AM FREQUENCY AND MODULATION MONITOR

MODEL 713

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TIME AND FREQUENCY TECHNOLOGY, INC.

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MODEL 713

Frank Stoltenberg

TIME & FREQUENCY TECHNOLOGY, INC.
3000 Olcott Street
Santa Clara, Ca. 95050
246-6365

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SECTION 1

GENERAL INFORMATION

1.1 General Description.

The Model 713 AM Frequency and Modulation Monitor is intended for continuous monitoring of an AM transmitter operating in the standard broadcast band (540 to 1600 kHz) to enable the station to comply with the requirements of Sections 73.56 and 73.60 of the FCC Rules and Regulations. The Monitor, which is factory-adjusted for the customer's assigned transmitter frequency, provides digital display of the carrier frequency error, and direct peak-reading meter indication of modulation percentage. Other features include --

- An extremely stable built-in frequency standard with an aging rate of 1 ppm per year, eliminating the need for frequent calibration.
- A flasher to indicate 100-percent negative modulation peaks.
- An adjustable flasher to indicate positive or negative modulation peaks.
- Optional binary-coded-decimal (BCD) or analog output for automatic logging of frequency error.

1.2 Specifications.

RF Input

Frequency Range	540 - 1600 kHz
Sensitivity	Approx. 1.0 mV, 40 dB automatic gain control range
Input level (without ext. pad).	1.0 mV to 100 mV
(with ext. pad)	100 mV to 5 V
Selectivity	
±10 kHz	0.25 dB
±11 kHz	-3 dB
±20 kHz	-40 dB
±30 kHz	-60 dB
Input impedance	50 ohms nominal
Input connector	BNC
Image rejection	50 dB or greater

1.2 (Continued)

Carrier Frequency Measurement

Digital readout	Zero to ±1 kHz in 1 Hz increments from assigned center frequency
Accuracy	±2 Hz/year
Internal frequency standard	Uses a precision 5-MHz crystal oscillator in a proportional-controlled oven. One-MHz output is provided on the front panel for calibration against WWVB or a precision frequency source.
Off frequency alarm	Available as an option. Can be wired for desired frequency limits.
Automatic logging output	Available as an option. BCD outputs or a ±1 VDC output representing a carrier frequency error of ±20Hz.

Modulation Meter

Meter range	Switchable, 0 to 133% on positive peaks, 0 to 100% on negative peaks.
Accuracy	±2% at 100% modulation, ±4% at any other % modulation for modulation frequency between 30 Hz and 10 kHz.
Meter characteristics	Peak reading circuit, scale and ballistics conform to FCC requirements.
Remote metering	Output provided for Model 704A.

Peak Modulation Indicators

Variable peak indicator	Level set by front-panel 3-digit thumbwheel switch in 1% steps, 50 to 129% on positive peaks, 50 to 100% on negative peaks.
Fixed peak indicator	99.5% or greater on negative modulation only.
Accuracy	±2%
Response time	200 sec pulse
Remote Indicators	Output provided for Model 704A

Modulation Calibrator

Built-in modulation calibrator indicats ±100% modulation

Accuracy . . . . ±2%

Six-Digit Frequency Counter

Frequency range	10 Hz to 10 MHz
Input sensitivity	200 mV to 2V RMS
Input impedance	500K ohms. Shunted by 25pF
Resolution	1 Hz or 10 Hz front panel switchable
Display Accuracy	±1 count
Time base aging rate	1×10^{-8}/day

Rear Panel Outputs

Audio	Two volts RMS into 600 ohms at 100% modulation, ±0.5 dB 30 Hz to 10 kHz, less than 1% harmonic distortion.
Standard frequencies	1 kHz, TTL logic level
Local oscillator frequency	100 mV RMS, 50 ohms
Remote meter and peak flasher	For use with Model 704A remote meter and peak flasher panel.
Telemetry output	Available as an option. Subaudible telemetry signal recovered through low-pass filter, 1.5 V. p.p. at 5% modulation, 600 ohms unbalanced.
Peak modulation indication.	A relay contact closure when peak modulation exceeds the limit set on front panel thumbwheel switch.

Physical and Environmental Specifications

Power	115/230V, 50-400 Hz, 30 watts max.
Operating temperature	0° to +50°C
Dimensions	19" W x 7" H x 16" D
Weight	17 pounds
Cabinet	Rack mounting.

1.3 Accessory Equipment.

Model 704A Remote Meter and Peak Flasher Panel: Duplicates meter and peak flasher readings of the Model 713.

Model 722 Resonant Loop Antenna: For use with Model 713 where relatively strong signal is available.

1.4 **Warranty.**

TIME & FREQUENCY TECHNOLOGY, INC., warrants each of the instruments of its manufacture to be produced to meet the specifications delivered to the BUYER; and to be free from defects in material and workmanship and will repair or replace, at its expense, for a period of one year from the date of delivery of equipment, any parts which are defective from faulty material or poor workmanship.

Instruments found to be defective during the warranty period shall be returned to the factory with transportation charges prepaid by BUYER. It is expressly agreed that replacement and repair shall be the sole remedy of BUYER with respect to any nonconforming equipment and parts thereof and shall be in lieu of any other remedy available by applicable law. All returns to the factory must be authorized by the SELLER, prior to such returns. Upon examination by the factory, if the instrument is found to be defective, the unit will be repaired and returned to the BUYER, with transportation charges prepaid by SELLER.

Transportation charges for instruments found to be defective within the first thirty (30) days of the warranty period will be paid both ways by the SELLER.

Transportation charges for warranty returns, wherein failure is found not to be the fault of the SELLER, shall be paid both ways by the BUYER.

This warranty does not apply to instruments which, in the opinion of the SELLER, have been altered or misused.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. TFT IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

1.5 **Claim for Damage in Shipment.**

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier, or if insured separately, with the insurance company.

WE SINCERELY PLEDGE OUR IMMEDIATE AND FULLEST COOPERATION TO ALL USERS OF OUR PRECISION ELECTRONIC INSTRUMENTS.

PLEASE ADVISE US IF WE CAN ASSIST YOU IN ANY MANNER

Time & Frequency Technology, Inc.
3000 Olcott St.
Santa Clara, Ca. 95050

408-246-6365

SECTION 2

INSTALLATION

2.1 Unpacking and Inspection.

Upon receiving the instrument, inspect the packing box and instrument for signs of possible shipping damage. Operate the instrument in accordance with the procedures of Section 3 of this manual. If the instrument is damaged or fails to operate properly, file a claim with the transportation company, or with the insurance company if insured seperately.

2.2 Power Requirements.

The Model 713 is factory wired to operate from either a 115-volt or a 230-volt AC source. A marking on the rear panel of the instrument indicates which voltage is to be used. The line frequency must be between 50 and 400 hertz. Maximum power required is 30 watts.

2.3 Installation Remote from Transmitter.

When the instrument is installed in the studio, or any place distant from the transmitter, a rooftop antenna must be used. Where a strong strong signal can be expected (ie greater than 40 mV/meter) the Model 722 Resonant Loop Antenna may be used. In lower signal locations a long wire (approximately 200 ft.) can be used with good results. When the Model 722 is used a 50 ohm coax should be used to connect the antenna to the Model 713. When a long wire is used it can be connected at the R. F. Input of the Model 713, a 51 ohm resistor should also be connected from the input to the chassis ground. The procedure for proper adjustment of the input level is as follows:

a. Depress the PWR ON switch, CARRIER LEVEL switch and MAIN CARR switches on the Model 713 front panel.

b. Connect a D.C. Voltmeter with at least 20,000 ohms per volt impedance to pin D of the 9-pin rear-panel connector. This is the I. F. AGC Voltage. For the AGC to be in its operable range this voltage should be less than +5 volts and greater than +2 volts. The range between 2.5 and 2.75 volts is optimum.

c. When the Model 722 antenna is incorporated, rotate the antenna until a minimum AGC voltage read on the DC voltmeter. When a resonant loop antenna is contructed, change the value of "C" until a null is realized. (Fig. 3-2). (Note: the AGC voltage decreases as the RF level into the Model 713 increases.) If the AGC voltage goes below 2.0 volts, too much RF signal is being received and an attenuator pad must be inserted in the RF cable from the antenna.

d. With the AGC voltage in the proper range, adjust the CARRIER LEVEL pot such that the CARRIER LEVEL meter is at the SET position.

The monitor is now ready for use.

2.4 Installation at Transmitter Site.

When the instrument is installed at the transmitter site, connect the external 40-dB pad furnished between the Monitor and the modulated RF sampling point on the transmitter.

CAUTION

DO NOT CONNECT INSTRUMENT DIRECTLY TO THE TRANSMITTER RF SAMPLING POINT WITHOUT USING THE PAD.

Install a one-quarter inch wide braided ground wire from the Model 713 chassis to the transmitter ground bus.

When the Model 713 is connected at the transmitter, it may be operated in the Automatic Gain Control Mode or by Manual Gain Control. For operation in the AGC mode set the instrument up as in paragraph 2.3 except adjust the transmitter coupling for the proper AGC Voltage. To use the instrument in the Manual Gain Control Mode complete the adjustment of the input level as outlined above. Pull the center portion of the CARRIER LEVEL control to its outer position and rotate the outer knob until the Carrier Level Meter reads on the "SET" mark. The monitor is now ready to measure changes in carrier power as well as modulation and carrier frequency.

2.5 Automatic Logging Connection.

As an option, the Model 713 can be supplied with the BCD outputs of the digital display brought out to rear-panel connector J1 to operate automatic logging equipment. Refer to the Model 713 wiring diagram for pin connections. (Fig. 6-2) An analog voltage representing the carrier frequency error can be supplied on request as an option. This voltage is also brought out to rear-panel connector J1 to operate automatic logging equipment which accepts only analog signals. (Ref. Section 4.2.8).

SECTION 3

OPERATION

3.1 General.

The Model 713 AM Frequency and Modulation Monitor displays the frequency error of the carrier being monitored. It also displays modulation percentage and provides a flashing indication when the modulation percentage exceeds 99.5percent on negative peaks and when it exceeds a preset limit on either positive or negative peaks depending on the selection of the front panel switch. The Model 713 can also be used as a general-purpose six-digit frequency counter.

3.2 Front-Panel and Rear-Panel Controls.

The front-panel controls, connectors, and indicators of the Model 713 are described in Table 3-1 and illustrated in Figure 3-1. Rear-panel controls and connectors are described in Table 3-2 and illustrated in Figure 3-1.

3.3 Turn-On and Warm-up.

Check the marking on the rear panel to make sure the instrument is wired for the line voltage to be used (115 volts or 230 volts). Plug the line cord into the power source, and allow 30 minutes for the crystal oscillator oven temperature to stabilize. Energize the instrument by depressing the PWR ON switch. Depress the MAIN CARR switch to place the instrument in the monitoring mode. If the monitor is at the transmitter site, connect the rear-panel RF INPUT connector to the transmitter RF coupler through a 40-dB pad, as described in Section 2.4, and adjust the input level as described in that section.

If the Monitor is used at the remote control location, refer to Section 2.3 of this manual for proper adjustment.

3.4 Measurement of Amplitude Modulation Using Modulation Meter.

The modulation meter is used by simply pushing either the "+" or "-" switch on the front panel. The meter gives a quasi-peak indication of either "+" or "-" peak modulation depending upon front-panel selection. For maximum accuracy the modulation meter calibration should be checked regularly and adjusted if necessary. Calibration of the meter is performed by depressing the CAL button and adjusting the METER CAL control until the meter reads exactly 100 percent.

3.5 Peak Flasher Operation

The peak flasher is intended to catch fast transients and peaks that the meter cannot respond to. The peak flasher is operated by depressing either

3.5 (Continued)

the "+" or "-" switch and setting the thumbwheel switches to the desired percentage of modulation. If the modulation then exceeds that number in the direction selected, the flasher lamp will go on, and stay on for approximately 2 seconds. The peak flasher accuracy should also be checked regularly and adjusted if necessary. Peak flasher calibration is achieved by depressing the CAL button, setting the thumbwheel switches for 100 percent, and adjusting the FLASHER CAL control until the peak flasher lamp just comes on.

