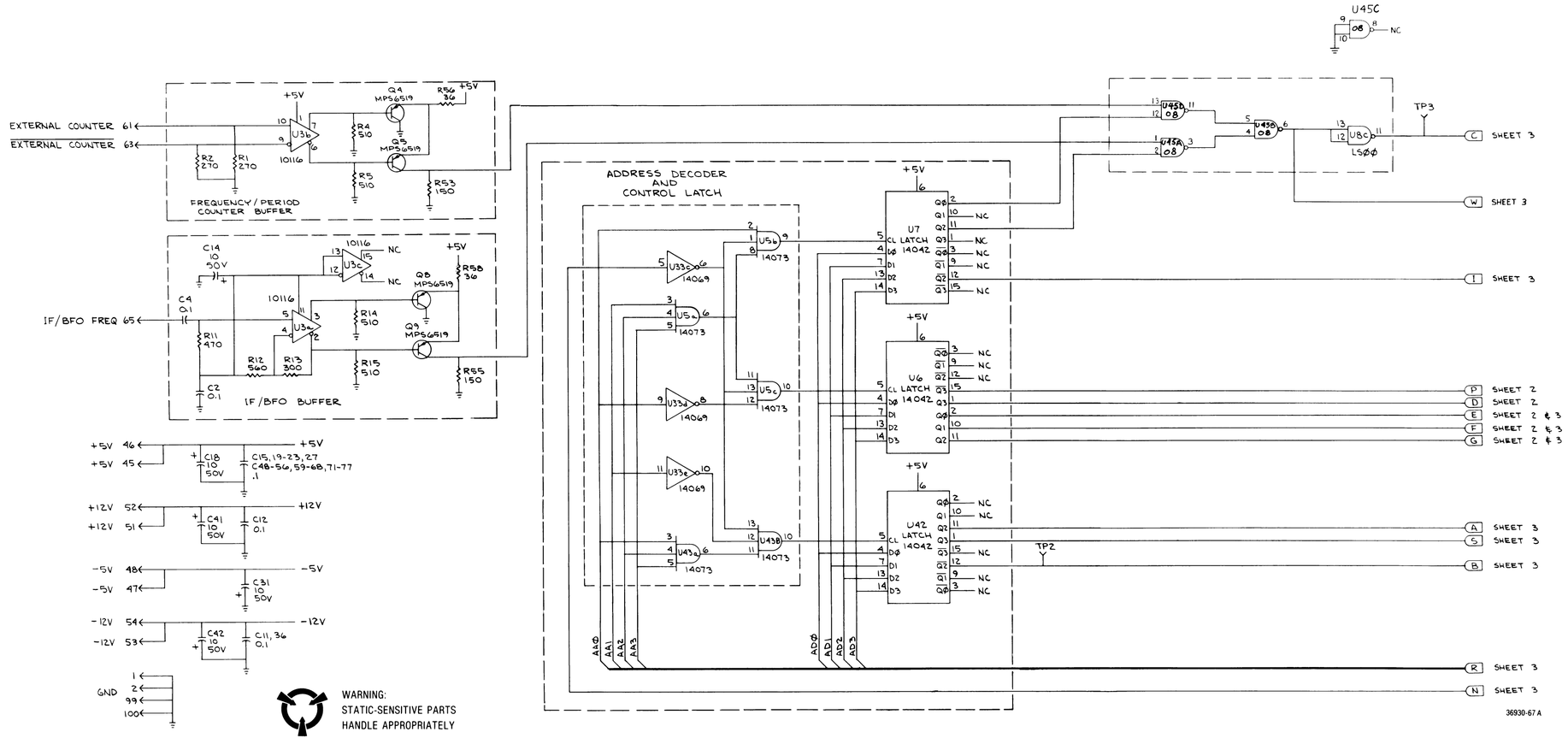