3.6 Carrier Frequency Error Measurement.

To measure the carrier frequency error, depress the MAIN CARR switch. THE DIGITAL DISPLAY THEN INDICATES THE NUMBER OF kHz (IN 1-Hz INCREMENTS) THAT THE CARRIER FREQUENCY DEVIATES FROM ITS ASSIGNED FREQUENCY. The "+" and "-" on the digital display indicate whether the carrier is above or below the assigned frequency, respectively.

3.7 Use of the Model 713 As a General-Purpose Counter.

The Model 713 can be used as a six-digit precision frequency counter at frequencies up to 10 MHz by depressing the front-panel CTR switch and applying the signal to be measured to the front-panel COUNTER INPUT connector. *The signal level must not exceed 2 volts. If it does, the use of a 10:1 oscilloscope* voltage-divider probe is recommended.

When operating in the Counter mode, the instrument performs as a conventional counter, with the count being displayed on the six digital readout tubes. When the 10 Hz/1 Hz COUNTER switch is depressed, frequency measurements are in 1-hertz increments from 0 to 999.999 kHz; when the 10 Hz/1 Hz switch is out, measurements are in 10-hertz increments from 0 to 9,999.99 kHz. Illumination of the OVERFLOW lamp indicates that the counter's limit has been exceeded.

3.8 Use of the Model 704A Remote Meter and Peak Flasher Panel.

This panel duplicates the indications of the front-panel MODULATION meter and the variable and -100% peak flasher lamps. The 50-foot cable from the Model 704A plugs into the 9-pin connector on the rear panel of the Model 713.

3.9 Off-Frequency Alarm (Optional).

The Model 713 contains a relay whose contacts close when the measured carrier frequency error exceeds a predetermined frequency error, i.e. ±10 Hz. An external alarm can be connected to the relay contacts through Pins B and H (ground) of the rear-panel 9-pin connector. Maximum power-handling capability of the relay contacts is 500 milliamperes at 50 volts.

3.10 Audio Output

An audio output is available at the AUDIO connector on the rear panel. Its level is approximately 4 volts RMS into an open circuit, and it can be fed into a distortion analyzer to measure system distortion. It can also be used to operate high-impedance earphones if desired. (600Ω output impedance)

3.11 Automatic Logging (Optional).

When this option is selected, the BCD output of the digital display is brought out to rear-panel connector J1 to drive external automatic logging equipment. Analog output is also available on request as an option.

3.12 Subaudible Telemetry (Optional).

When this option is incorporated, subaudible telemetry modulation on the carrier is delivered to the rear-panel TELEMETRY OUTPUT connector through a low-pass filter and amplifier.

3.13 Peak Modulation Indicator.

The Model 713 contains a relay which is energized when the peak modulation exceeds the limit set on the front-panel thumbwheel switch. The normally open relay contacts close to short the rear-panel banana jacks together. The contacts are floating with respect to the chassis and therefore can be hooked up in many different ways to ring an alarm or trigger an event counter.

3.14 Carrier Power Alarm (Optional).

When the Model 713 is directly connected to the transmitter and operated in the Mainual Gain Control mode this option provides a relay closure if the carrier level changes by +5% or -10%. When the Model 713 is operated in the Automatic Gain Control Mode this same option still reads a +5% or -10% power shift, however, in the AGC mode this will only register if there is an abrupt change in power level or if the signal drops out altogether, hence signaling the carrier is turned off.

Table 3-1. Front-Panel Controls, Connectors, and Indicators

Fig. 3-1 Ref. No.	Name	Function
1	COUNTER INPUT/1MHz OUTPUT CONNECTOR	In the General Purpose Counter mode, provides a means of introducing the signal to be counted (see Ref. No. 4 below). In the Monitor mode (see Ref. No. 5 below), this connector delivers a 1-MHz output from the internal time base, for calibrating the time base.

Fig. 3-1 Ref. No.	Name	Function
2	PWR On switch (red)	When depressed, energizes the instrument, NOTE: The crystal oven is not controlled by this switch; power is supplied to the oven circuit whenever the instrument is plugged into a power source.
3	10 Hz/1 Hz switch	Used in the Counter mode only. When depressed, provides 1-Hz resolution of the frequency count; when in the out position, provides 10-Hz resolution.
4	CTR switch	This switch is mechanically coupled to the MAIN CARR switch so that when one is depressed, the other is out. When the CTR switch is depressed, it places the instrument in the General Purpose Counter mode.
5	MAIN CARR switch	When depressed, places the instrument in the Monitor mode for reading carrier frequency ERROR.
6	(-) switch	When depressed, causes the MODULATION meter and the upper PEAK lamp to read negative modulation.
7	(+) switch	When depressed, causes the MODULATION meter and the upper PEAK lamp to read positive modulation.
8	CAL switch	When depressed, provides an internal calibration signal for the MODULATION meter and the upper PEAK flasher (see sections 3.4 and 3.5).
9	FLASHER CAL adjustment	Used in calibrating the upper PEAK flasher (see Section 3.5)
10	METER CAL adjustment	Used in calibrating the MODULATION meter (See Section 3.4).

Fig. 3-1 Ref. No.	Name	Function
11	MODULATION meter	Reads carrier modulation directly in percentage. The modulation being monitored, positive or negative, depends on the setting of the (-) and (+) switches (Ref. Nos. 6 and 7).
12	PEAK MODULATION thumbwheel switch	Sets the peak modulation percentage at which the upper PEAK lamp will flash.
13	-100% PEAK lamp	Flashes when negative modulation peaks exceed 99.5%.
14	PEAK lamp	Flashes when the peak modulation percentage exceeds the value set on the thumbwheel switch. The PEAK lamp will indicate either positive or negative modulation peaks, depending on the setting of the (-) and (+) switches (Ref. Nos. 6 and 7).
15	CARRIER LEVEL meter	In conjunction with the CARRIER LEVEL adjustment (Ref. No. 22), used to set the proper carrier level for correct MODULATION meter and peak flashers readings.
16	Frequency error display	Indicates the carrier frequency ERROR in kHz.
17	"-" lamp	Indicates that the carrier frequency is below its assigned frequency.
18	"+" lamp	Indicates that the carrier frequency is above its assigned frequency.
19	MAIN CARR lamp	Indicates that the instrument is operating in the Monitor mode and that the display is indicating transmitter carrier frequency ERROR.

Table 3-1. (Continued)

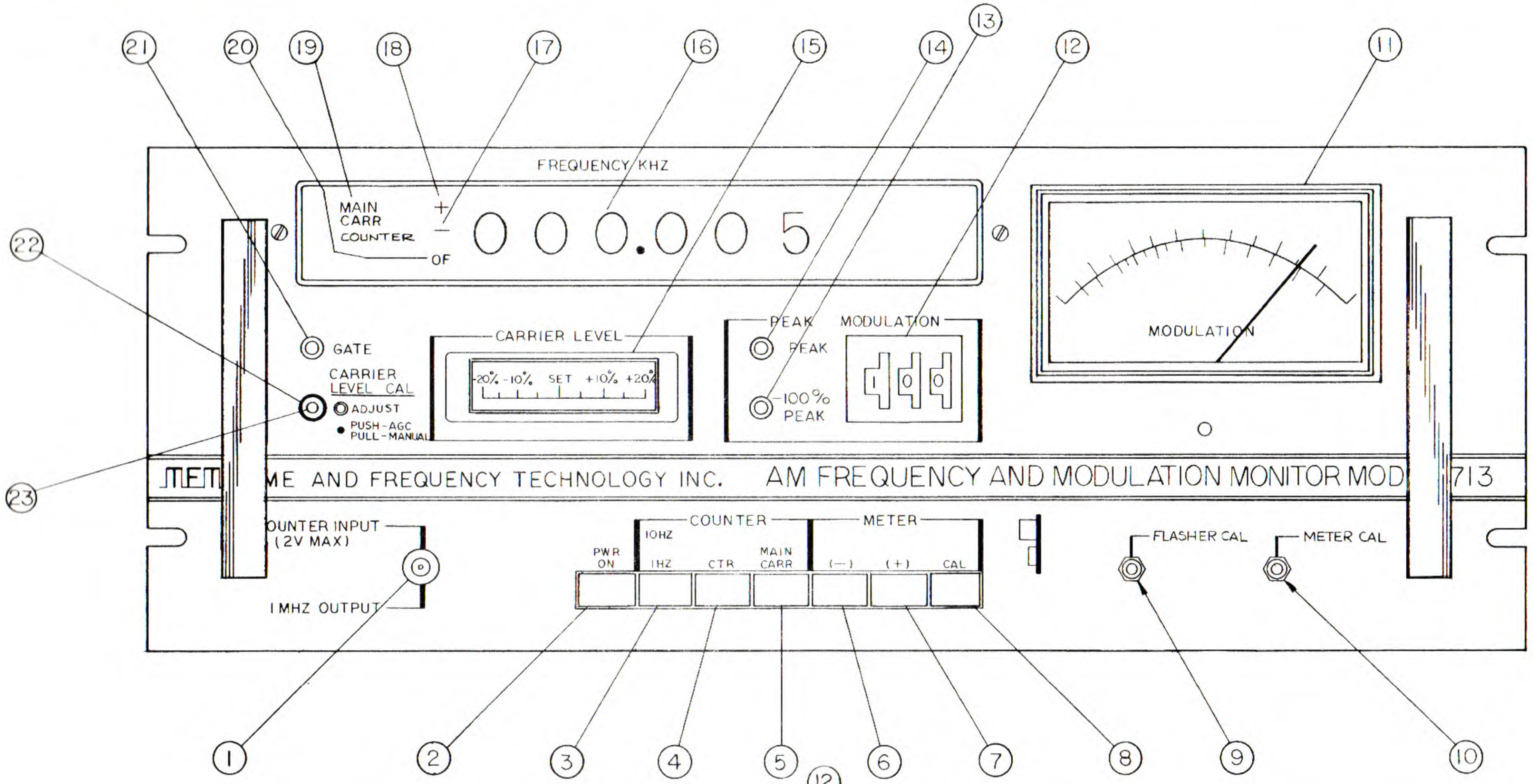
Fig. 3-1 Ref. No.	Name	Function
20	OVERFLOW lamp	When lighted, indicates that the counter capacity has been exceeded (General Purpose Counter mode only).
21	GATE lamp	Flashes every two seconds to indicate that the counter gating is operating properly, and that frequency sampling is taking place.
22	CARRIER LEVEL adjustment	Adjusts the carrier level to the proper value for the correct operation of the MODULATION meter and PEAK flashers.
23	PUSH-PULL switch	PUSH position is for automatic gain control operation and PULL position is for manual gain control operation.

Table 3-2 Rear-Panel Controls and Connectors

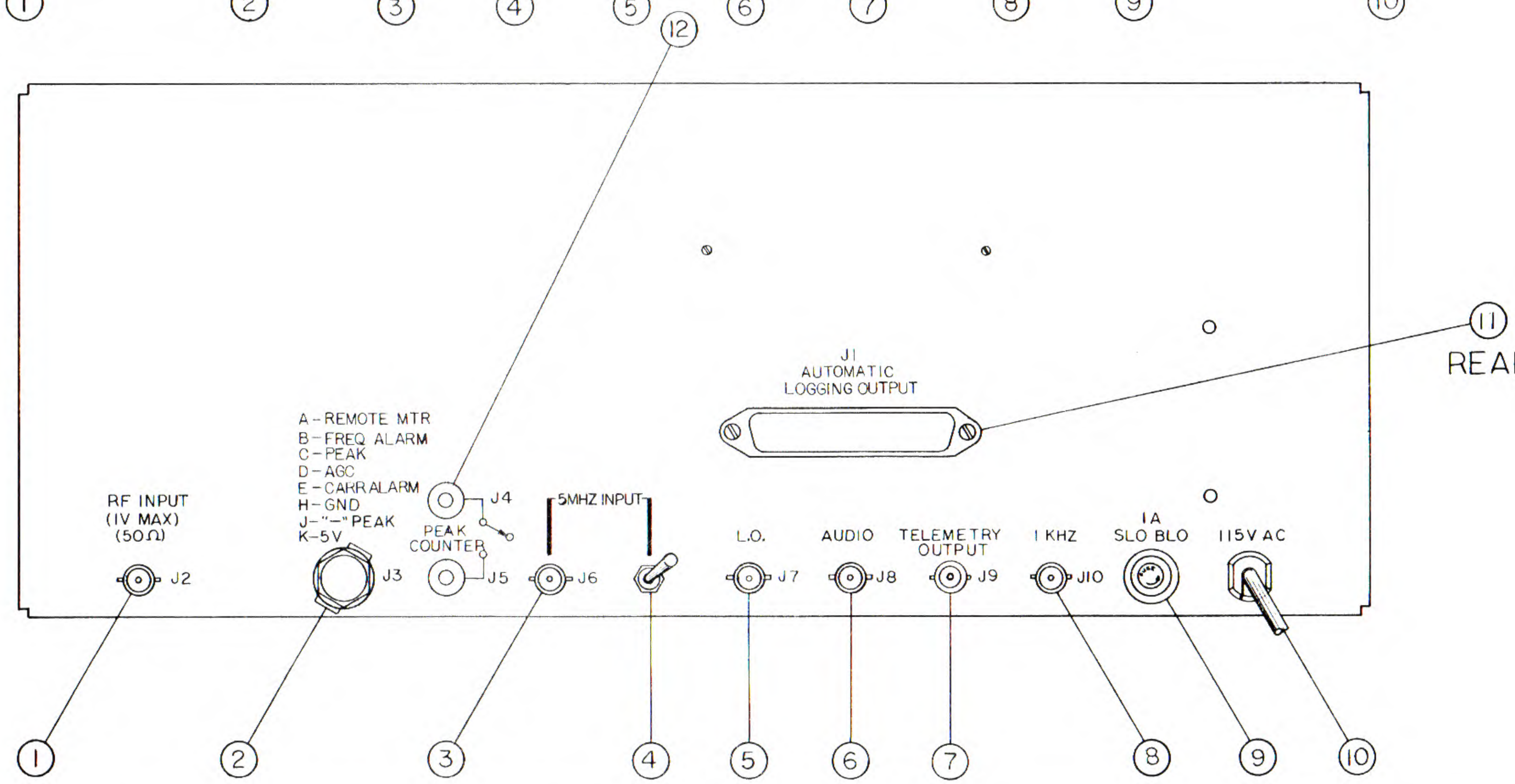
Fig. 3-1 Ref. No.	Name	Function
1	RF INPUT connector	Provides a means for connecting a 50-ohm cable from a rooftop antenna at a remote site, or from the transmitter RF coupler through a 40-dB pad at the transmitter site.
2	9-pin connector	Provides the following outputs: A. The same voltage that operates the MODULATION meter, to operate a remote meter (Model 704A). B. Closes a circuit to ground when the measured carrier frequency error exceeds a preset limit for operation of an external alarm. Will handle a load of 500 mA at 50V. Optional. C. The same voltage that operates the front-panel PEAK lamp, for operating a remote peak flasher (Model 704A). D. AGC voltage. Should be measured with a 20,000-ohms-per-volt meter. Decreases with increasing carrier level.

Table 3-2. (Continued)

Fig. 3-1 Ref. No.	Name	Function
		E. Carrier Alarm. Relay Closure to ground when carrier power limits are exceeded in manual gain control. It becomes a carrier off alarm when in automatic gain control. (Optional)
		H. Ground.
		J. The same voltage that operates the front-panel -100% PEAK lamp, for operating a remote peak flasher (Model 704A).
		K. +5V DC.
3	5 MHz INPUT connector	Provides input connection for an external 5-MHz time base.
4	5 MHz INPUT switch	When in lower position, Monitor operates on its internal time base. When in upper position, Monitor operates on time base connected to the 5 MHz INPUT connector.
5	L.O. connector	Provides the output of the internal local oscillator for frequency measurement.
6	AUDIO connector	Provides the audio signal obtained by demodulating the transmitter carrier. Level is 2 volts RMS into 600 ohms at 100% modulation Response is constant within ±0.5% dB from 30 Hz to 10 kHz. Harmonic distortion is less than 1%.
7	TELEMETRY OUTPUT connector	Supplies telemetry information contained in the carrier as subaudible modulation. Optional.
8	1kHz connector	Provides a 1-kHz reference signal from the internal time base for use with Digital Clock and Calendar Systems.

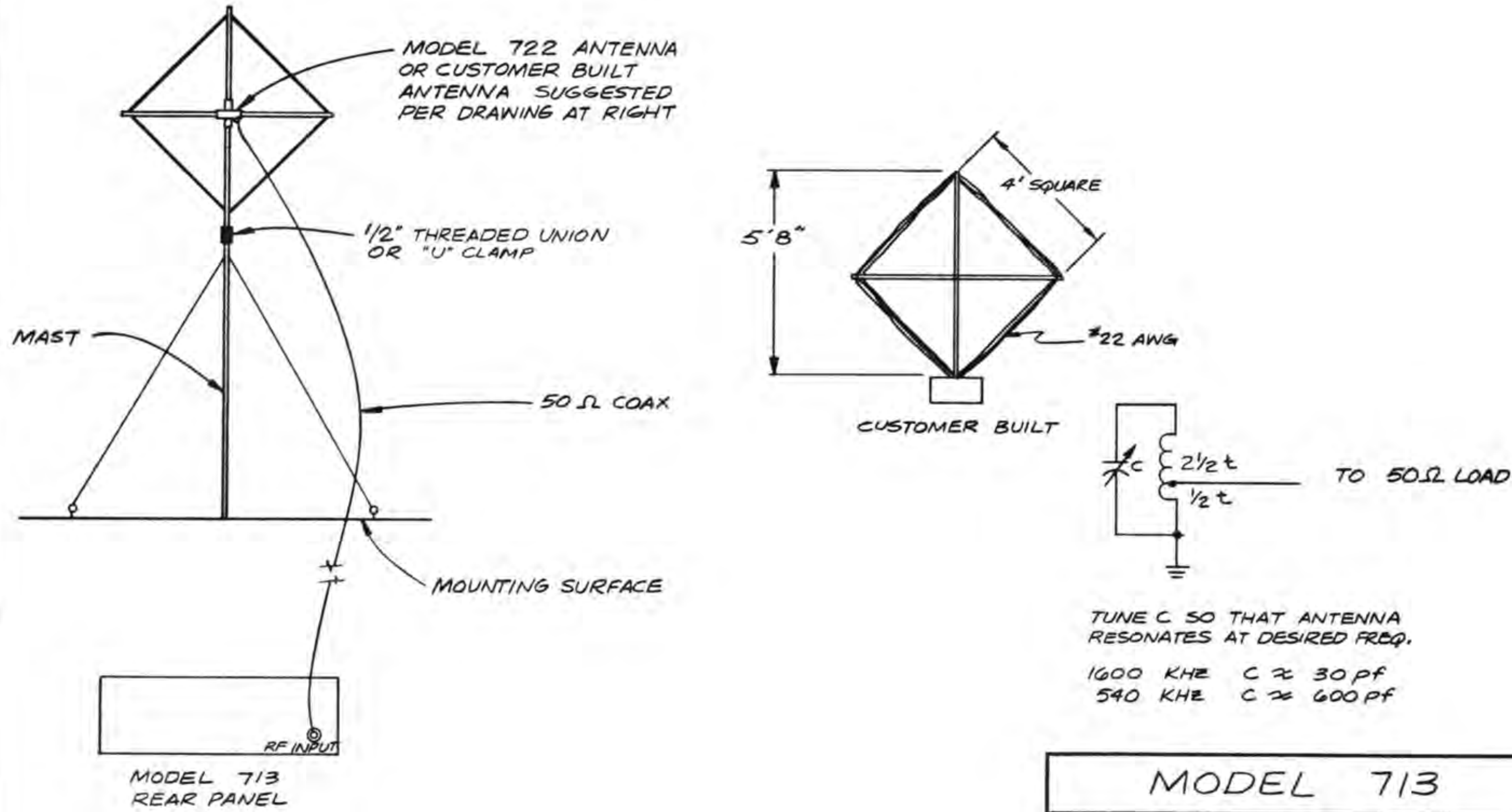


FRONT PANEL



REAR PANEL

TOLERANCES (EXCEPT AS NOTED)	MODEL 713		
DECIMAL ±		SCALE	DRAWN BY RM / APPROVED BY
FRACTIONAL ±	TITLE FRONT & REAR PANEL		
ANGULAR ±	DATE 1-17-72	DRAWING NUMBER 6600-0014	FIG. 3-1



MODEL 713		
SCALE:	APPROVED BY:	DRAWN BY
DATE:		REVISED
SUGGESTED ANTENNA SET-UP.		
FIG. 3-2		DRAWING NUMBER 6600-0007B

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SECTION 4

THEORY OF OPERATION

4.1 General.

The Model 713 AM Frequency and Modulation Monitor is a single-conversion superheterodyne receiver. The Model 713 makes high-accuracy measurements of the carrier frequency and percentage modulation of an AM broadcast signal.

Figure 6-1 is a block diagram of the Model 713. The RF signal to be monitored is brought in through the RF INPUT connector and applied through an RF filter to one input of the gain controlled mixer. The RF filter is factory selected to pass the frequency of the carrier to be monitored. The gain controlled mixer converts the carrier down to 450 KHz, the amplitude of the 450 KHz product can be controlled by the AGC circuit as described in a later paragraph.

The local-oscillator (L.O.) input to the mixer comes from Board A3. The input to Board A3 is normally from a highly stable 5 MHz crystal oscillator (A6) housed in a proportional controlled oven. If desired, the 5 MHz input can be provided by an external precision source connected to the rear-panel 5 MHz INPUT connector; the rear-panel toggle switch located next to the connector must be in the up position for operation from an external source.

The precision 5 MHz frequency is divided by 5 and again by 100 to provide a 10 KHz input to the phase detector on Board A3. The other input to the phase detector is the output of a voltage-controlled oscillator (VCO). The output of the VCO must be 450 KHz above the transmitter's assigned carrier frequency to provide the required 450 KHz IF output. Therefore the ÷ N circuit output is exactly 10 KHz when the VCO output is exactly 450 KHz above the transmitter's assigned carrier frequency.

When the two inputs to the phase detector are equal in frequency (both 10 KHz), the DC voltage supplied by the phase detector to the VCO is of the proper value to tune the VCO 450 KHz above the assigned transmitter frequency. If the VCO frequency drifts above or below the correct L.O. frequency, the input to the phase detector from the ÷ N circuit will not be exactly 10 KHz, causing the phase detector to produce a correcting voltage to oppose the VCO frequency drift. The loop will stabilize with the VCO on the correct L.O. frequency within the accuracy limits of the 5 MHz source.

4.1 (Continued)

The output of the IF amplifier, which is exactly 450 kHz if the transmitter is exactly on its assigned frequency, is fed to frequency counter A5 through a limiting amplifier, which shapes the waveform into a square wave suitable for the up-down counter input. The counter is preset to a count of 450,000. When counting commences, the counter counts down. If the IF is exactly 450.000 kHz, the counter will read 000.000 at the end of each 1-second counting period. If the carrier is lower than its assigned frequency, the IF will be higher than 450 kHz by the same number of kHz, and the counter will count down to zero and back up to the required count to indicate the frequency error. When the counter passes through zero, counter circuitry will cause the "-" lamp to light. Conversely, if the transmitter carrier is above its assigned frequency the counter will count down and stop at a count above zero. In this case the "+" lamp will light. The 1-second counting interval is derived from the 1-kHz frequency which in turn is derived from the precision 5-MHz source.

The audio output from the audio detector is fed through an amplifier to the modulation measurement circuits on Board A2. When the amplitude of the negative half cycles of the audio signal corresponds to 100-percent modulation of the transmitter carrier, the output of the -100% peak detector triggers a one-shot multivibrator, which turns on the -100% PEAK light-emitting diode (LED) to cause it to flash, indicating that the transmitter carrier has been modulated to 100 percent in a negative direction.