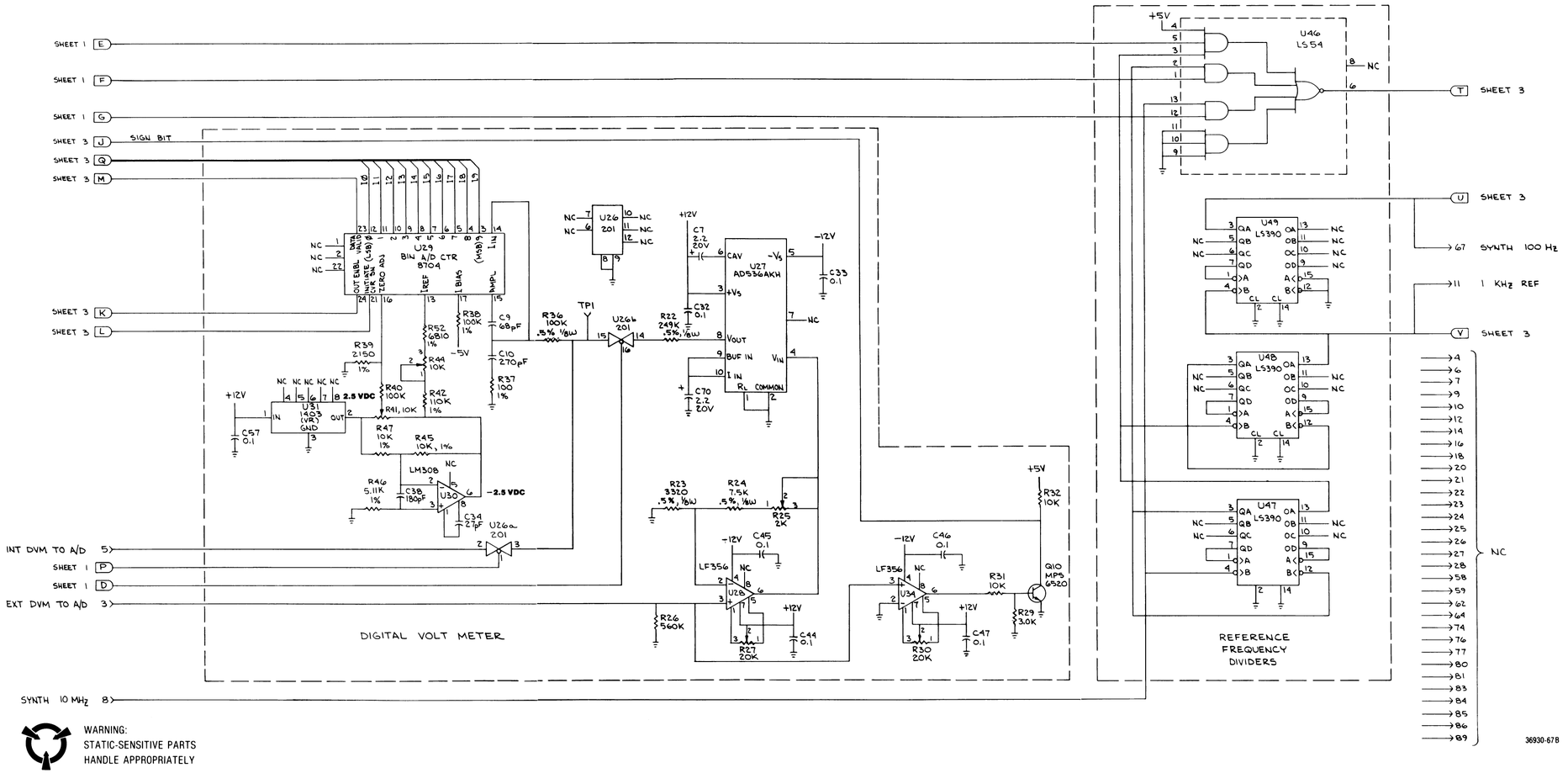