The output of the audio amplifier is also fed through two unity-gain amplifiers, one inverting and one noninverting. The noninverting amplifier output is selected by the METER (+) switch, and the inverting amplifier output by the METER (-) switch. The selected output is fed through the meter calibration potentiometer and an amplifier to the MODULATION meter. The same selected output is also fed through the flasher calibration potentiometer to the programmable peak detector. This peak detector is referenced to a voltage selected by a front panel thumbwheel switch. When the peak detector input voltage exceeds the reference DC voltage, it triggers a one-shot multivibrator which produces a pulse to light the PEAK LED for 2 seconds.

To calibrate the MODULATION meter and PEAK lamp, the METER CAL switch is depressed, causing a stable 1-kHz sine wave derived from the 5-MHz precision source to be substituted for the detected audio signal. The amplitude of the 1-kHz sine wave corresponds to 100-percent modulation of the monitored carrier when the carrier level is adjusted to its calibrated value as indicated by the CARRIER LEVEL meter. The METER CAL potentiometer is then adjusted so that the MODULATION meter reads 100 percent, and the FLASH CAL potentiometer is adjusted so that the PEAK lamp flashes with the front-panel PEAK MODULATION thumbwheels set for 100 percent.

4.2 Detailed Circuit Description.

4.2.1 Crystal Oscillator (A6).

(Circuit Diagram: Figure 6-9)

This circuit delivers a highly stable 5-MHz output at a level of at least 100 mV to LO Board A3 through a rear panel switch. The oscillator circuit, including the crystal, is on a printed-circuit board mounted in a proportionally controlled oven. The output frequency is factory adjusted to provide an output of 5 MHz $\pm 1 \times 10^{-8}$ MHz at the crystal operating temperature. A 1 MHz signal, obtained from the Crystal Oscillator by means of a divider circuit on Board A3, is fed to a front-panel BNC connector to provide a means for checking the oscillator frequency against WWVB or a precision frequency source. The Crystal Oscillator can be recalibrated by adjusting capacitor C5 (see the schematic diagram, Figure 6-9).

4.2.2 LO Board (A3).

(Circuit Diagram: Figure 6-6)

The 5 MHz signal from the Crystal Oscillator enters Board A3 at pin 21 of P1, is amplified and squared by Z8 and is applied to divide-by-five IC Z11. The 1 MHz output at pin 11 of Z11 is buffered by Z8 and delivered to FP-S5-9 and then to the 1 MHz OUTPUT connector. The 1 MHz output from Z11 is also fed through two divide-by-ten IC's, Z10 and Z9. The resulting 10 kHz signal at pin 11 of Z9 is applied to a phase detector (discussed in the next paragraph) and to divide-by-ten IC Z7, which supplies a 1 kHz output to Counter Board A5 through pin 18 of P1; to the rear-panel 1 kHz OUTPUT connector through buffer Z8 and pin 16 of P1; and to a waveform shaper consisting of amplifier Q15 and operational amplifiers Z12 and Z13. Operational amplifier Z12 and associated components constitute a low-pass filter, which converts the square wave input to a sine wave. Potentiometer R68 in the output of Z12 adjusts the amplitude of the sine-wave input to Z13 so that the AC output of Z13 is approximately 2.8 volts peak-to-peak. Potentiometer R69 adjusts the DC reference to Z13 so that the AC output of Z13 varies between 0V DC and +2.8V DC. The 1 kHz sine wave from Z13 is fed through pin 20 of P1 to Board A2 to calibrate the modulation measurement circuits.

Figure 4-1 is a simplified block diagram of the phase detector. Capacitor C34 charges at a linear rate through constant-current source Q14. When the 10 kHz signal from Z9 (at TP-3) is high, switch Q13 is turned on and discharges C34. When the 10 KHz input is low, switch Q13 opens and allows C34 to charge and produce a ramp waveform. At some time during the charging of C34, a short pulse is received from the divide-by-N circuit through transformer T2 which turns on gates Q11 and Q12. These gates pass the ramp voltage existing at the time of the sampling pulse on to holding capacitor C26. Thus the value of the voltage on C26 will depend on the time at which the sample pulse from the divide-by-N circuit arrives with respect to the timing of the ramp. This DC voltage on C26 is applied through a low-pass filter to the voltage-controlled oscillator (VCO), where is controls the frequency of the VCO. Thus, changes in the nominal frequency of the VCO will cause changes in the arrival time of the sampling pulses from the divide-by-N circuit, which will change the voltage on C26 in the proper direction to bring the VCO back on frequency.

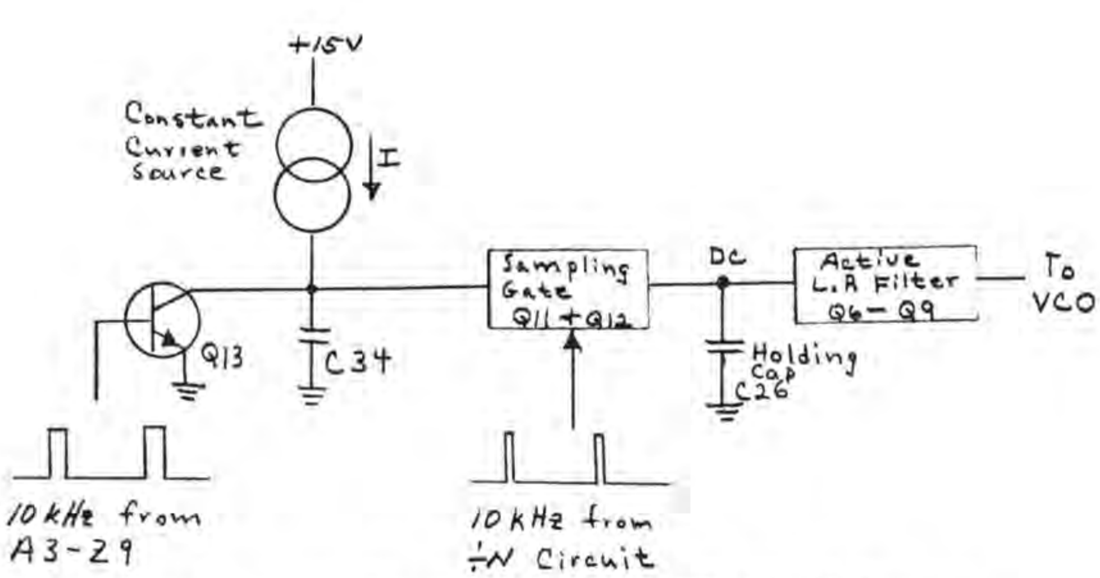


Figure 4-1. Phase Detector, Simplified Block Diagram.

The purpose of the low-pass filter in the phase detector circuit is to eliminate spikes and other transients in the DC voltage. The twin FET's (Q8) act as a differntial amplifier and present a high-resistance load to holding capacitor C26. The FET differential amplifier drives another differential amplifier (Q6/Q7), which supplies a single-ended output from the collector of Q7 to varicaps CR1 and CR2, which tune oscillator Q1. Inductor L3 is factory adjusted so that the VCO frequency is 450 kHz above the nominal frequency to be monitored when the DC voltage applied to the varicaps is within the range of the ramp voltage generated in the phase detector.

The LO output at the collector of Q1 is fed through buffer amplifier Q2 and impedance-matching transformer T1 to the mixer on Board A1. Output level at pin 2 of P1 is 1.5 P-P volts into 50 ohms. The LO output at the emitter of Q2 is fed to the rear-panel LO jack, J7. Output level at pin 6 of P1 is 100 millivolts into 50 ohms. The VCO output at the collector of Q1 is also fed through buffer Q4/Q5 to the divide-by-N circuit, which consists of integrated-circuit dividers Z4, Z5, Z6 and Z2 with associated components. The dividers are programmed for the proper value of N to produce a 10 kHz output by factory wiring of the leads marked A through H, J and K. The output of the divide-by-N circuit, at pin 6 of Z2 and TP-2 is a positive pulse of approximately 1.1 microseconds duration. It is applied to the phase detector as a sampling pulse, as described earlier.

4.2.3 IF Board (A1).

(Circuit Diagram: Figure 6-4)

The signal to be monitored, at pin 4 of P1, is applied through an RF filter to one input of integrated circuit mixer Z1. The filter, which consists of all the components shown on the schematic diagram between pin 4 of P1 and the attenuator, provides 50 dB of image rejection.

The filter components are factory selected to provide a 3-dB bandwidth of 90KHz, centered on the frequency to be monitored. The second input to mixer Z1 is the LO signal from Board A3, brought into Board A1 through pin 2 of P1. The mixer output, at pin 9 of Z1, is fed through jumpered test points TP-1 and TP-2 to the input of the first IF filter. Potentiometers R18 and R22 adjust the filter input and output resistances respectively for proper matching. Buffer Q3 provides isolation between the first and second IF filters, and R43 and R39 adjust input and output resistances of the second filter. The 450KHz IF signal passes through buffer Q5 to a limiting amplifier to drive the frequency counter, and also to the audio detector.

The gain of the IF strip is controlled by varying the gain at the IC mixer Z1 This is accomplished using an optically coupled isolater consisting of a photosensitive resistor and Light Emitting Diode (LED) packaged together. As the current through the LED varies, it changes the resistance of the photoresistor. The resistance increases as the current through the diode decreases. The LED is driven from the AGC circuits.

The tuned limiting amplifier consists of Q7, Q8, Q9 and associated components. The 450KHz sine-wave output at the collector of Q9 is squared by Z10 and fed through gate Z10 and pin 20 to P1 to the counter circuits on Board A5. The signal gate is controlled by the AGC signal at pin 14 of P1 amplified by Z9. When the AGC voltage at pin 10 of Z10 is high, the 450KHz signal does not pass through the gate; when the AGC voltage is low, the signal is passed. Thus Z9 and Z10 act as a squelch circuit to switch off the 450KHz signal to the counter in the absence of an RF signal to prevent false counter readings.

The audio detector is an active rectifier consisting of Z2, CR2, CR3 and associated components. The resulting waveform at TP-6 contains the positive half cycles of the 450KHz signal, bounded by the modulation envelope. This signal is applied through an active low-pass filter (Z3) with a cutoff of approximately 25KHz to differential amplifier Z4 in the AGC amplifier circuit; to amplifier Z8 in the meter amplifier circuit; and to audio amplifier Z5. The output of the low-pass filter contains the Audio Information and Carrier Level Information.

The Model 713 gain can be controlled manually or by the internal automatic gain control circuitry, by the use of the front panel CARRIER LEVEL pot and concentric PUSH-PULL switch. With switch in the manual mode the gain of the mixer (Z1) is controlled by the 1K ohm section of the CARRIER LEVEL pot. (Ref. Fig. 6-2).

When the Model 713 is operated in the automatic gain control mode the wiper of the front -panel 100 ohm CARRIER LEVEL pot supplies a reference voltage to the noninverting input of Z4, with the rectified IF signal from Z3 being applied to the inverting input of Z4. If the carrier level increases, the rectified IF level increases, causing the output of Z4 to decrease and increasing the resistance of the optically coupled isolator which reduces the IF level to its proper value. A decrease in the carrier power has just the opposite effect. The AGC amplifier has a high frequency cutoff at about 5Hz so that it responds only to the average value of the rectified IF signal and not to the modulation. Zener diode CR1 in the base circuit of Q6 limits the current through the LED to a safe value. Note the AGC voltage at the output Z4 and at pin D of the rear panel connector (J3) decreases with increasing carrier level.

The meter amplifier consists of differential amplifier Z8 and current drive Z7. Current through the CARRIER LEVEL meter varies with the average value of the rectified IF applied to pin 2 of Z8. The reference voltage at pin 3 of Z8 is factory set by potentiometer R70 so that an IF level of 400 millivolts at the output of buffer amplifier Q5 (TP-5 and TP-9) will cause the CARRIER LEVEL meter to indicate midscale (SET position).