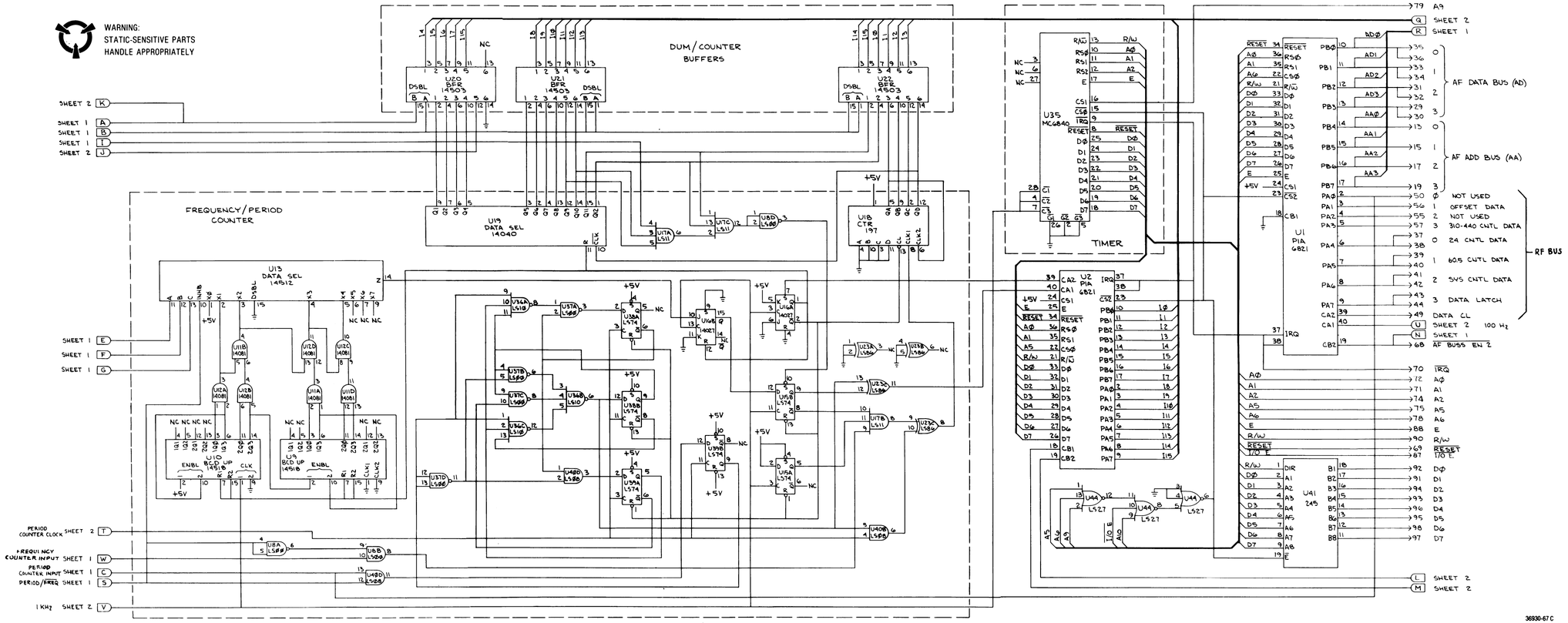
Figure 13-2b. Schematic (Sheet 2 of 3)