The audio amplifier consists of integrated-circuit amplifier Z5 with a gain of 5 and integrated-circuit amplifier Z6 with a gain of 2.5. Two audio outputs are provided, one at pin 5 of J1 for the rear-panel AUDIO jack and the other at pin 8 at J1 for the rear-panel TELEMETRY OUTPUT jack.

4.2.4 Counter Board (A5).

(Circuit Diagram: Figure 6-8)

If the carrier being monitored is precisely on its assigned frequency, the IF will be precisely 450-kHz. The counter measures and displays any error in this frequency. The counter can also be used for general test purposes as described below.

The source for the counter time base is the 1-kHz signal from Board A3, which enters the counter board at pin 16 of J1. The 1-kHz signal is divided by decade dividers (Z6, Z5 and Z4) to produce a 1-Hz square wave at pin 11 of Z4. This 1-Hz pulse is ANDed with 500-Hz and 100-Hz pulses from Z6-12 and Z6-11 to toggle flip-flop Z1 (pin6) in such a way that a waveform is produced at TP2 which is high for 1 second and low for 10 milliseconds, repetitively. The frequency to be counted (nominally 450-kHz) at pin 2 of J1 and at TP1 is thus gated on through NAND gate for 1 second and then gated off for 10 milliseconds, repetitively.

The gated signal is applied to the up-down counter chain consisting of Z17, Z16, Z15, Z14, Z13 and Z12. This counter, which is laid out in Figure 6-8 in the same order from left to right as the Nixie display tubes appear on the front panel, is preset to a count of 450,000. During the 1 second that the monitored signal is gated through to the counter, the counter counts down. If and when the count reaches zero, all inputs to zero detector Z18 will be logic 1 and Z18 drives the set input (pin7) of flip-flop Z20 low to produce a logic 0 at pin 10 of Z20, thus causing the counter to start counting up. The other Z20 flip-flop stores information as to whether the counter was counting up or down at the end of the 1-second counting period and drives the "+" or "-" lamp on the front-panel frequency error display to indicate whether the frequency is high or low. Gate Z19 is disabled by a control signal from Z11 when the counter is in the general-purpose counter mode.

At the end of the 1-second counting period, the level at the TP2 GATE test point drops to 0 for 10 milliseconds, as explained in a preceding paragraph. During this 10-millisecond interval, the count reached by the six counters is transferred to the storage register consisting of latches Z21 through Z26. Transfer is effected by a logic 1 level from the 1-Hz time-base circuit which is fed to the storage register latches on the line connecting to test point TP4 TRANSFER. The count is held in the storage register during the next 1-second counting period. Each storage-register latch drives a Nixie display tube through a BCD-to-decimal decoder (Z27 through Z32) to indicate the frequency count.

After transfer of information from the counters to the storage register is completed, the counters are reset to a count of 450,000 by a logic 0 from the 1-Hz time-base circuit which is fed to counters Z12 through Z17 on the line connecting to test point TP-3 LOAD. While the level on the LOAD line is 0 each counter is preset to a count determined by the logic level on its data inputs (pins 9, 10, 1 and 15). These data inputs are wired to ground or +5 volts, depending on the count required. At the end of the zero-level pulse on the LOAD line, the counters are ready to begin a new 1-second count.

When -100% peaks are reached on the modulation there is insufficient level to drive the counter and erroneous frequency readings result. When the -100% peak lamp flashes in the Model 713 the output of Z37 is set low and no transfer pulse is generated for the storage latches, Z21-Z26. This causes the counter to hold it last reading until another one-second count is completed before another -100% peak is detected. The GATE lamp also stops functioning when this condition occurs.

The -100% peak input to Z37 is disabled in Z36 when the counter is in the auxiliary counter mode.

A positive-going transfer pulse at pin 6 of Z36 is applied to pin 1 of flip-flop Z1, which produces an output at pin 15 to turn the front-panel GATE LED on and off at the counter gating rate to indicate normal operation of the gate. The GATE lamp will not operate when the transfer gates are disabled by negative modulation peaks in excess of 100 percent, as described earlier.

When the counter is operated as a general-purpose counter, the resolution can be set to either 1 Hz or 10 Hz by a front-panel switch. When the switch is in the 10-Hz position, gates Z9 select the output of Z8 rather than the signal at pin 2 of J1. The output of Z8 is the frequency at pin 2 of J1 divided by 10.

The circuit consisting of Z23, Z10 and Z11 operates in the general-purpose counter mode to turn on the front-panel OVERFLOW lamp when the count into the counter exceeds its capacity.

Relay K1 and associated circuitry in the lower right-hand corner of Figure 6-8 are for an optional off-frequency alarm. The gate inputs can be wired to the counter BCD outputs to cause K1 to energize and place a ground on pin B of rear-panel connector J3 whenever the measured frequency error exceeds a specified limit. This limit is factory wired,usually ±20 Hz unless otherwise specified.

4.2.5 Peak Flasher and Meter Amplifier (A2).

(Circuit Diagram: Figure 6-5)

This board drives the modulation meter, the peak modulation lamps, and the peak counter relay from the audio signal on Board A1. The audio signal is brought into Board A2 at pin 2 of the board connector. When the front-panel METER CAL switch is depressed, this audio input is a sine wave from Board A3 with a negative peak of 0VDC and a positive peak of approximately $+2.8V_{DC}$ which corresponds to 100-percent modulation of the monitored carrier. The audio input is applied to the inverting input of operational amplifier Z1, which acts as a comparator. The other input to the comparator is a DC voltage, very nearly 0V DC, factory-set by potentiometer R3 to give a positive pulse out of Z1 when the negative peaks of the audio input just reach 0V DC When the front-panel METER "+" or "-" switch is depressed, thus releasing the METER CAL switch, any audio input from Board A1 at pin 2 of the Board A2 connector whose negative peaks reach zero or a negative value will produce a positive pulse at the output of Z1. This positive pulse triggers the one-shot multivibrator Z2, R4 and C7 producing a positive pulse approximately 1 second in duration at pin 2 of Z2. This 1-second pulse is inverted by Z3 and applied to driver Z4 which turns on the -100% PEAK LED for the duration of the pulse out of the one-shot multivibrator. This same output is also fed to pin J of rear-panel connector J3 to operate a remote negative-peak lamp.

The audio input at pin 2 of the board connector is also applied to inverting unity-gain amplifier Z5 and noninverting unity-gain amplifier Z6. The outputs from these two amplifiers are fed to the front-panel METER "-" and METER "+" switches so that either the negative or positive peaks can be measured. The selected output is applied to front-panel METER CAL potentiometer R2 and front-panel FLASH CAL potentiometer R1 (see Figures 6-1 and 6-2).

The selected (positive or negative peak) audio signal at the wiper of R2 on the front panel enters Board A2 at pin 18 of the board connector, and is applied through emitter follower Q1 and amplifier Z9 to the audio rectifier consisting of CR2 and associated components. The DC voltage at the cathode of CR2, whose value is proportional to the peak modulation amplitude, is fed through current driver Z10 to the front-panel MODULATION meter and to rear-panel connector J3-A to drive a remote meter.

The selected (negative or positive) audio signal at the wiper of R1 of front panel enters Board A2 at pin 8, and is applied to the noninverting input of the comparator Z7. The inverting input to Z7 is from constant-current source Z8. The voltage output of Z8 applied to the inverting input of Z7 is controlled by the resistance selected by the front-panel thumbwheel switches SW8 and SW9. Thus, when the audio input at pin 8 of the board connector exceeds the voltage at pin 4 of Z7, a positive pulse is produced at pin 9 of Z7. This pulse is stretched by one-shot multivibrator Z2 to approximately 1 second and this 1-second pulse is applied through inverter Z3 and driver Z4 to the front-panel PEAK LED CR1 and to Board A8 to energize a relay and also to drive a remote peak indicator.

When the front-panel CTR switch is depressed, the external frequency to be counted is brought into Board A2 through pin 3 of the board connector and applied to the gate of FET Q2. The signal at the source of the FET is fed through differential amplifier Q3/Q4 to Schmitt trigger 4-input NAND gate Z11 which shapes the input signal into a good square wave to operate the counter. The Schmitt-trigger output, at pin 4 of the board connector, is delivered through the front-panel CTR and MAIN CARR switches to pin 2 of Counter Board A5.

4.2.6 Power Supply (A4).

(Circuit Diagram: Figures 6-2 and 6-7)

The Power Supply provides four outputs: -15V, +15V, +5V and +170V. In the- 15V supply, AC from pins 11 and 12 of T1 on the chassis is rectified by CR1 through CR4, filtered by C1 and regulated by Q1 and Z1. The output voltage level is adjusted by R3.

The +15V supply is similar to the -15V supply, except that the rectifier for the +15V supply (CR1) is located on the chassis. The output is adjusted by R7.

In the +5V supply, the rectifier (CR2) is located on the chassis. The output of the rectifier is delivered to pin 22 of P1 where it is filtered and returned to series regulator Q1 also located on the chassis. The series regulator is controlled by regulator Z3, and the output is adjusted by R13.

The +170V supply for the Nixie tubes is fed from AC at pins 5 and 6 of T1 through front-panel PWR ON switch SW7. The AC is rectified by CR5, filtered by C4 and fed to the Nixie tubes on Board A5 through P1-18.

4.2.7 Telemetry Output Board (A8)

(Circuit Diagram: Figure 6-11)

This board contains the circuitry for the remote peak counter and is standard equipment. The board also contains the telemetry circuitry and the carrier alarm circuitry when these options are selected.

The peak counter circuit consists of relay K1 and associated components. The relay is energized when the output of driver Z4 on A2 board goes low, as described in section 4.2.5. When relay K1 energizes, it supplies a contact closure to rear-panel connectors J4 and J5.

The telemetry circuit is simply a low-pass active filter consisting of Z5 and associated components. This filter has an upper cut-off of approximately 35 Hz to pass only subaudio telemetry signals.

The carrier alarm consists of Z1, Z2, Q1, K2 and associated components. Input is from the carrier level meter circuit on Board A1 through pin 9 of the A8 board connector. Integrated circuits Z1 and Z2 are comparators. When the Model 713 is located at the transmitter being monitored, potentiometers R9 and R6 can be adjusted to causeK2 to energize when the carrier level goes 5 percent above or 10 percent below nominal. During this mode of operation, the gain must be controlled manually as described in Section 4.2.3. For remote operation and automatic gain control of the Model 713, the alarm circuitry can only be used to energize K2 when the carrier goes completely off. The contacts of K2 provide a ground on rear-panel connector J3-E when relay K2 is energized.

4.2.8 Digital to Analog Converter Board (A9)

(Circuit Diagram: Figure 6-12)

This board provides a DC voltage output proportional to the digital counter reading for automatic logging equipment that requires an analog input. The digital BCD information is brought from the counter board and is converted to a DC voltage by Z1. Z3, Q1 and Q2 switch the output of Z5 to positive when "+" errors are detected by the Counter Board and to negative when "-" errors are detected. The output of Z5 swing ±1volts for ±20-Hz frequency error and is connected to J1 on the rear panel.

4.2.9 BCD Automatic Logging (Optional)

The BCD Auto Log option brings the digital information for the counter display to the rear panel connector J1. This BCD information reads the error frequency only when the MAIN CARRIER button is depressed on the Model 713 front panel. The "+" and "-" information is also brought out for recorders equipped to accept it. The digital information is positive true BCD with TTL compatible levels. The pin connections for J1 are shown in the table below.

RP-J1 Wiring with BCD Auto-logging option - Pin Function

1	-	D	10 kHz Digit	17	-	D	1 Hz Digit
2	-	C		18	-	C	
3	-	B		19	-	B	
4	-	A		20	-	A	
5	-	D	100 kHz Digit	21	-	D	10 Hz Digit
6	-	C		22	-	C	
7	-	B		23	-	B	
8	-	A		24	-	A	
9	-	D	100 Hz Digit	25	-	N.C.	
10	-	C		26	-	Gnd.	
11	-	B		50	-	+5 Volts DC	
12	-	A					
13	-	D	1 kHz Digit				
14	-	C					
15	-	B					
16	-	A					

SECTION 5

MAINTENANCE

5.1 General.

Since the Model 713 is a solid-state instrument and its power requirements are low, no maintenance problems due to high temperature should be encountered, provided the instrument is installed well away from vacuum-tube and other heat-generating equipment. Likewise, because the operating voltages are low, excessive dust accumulation associated with high-voltage devices should not occur.