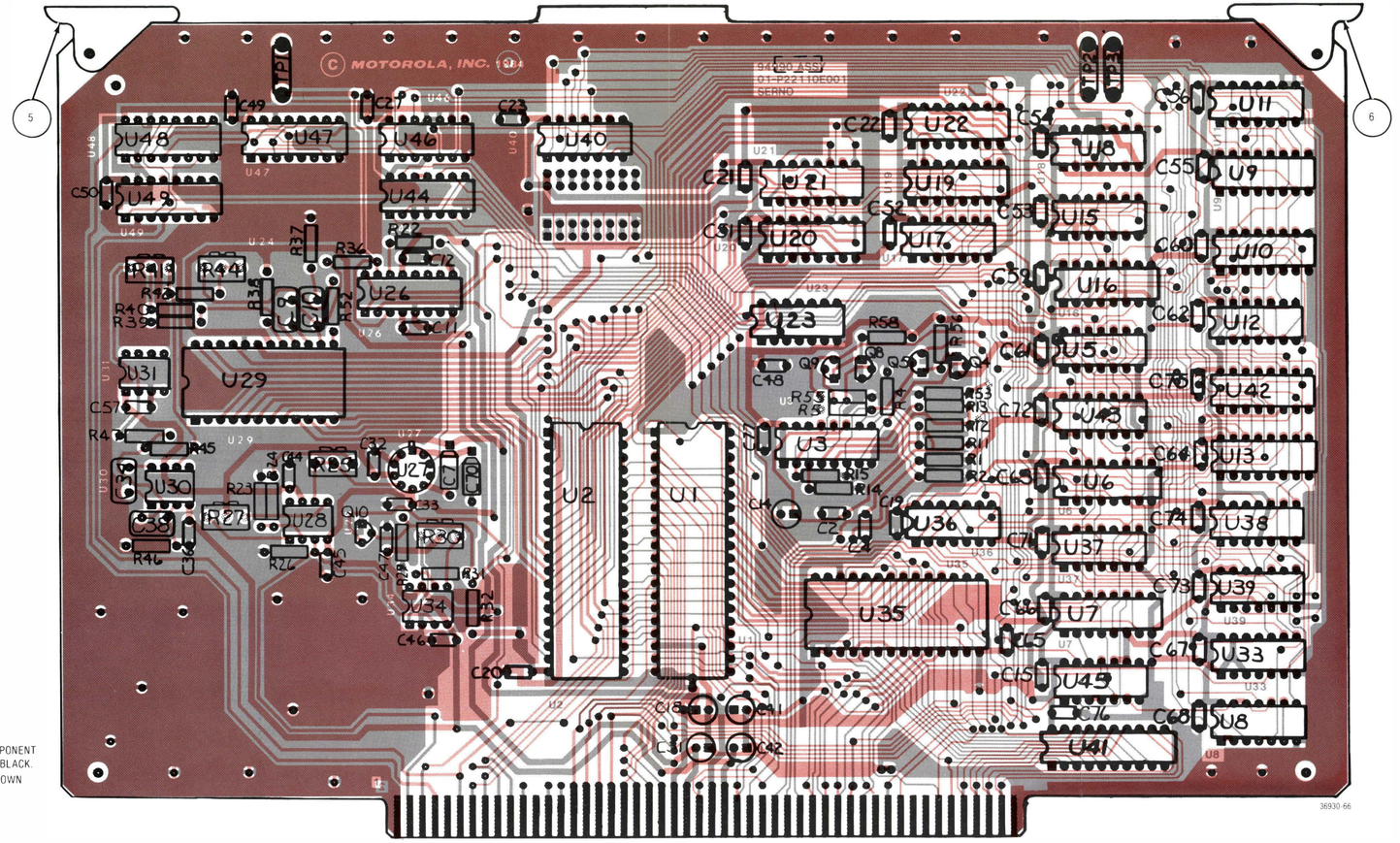


PROCESSOR INTERFACE BOARD (A11)

(RTC-1009A)

Figure 13-2c. Schematic (Sheet 3 of 3)





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

PROCESSOR INTERFACE BOARD (A11)
RTC-1009A

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
005	1	45-80339B28	CARD EJECTOR	
006	1	45-80339B30	CARD EJECTOR	MARKED
C 002	1	21-80342B10	CAPACITOR	1UF-20-50
C 004	1	21-80342B10	CAPACITOR	1UF-20-50
C 007	1	23-80341B02	CAPACITOR	2.2UF-20-20
C 009	1	21-80396A47	CAPACITOR	68PF-5-500
C 010	1	21-80339B22	CAPACITOR	270PF-5-300
C 011	1	21-80342B10	CAPACITOR	1UF-20-50
C 012	1	21-80342B10	CAPACITOR	.1UF-20-50
C 014	1	23-80341B15	CAPACITOR	10UF-20-50
C 015	1	21-80342B10	CAPACITOR	1UF-20-50
C 018	1	23-80341B15	CAPACITOR	10UF-20-50
C 019	1	21-80342B10	CAPACITOR	1UF20-50
C 020	1	21-80342B10	CAPACITOR	1UF-20-50
C 021	1	21-80342B10	CAPACITOR	1UF20-50
C 022	1	21-80342B10	CAPACITOR	1UF-20-50
C 023	1	21-80342B10	CAPACITOR	1UF-20-50
C 027	1	21-80342B10	CAPACITOR	1UF-20-50
C 031	1	23-80341B15	CAPACITOR	10UF-20-50
C 032	1	21-80342B10	CAPACITOR	1UF-20-50
C 033	1	21-80342B10	CAPACITOR	.1UF-20-50
C 034	1	21-80369A89	CAPACITOR	27PF-5-500
C 036	1	21-80342B10	CAPACITOR	.1UF-20-50
C 038	1	21-80369A95	CAPACITOR	180PF-5-500
C 041	1	23-80341B15	CAPACITOR	10UF-20-50
C 042	1	23-80341B15	CAPACITOR	10UF-20-50
C 044	1	21-80342B10	CAPACITOR	1UF-20-50
C 045	1	21-80342B10	CAPACITOR	1UF-20-50
C 046	1	21-80342B10	CAPACITOR	1UF-20-50
C 047	1	21-80342B10	CAPACITOR	1UF-20-50
C 048	1	21-80342B10	CAPACITOR	1UF-20-50
C 049	1	21-80342B10	CAPACITOR	1UF-20-50
C 050	1	21-80342B10	CAPACITOR	1UF-20-50
C 051	1	21-80342B10	CAPACITOR	1UF-20-50
C 052	1	21-80342B10	CAPACITOR	1UF-20-50
C 053	1	21-80342B10	CAPACITOR	1UF-20-50
C 054	1	21-80342B10	CAPACITOR	1UF-20-50
C 055	1	21-80342B10	CAPACITOR	1UF-20-50
C 056	1	21-80342B10	CAPACITOR	1UF-20-50
C 057	1	21-80342B10	CAPACITOR	1UF-20-50
C 059	1	21-80342B10	CAPACITOR	1UF-20-50
C 060	1	21-80342B10	CAPACITOR	1UF-20-50
C 061	1	21-80342B10	CAPACITOR	1UF-20-50
C 062	1	21-80342B10	CAPACITOR	1UF-20-50
C 063	1	21-80342B10	CAPACITOR	1UF-20-50
C 064	1	21-80342B10	CAPACITOR	1UF-20-50
C 065	1	21-80342B10	CAPACITOR	1UF-20-50
C 066	1	21-80342B10	CAPACITOR	1UF-20-50
C 067	1	21-80342B10	CAPACITOR	1UF-20-50
C 068	1	21-80342B10	CAPACITOR	.1UF-20-50
C 070	1	23-80341B02	CAPACITOR	2.2UF-20-20
C 071	1	21-80342B10	CAPACITOR	1UF-20-50
C 072	1	21-80342B10	CAPACITOR	1UF-20-50
C 073	1	21-80342B10	CAPACITOR	1UF-20-50
C 074	1	21-80342B10	CAPACITOR	1UF-20-50
C 075	1	21-80342B10	CAPACITOR	.1UF-20-50
C 076	1	21-80342B10	CAPACITOR	1UF-20-50
C 077	1	21-80342B10	CAPACITOR	.1UF-20-50
Q 004	1	48-80340B85	TRANSISTOR	MPS6519
Q 005	1	48-80340B85	TRANSISTOR	MPS6519
Q 008	1	48-80340B85	TRANSISTOR	MPS6519
Q 009	1	48-80340B85	TRANSISTOR	MPS6519
Q 010	1	48-80340B86	TRANSISTOR	MPS6520
R 001	1	06-11009C35	RESISTOR	270-5-1/4
R 002	1	06-11009C35	RESISTOR	270-5-1/4
R 004	1	06-11009C42	RESISTOR	510-5-1/4
R 005	1	06-11009C42	RESISTOR	510-5-1/4
R 011	1	06-11009C41	RESISTOR	470-5-1/4
R 012	1	06-11009C43	RESISTOR	560-5-1/4
R 013	1	06-11009C61	RESISTOR	3.3K-5-1/4
R 014	1	06-11009C42	RESISTOR	510-5-1/4
R 015	1	06-11009C42	RESISTOR	510-5-1/4
R 022	1	06-80396A66	RESISTOR	249K-.5-1/8
R 023	1	06-80396A67	RESISTOR	3.32K-.5-1/8
R 024	1	06-80396A69	RESISTOR	7.5K-.5-1/8
R 025	1	18-83452F01	RESISTOR,VARIABLE	2K
R 026	1	06-11009D16	RESISTOR	560K-5-1/4
R 027	1	18-83452F15	RESISTOR,VARIABLE	20K
R 029	1	06-11009C60	RESISTOR	3K-5-1/4
R 030	1	18-83452F15	RESISTOR,VARIABLE	20K
R 031	1	06-11009C73	RESISTOR	10K-5-1/4
R 032	1	06-11009C73	RESISTOR	10K-5-1/4

PROCESSOR INTERFACE BOARD (A11)
(RTC-1009A)