Access to components and periodic maintenance are covered in Sections 5.2 and 5.3. Three methods of calibrating the master oscillator are described in Section 5.4. Other calibration procedures are covered in Sections 5.5 through 5.7, and troubleshooting procedures are given in Section 5.8.

5.2 Access.

To gain access to the top-of-chassis components (all printed-circuit boards and the master oscillator assembly) remove six screws from the top cover, three on each side, and then remove the top cover. Removing six similar screws from the bottom cover provides access to the below-chassis components (connectors, power transformer and switches).

5.3 Periodic Maintenance.

Except for the master oscillator calibration described in Section 5.4, the only periodic maintenance required is cleaning. Once a year, or more often in dusty locations, remove the printed-circuit boards and blow off the dust with compressed air.

5.4 Master Oscillator Calibration.

The 5-MHz crystal master oscillator should be calibrated periodically. The aging rate of the master oscillator is typically 1 ppm per year. For a monitored frequency of 1.6 MHz, the local oscillator frequency is 2.0 MHz, and the typical error would be 2 Hz per year. Thus, calibration once a year should ensure keeping the monitor's error well within the FCC allowable transmitter frequency error of 20 Hz, even at the high-frequency end of the broadcast band.

Three calibration methods are described in Sections 5.4.1, 5.4.2, and 5.4.3. For all methods, to adjust the master oscillator frequency remove the instrument from the rack and remove the top cover, as described in Section 5.2. Then remove the button plug from the master oscillator module, and turn the master oscillator trimmer capacitor shaft with a nonmetallic adjusting tool.

5.4.1 Calibration Using a Secondary Standard.

A secondary standard such as the HP Model 5245 counter or the HP 105A quartz oscillator can be used to calibrate the Model 713 master oscillator.

a. Remove the instrument from the rack and remove the top cover.

b. Depress the front-panel MAIN CARR switch button.

c. Connect the 1-MHz output of the secondary standard to the external sync input of a 10-MHz oscilloscope. Adjust the oscilloscope for external sync.

d. Connect the 1-MHz OUTPUT connector on the front panel of the Model 713 to the vertical input of the oscilloscope.

e. Adjust the oscilloscope vertical gain for full scale deflection and adjust the horizontal sweep speed to 0.1 microsecond per centimeter.

f. Adjust the Model 713 master oscillator frequency for the least movement of the oscilloscope display.

5.4.2 Calibration by Measuring a Standard Frequency Using Frequency Counter Mode.

If a frequency standard of higher accuracy than the monitor's master oscillator is available, such as the color subcarrier transmitted by TV network originated programs, the following method can be used to calibrate the master oscillator.

a. Depress the front-panel CTR switch button.

b. Connect the output of the frequency standard into the front-panel COUNTER INPUT jack, first making sure the standard signal does not exceed 2V RMS. (Use an attenuator to start with if the voltage is unknown).

c. Adjust the Model 713 master oscillator until the monitor readout indicates the frequency of the signal being applied.

5.4.3 Calibration Using a WWVB Receiver.

This method provides the best calibration accuracy.

a. Depress the MAIN CARR pushbutton on the Model 713 front panel to provide a 1-MHz output at the front-panel connector.

b. Connect the front-panel 1-MHz OUTPUT connector to the WWVB receiver.

c. Refer to the WWVB receiver instructions for the proper setup and method of calibrating the ma ster oscillator.

5.5 Calibration of Modulation Meter.

a. Depress the front-panel METER CAL switch. The modulation meter should read 100%. If it does not, adjust the front-panel METER CAL potentiometer.

b. To check balance, hold the METER CAL switch down while pressing the METER (-) switch. The meter should read the same as before within 2%.

5.6 Calibration of Peak Flasher.

a. Depress the front-panel METER CAL pushbutton.

b. Set the front-panel thumbwheel switches to read 100%. The peak flasher should light or flash on and off.

c. Set the thumbwheel switches to 101%. The PEAK lamp should go off.

d. If the PEAK flasher is not on or flashing at a thumbwheel setting of 100%, or if it does not remain off at a setting of 101%, adjust the front-panel FLASHER CAL potentiometer.

e. The -100% PEAK lamp is factory adjusted.

5.7 CARRIER LEVEL Meter Calibration Check.

With the top cover of the instrument removed, connect a precision AC voltmeter (HP 3469A digital volmeter or equivalent) to test point TP5 on IF Board A1. With a signal input to the monitor that is of the correct frequency and of sufficient amplitude to cause the CARRIER LEVEL meter to read to the SET position, the voltage at TP5 should be 400 mV RMS ±4 mV. If it is not, calibrate the meter as follows:

a. Rotate the front-panel CARRIER LEVEL potentiometer counterclockwise until the AC voltmeter reads 320 mV. (NOTE: gain control should be in the AGC mode).

b. Adjust potentiometer R70 on the A1 board so that the CARRIER LEVEL meter reads -20%.

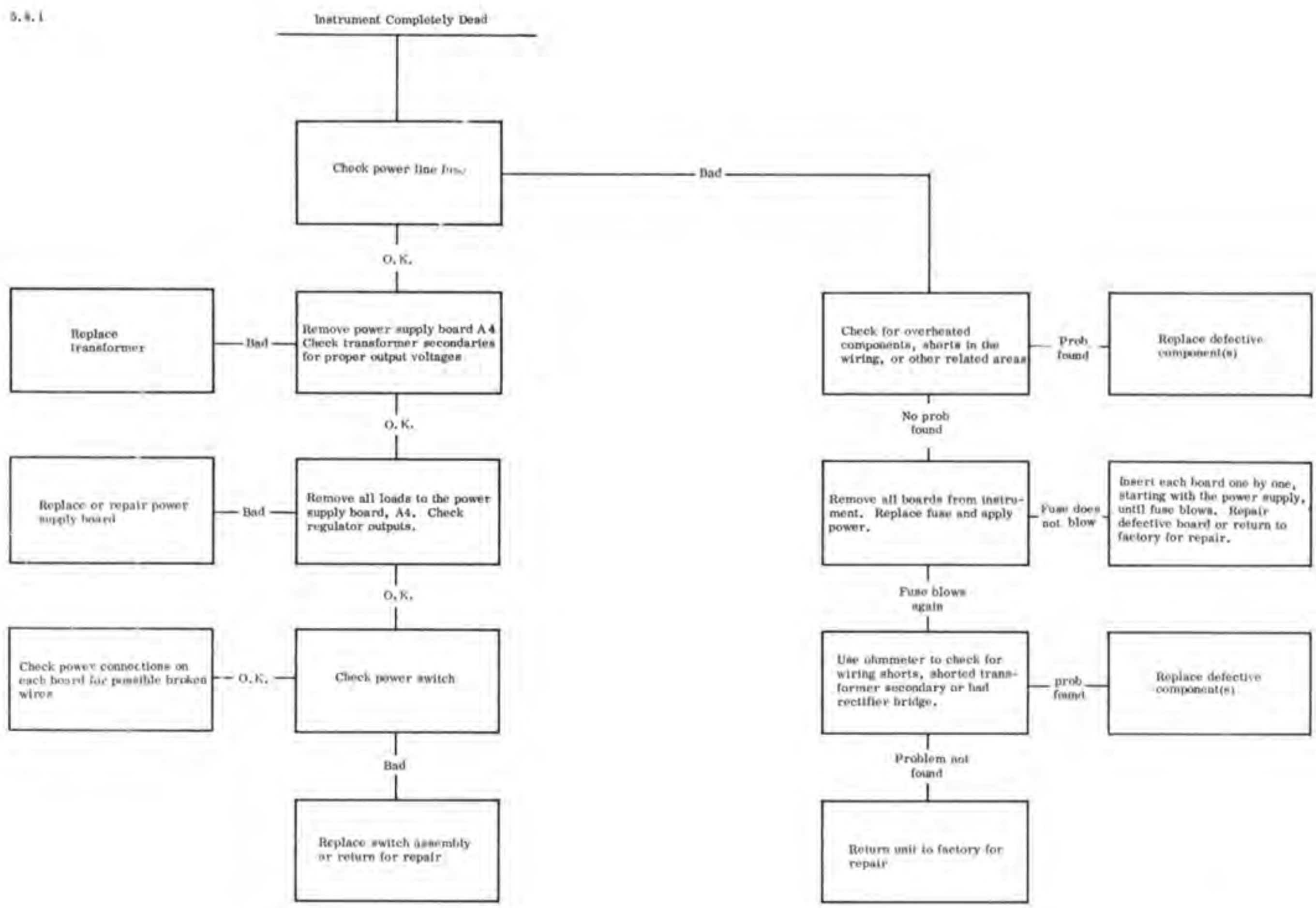
c. Rotate the CARRIER LEVEL potentiometer clockwise until the AC voltmeter reads 480 mV.

d. Adjust potentiometer R66 on the A1 board so that the meter reads +20%.

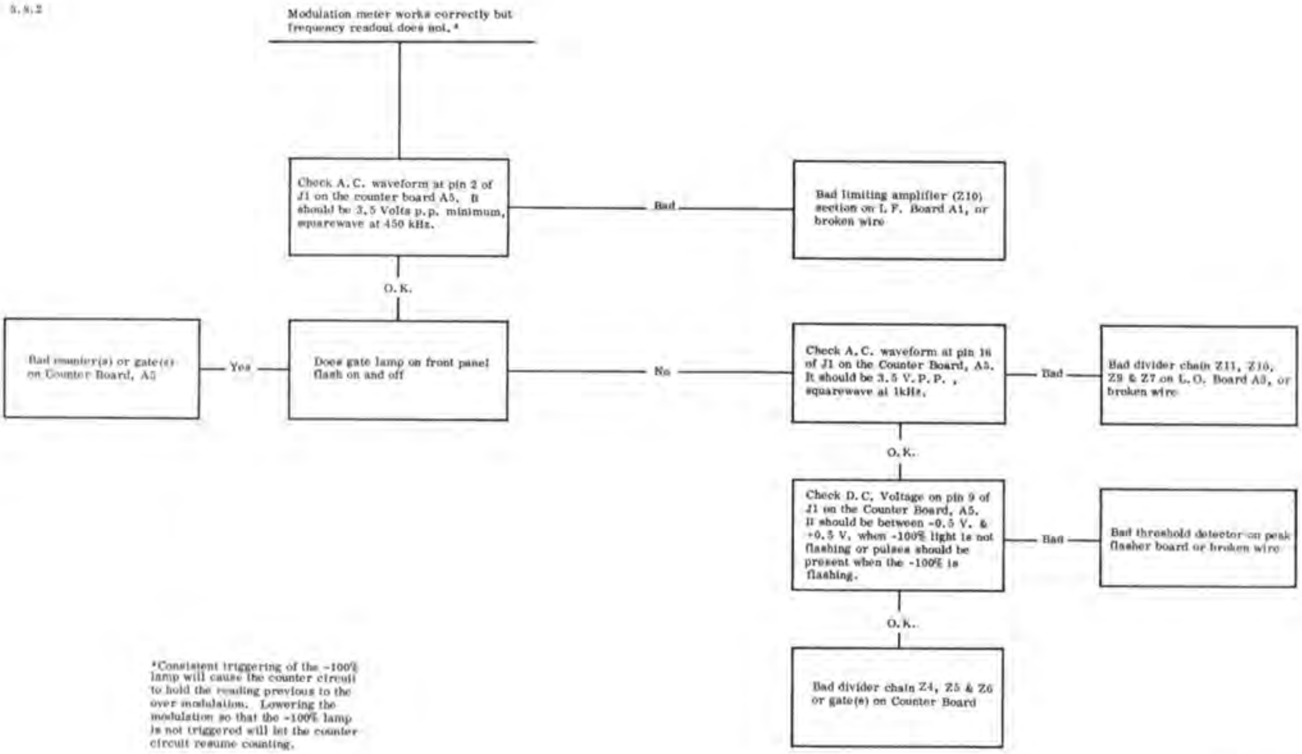
e. Rotate the CARRIER LEVEL potentiometer counterclockwise again until the voltmeter reads 400 mV. The CARRIER LEVEL meter should now read exactly on SET.

5.8	General Troubleshooting Trees
5.8.1	Instrument completely dead
5.8.2	Modulation meter works correctly, but frequency readout does not
5.8.3	Frequency display works correctly, but Modulation Meter or Peak Flashers do not.
5.8.4	Neither Modulation Meter nor frequency display works correctly, but display tubes lite when power is on.

5.8.1

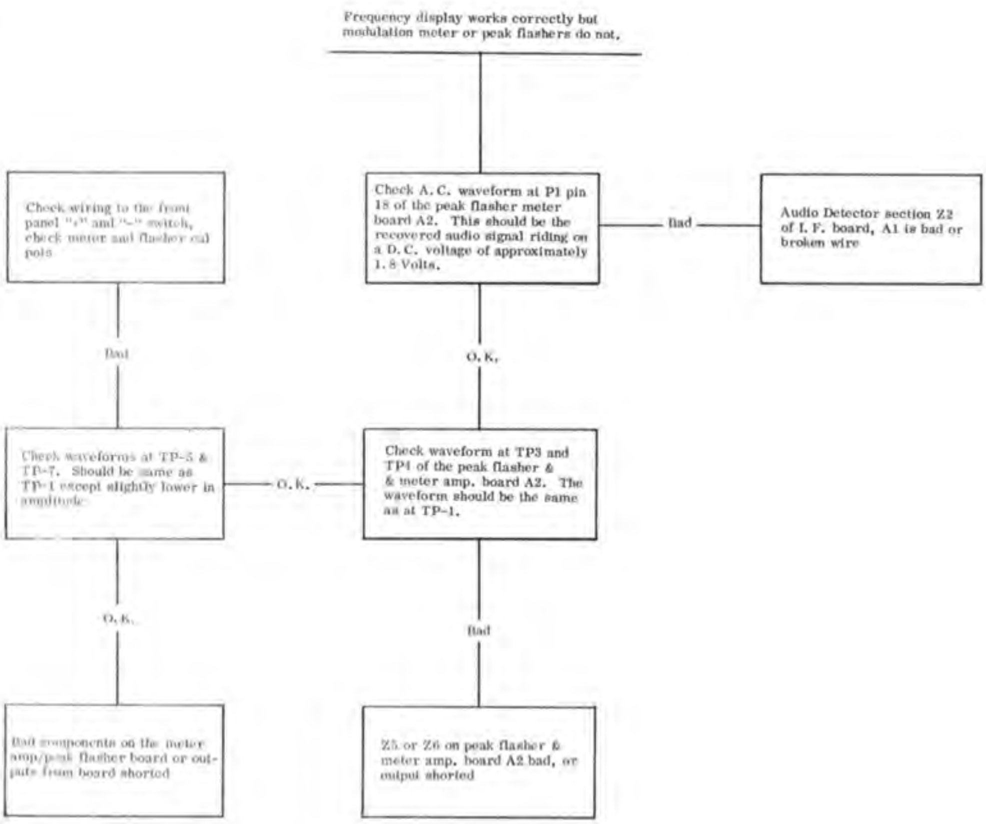

Instrument Completely Dead
Check power line fuse
Bad
O.K.
Replace transformer
Bad
Remove power supply board A4 Check transformer secondaries for proper output voltages
O.K.
Replace or repair power supply board
Bad
Remove all loads to the power supply board, A4. Check regulator outputs.
O.K.
Check power connections on each board for possible broken wires
O.K.
Check power switch
Bad
Replace switch assembly or return for repair
Check for overheated components, shorts in the wiring, or other related areas
Prob. found
Replace defective component(s)
No prob found
Remove all boards from instrument. Replace fuse and apply power.
Fuse does not blow
Insert each board one by one, starting with the power supply, until fuse blows. Repair defective board or return to factory for repair.
Fuse blows again
Use ohmmeter to check for wiring shorts, shorted transformer secondary or bad rectifier bridge.
prob found
Replace defective component(s)
Problem not found
Return unit to factory for repair

5.8.2



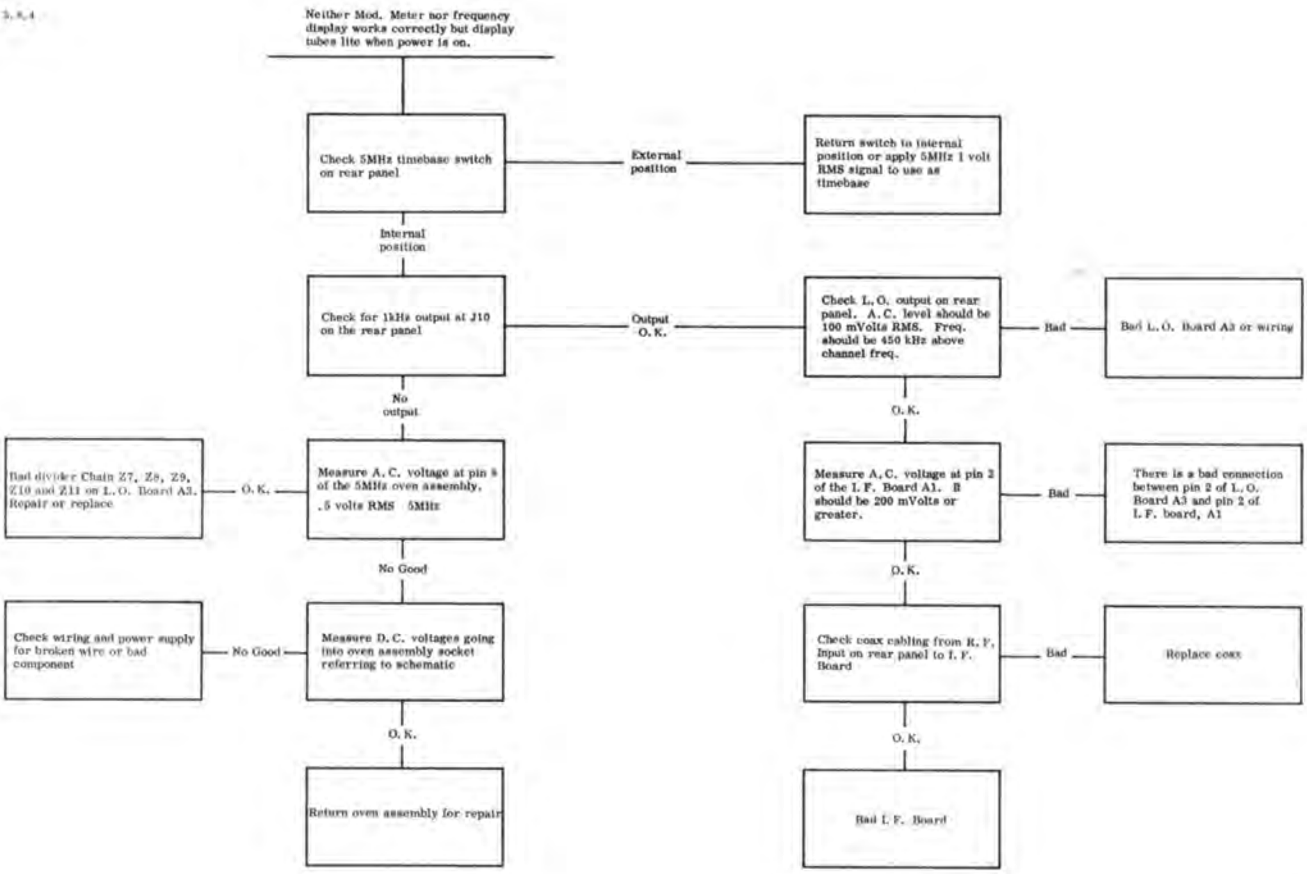
*Consistent triggering of the -100% lamp will cause the counter circuit to hold the reading previous to the over modulation. Lowering the modulation so that the -100% lamp is not triggered will let the counter circuit resume counting.

5.8.3

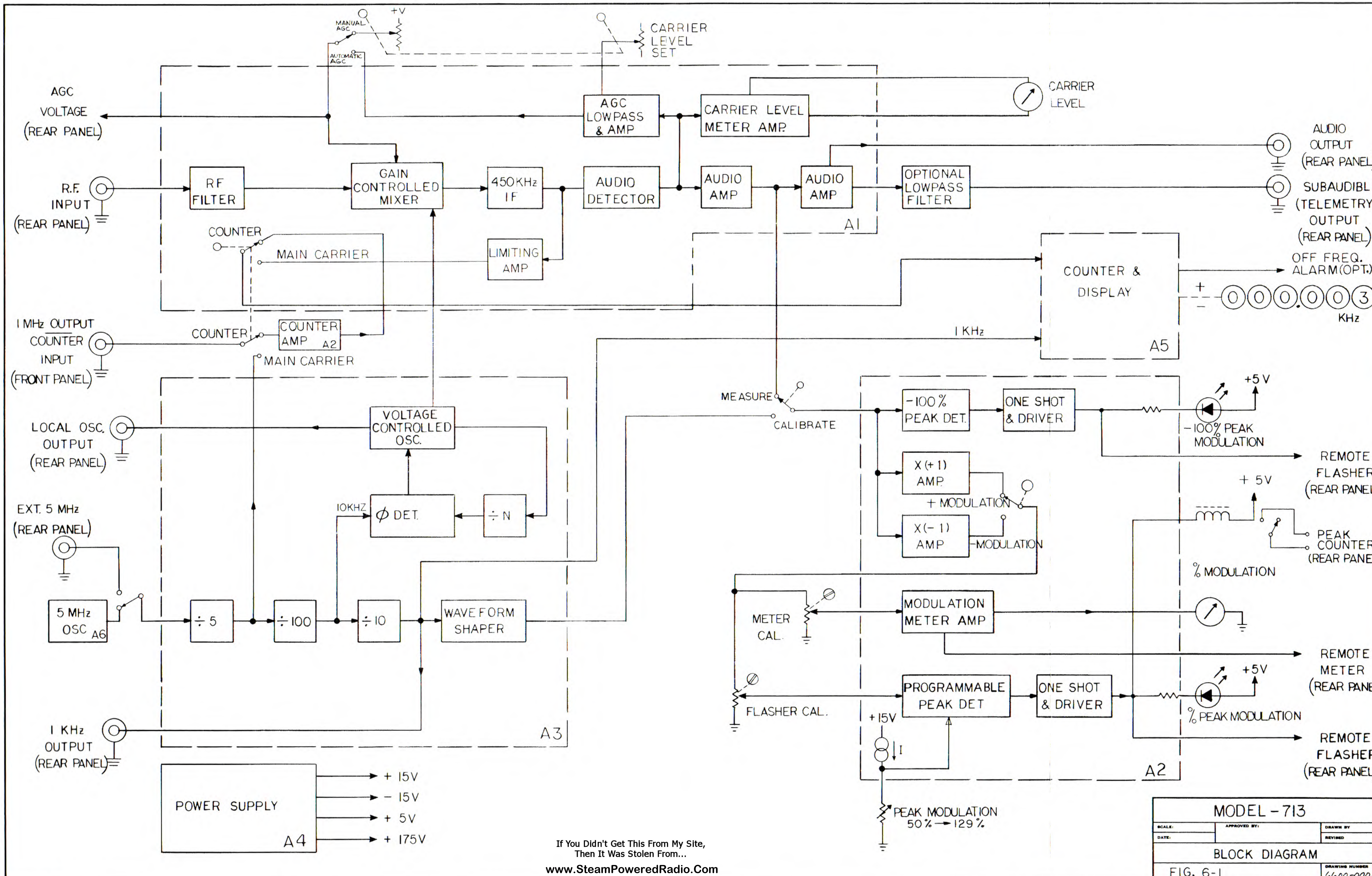


Frequency display works correctly but modulation meter or peak flashers do not.
Check A. C. waveform at P1 pin 18 of the peak flasher meter board A2. This should be the recovered audio signal riding on a D. C. voltage of approximately 1. 8 Volts.
Bad
Audio Detector section Z2 of I. F. board, A1 is bad or broken wire
O. K.
Check waveform at TP3 and TP4 of the peak flasher & & meter amp. board A2. The waveform should be the same as at TP-1.
Bad
Z5 or Z6 on peak flasher & meter amp. board A2 bad, or output shorted
O. K.
Check waveforms at TP-5 & TP-7. Should be same as TP-1 except slightly lower in amplitude
Bad
Check wiring to the front panel "+" and "-" switch, check meter and flasher cal pots
O. K.
Bad components on the meter amp/peak flasher board or outputs from board shorted