Figure 13-3. Printed Wiring Board Assembly and Parts List

PROCESSOR INTERFACE BOARD (A11) (Cont)
RTC-1009A

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
R 036	1	06-80396A59	RESISTOR	100K-.5-1/8
R 037	1	06-10621A97	RESISTOR	100-1-1/4
R 038	1	06-10621D88	RESISTOR	100K-1-1/4
R 039	1	06-10621C27	RESISTOR	2.15K-1-1/4
R 040	1	06-10621D88	RESISTOR	100K-1-1/4
R 041	1	18-83452F13	RESISTOR,VARIABLE	10K
R 042	1	06-10621D92	RESISTOR	110K-1-1/4
R 044	1	18-83452F13	RESISTOR,VARIABLE	10K
R 045	1	06-10621C91	RESISTOR	10K-1-1/4
R 046	1	06-10621C63	RESISTOR	5.11K-1-1/4
R 047	1	06-10621C91	RESISTOR	10K-1-1/4
R 052	1	06-10621C75	RESISTOR	6.81K-1-1/4 NOMINAL
R 053	1	06-11009C29	RESISTOR	150-5-1/4
R 055	1	06-11009C29	RESISTOR	150-5-1/4
R 056	1	06-11009C14	RESISTOR	36-5-1/4
R 058	1	06-11009C14	RESISTOR	36-5-1/4
TP001	1	09-80331A88	JACK	WHITE
TP002	1	09-80331A88	JACK	WHITE
TP003	1	09-80331A88	JACK	WHITE
U 001	1	51-82807K20	INTEGRATED CIRCUIT	
U 002	1	51-82807K20	INTEGRATED CIRCUIT	
U 003	1	51-80323A60	INTEGRATED CIRCUIT	
U 005	1	51-82884L60	INTEGRATED CIRCUIT	
U 006	1	51-82884L15	INTEGRATED CIRCUIT	
U 007	1	51-82884L15	INTEGRATED CIRCUIT	
U 008	1	51-84561L04	INTEGRATED CIRCUIT	
U 009	1	51-82884L12	INTEGRATED CIRCUIT	
U 010	1	51-82884L12	INTEGRATED CIRCUIT	
U 011	1	51-84371K93	INTEGRATED CIRCUIT	
U 012	1	51-84371K93	INTEGRATED CIRCUIT	
U 013	1	51-82884L75	INTEGRATED CIRCUIT	
U 015	1	51-83627M93	INTEGRATED CIRCUIT	
U 016	1	51-82884L10	INTEGRATED CIRCUIT	
U 017	1	51-84561L44	INTEGRATED CIRCUIT	
U 018	1	51-80368A75	INTEGRATED CIRCUIT	SN74LS197N
U 019	1	51-05467G07	INTEGRATED CIRCUIT	
U 020	1	51-82884L74	INTEGRATED CIRCUIT	
U 021	1	51-82884L74	INTEGRATED CIRCUIT	
U 022	1	51-82884L74	INTEGRATED CIRCUIT	
U 023	1	51-82609M79	INTEGRATED CIRCUIT	
U 026	1	51-80345A05	INTEGRATED CIRCUIT	HI-201-5 SCREENED
U 027	1	51-80396A18	INTEGRATED CIRCUIT	AD536AKH SCREENED
U 028	1	51-80339B97	INTEGRATED CIRCUIT	
U 029	1	51-80396A17	INTEGRATED CIRCUIT	8704CJ SCREENED
U 030	1	51-80365A27	INTEGRATED CIRCUIT	
U 031	1	51-05469E13	INTEGRATED CIRCUIT	
U 033	1	51-05596E02	INTEGRATED CIRCUIT	
U 034	1	51-80339B97	INTEGRATED CIRCUIT	
U 035	1	51-82848M44	INTEGRATED CIRCUIT	
U 036	1	51-84561L08	INTEGRATED CIRCUIT	
U 037	1	51-84561L04	INTEGRATED CIRCUIT	
U 038	1	51-83627M93	INTEGRATED CIRCUIT	
U 039	1	51-83627M93	INTEGRATED CIRCUIT	
U 040	1	51-84561L07	INTEGRATED CIRCUIT	
U 041	1	51-82609M57	INTEGRATED CIRCUIT	
U 042	1	51-82884L15	INTEGRATED CIRCUIT	
U 043	1	51-82884L60	INTEGRATED CIRCUIT	
U 044	1	51-84561L38	INTEGRATED CIRCUIT	
U 045	1	51-84561L04	INTEGRATED CIRCUIT	
U 046	1	51-80340B83	INTEGRATED CIRCUIT	
U 047	1	51-82609M68	INTEGRATED CIRCUIT	74LS390 SCREENED
U 048	1	51-82609M68	INTEGRATED CIRCUIT	74LS390 SCREENED
U 049	1	51-82609M68	INTEGRATED CIRCUIT	74LS390 SCREENED