3.8.4



Neither Mod. Meter nor frequency display works correctly but display tubes lite when power is on.
Check 5MHz timebase switch on rear panel
External position
Return switch to internal position or apply 5MHz 1 volt RMS signal to use as timebase
Internal position
Check for 1kHz output at J10 on the rear panel
Output O.K.
Check L.O. output on rear panel. A.C. level should be 100 mVolts RMS. Freq. should be 450 kHz above channel freq.
Bad
Bad L.O. Board A3 or wiring
No output
Measure A.C. voltage at pin 8 of the 5MHz oven assembly. .5 volts RMS 5MHz
O.K.
Bad divider Chain Z7, Z8, Z9, Z10 and Z11 on L.O. Board A3. Repair or replace
No Good
Measure D.C. voltages going into oven assembly socket referring to schematic
No Good
Check wiring and power supply for broken wire or bad component
O.K.
Return oven assembly for repair
O.K.
Measure A.C. voltage at pin 2 of the I.F. Board A1. It should be 200 mVolts or greater.
Bad
There is a bad connection between pin 2 of L.O. Board A3 and pin 2 of I.F. board, A1
O.K.
Check coax cabling from R.F. Input on rear panel to I.F. Board
Bad
Replace coax
O.K.
Bad I.F. Board



MODEL − 713

SCALE: APPROVED BY: DRAWN BY
DATE: REVISED

BLOCK DIAGRAM

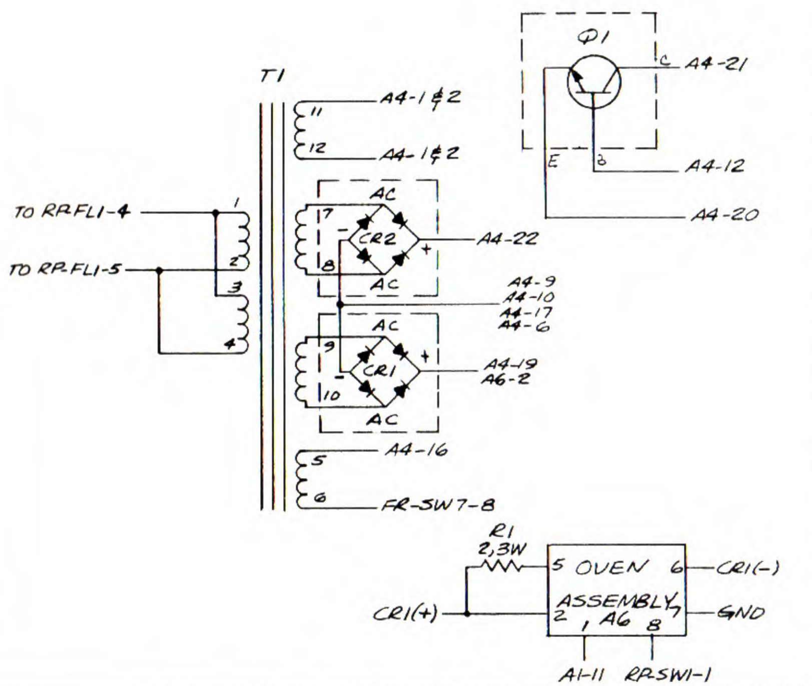
FIG. 6-1

DRAWING NUMBER 6600-0008

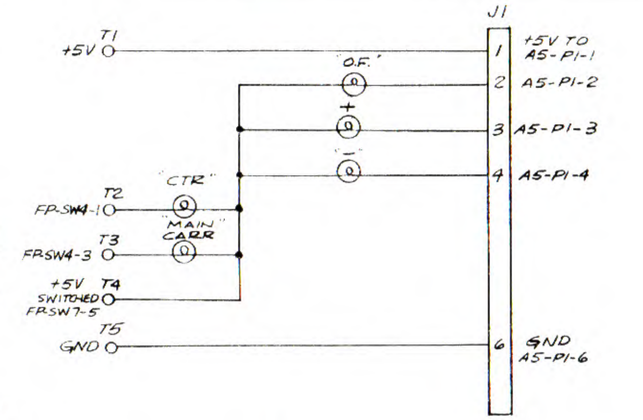
CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
MAIN CHASSIS			
CR1	SCAJ-2 Bridge Rectifier	1284-9522	Semtech
CR2	SCAJ-2 Bridge Rectifier	1284-9522	Semtech
Q1	MJE 3055 NPN Power transistor	1272-3055	Motorola
R1	2ohm ±5% 3 Watt Wive Wound Resistor	1068-0002	Ohmite
R2	10kohm ±5% 1/4W Carbon Comp	1065-1002	Allen-Bradley
R3	3.3kohm ±5% 1/4W Carbon Comp	1065-3301	Allen-Bradley
R4	680ohm ±5% 1/4W Carbon Comp	1065-0680	Allen-Bradley
T1	Power transformer	1500-0002	Tranex
TB1	7 Position terminal Strip	1700-0007	Chinch
TB2	7 Position terminal Strip	1700-0007	Chinch
J1-J5	22 Pin Single Row Edge Connector	2250-1030	SAE

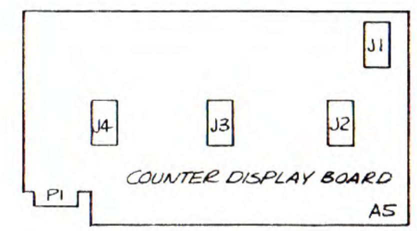
CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
FRONT PANEL			
CR1	Light Emitting Diode	1285-4403	Monsanto
CR2	Light Emitting Diode	1285-4403	Monsanto
CR3	Light Emitting Diode	1285-4403	Monsanto
M1	400 Amp Special Scale Meter	1400-7075	API
M2	500 Amp Special Scale Meter	1400-1002	Simpson
R1	1K Potentiometer	1071-1001	CTS
R2	1K Potentiometer	1071-1001	CTS
R3, R4	Ganged Pot. Assembly	1075-1048	Allen-Bradley
R5-R13	10Ω ±1% 1/8W, Metal Film	1061-0010	Dale
R14-R20	100Ω ±1% 1/8W, Metal Film	1061-0100	Dale
SW1-SW7	7 Station Ganged Push Button Switch Assembly	1850-0070	IEE
SW8-Sw9	2 Station Ganged Thumbwheel Switch Assembly	1875-9111	Interswitch
SW10	Part of R3-R4 Assembly	1075-1048	Allen-Bradley
J1	BNC Connector	2200-7935	Kings
	Miscellaneous Parts		
	Plastic Display Window	3000-0013	TFT

CHASSIS WIRING



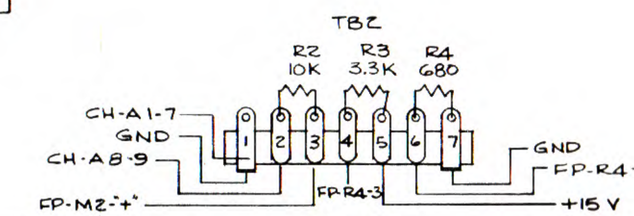
PIN	A1	A2	A3	A4
1	GND	GND	GND	T1-11, T1-12
2	A3-2	FP-SW1-5	A1-2	T1-11, T1-12
3	GND	FP-SW5-7	GND	
4	RP-J2	FP-SW5-6	-15V	FP-SW7-11
5	RP-J9	+5V	+15V	
6	FP-SW1-4	FR-SW3-6	RP-J7	
7	FP-M2-+	FP-SW3-7		
8	RP-J8	FP-R1-2		
9	-15V	FP-SW8-A		CR1 (-)
10	FP-M2-(-)	RP-J3-J		
11		FP-CR2-1		FP-SW7-2 & A6-1
12	+15V	FP-SW9 A		Q1-B
13		RP-J3-C		+5V
14		FP-CR1-1		+5V
15	FP-R3-3	CH-A5-J1-9		FP-SW7-7
16	FR-R3-1	GND	RP-J10	T1-5 & GND
17	FP-J3-D	-15V	+5V	CR2 (-) & GND
18	FP-R3-2	FP-R2-2	A5-J1-16	P1-8
19	+5V	+15V	FP-SW5-9	CR1 (+)
20	FP-SW4-7	FP-M1-(+)	FP-SW1-7	Q1-E
21	N.C.	RP-J3-A	RP-SW1-2	Q2-C
22	GND	GND, FR M1-(-)	GND	CR2 (+)
	I.F.	PEAK FLASHER AND METER AMPL	L.O.	PWR SUPPLY



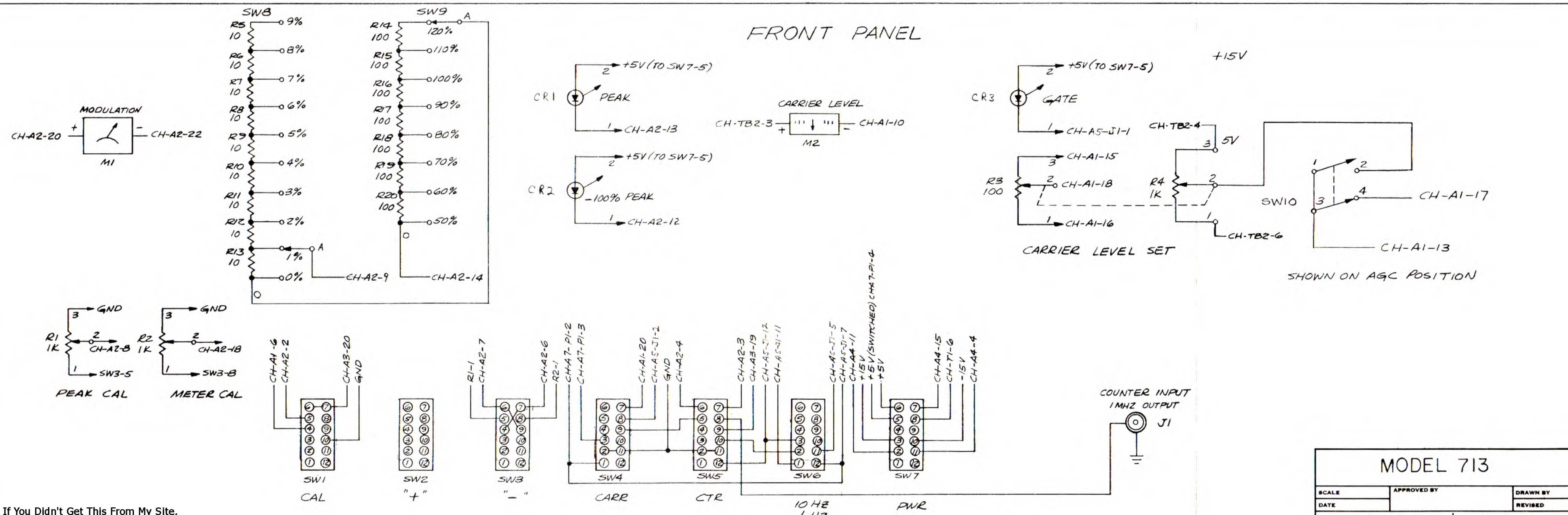


A5, COUNTER DISPLAY BOARD PIN CONNECTION TABLE

PIN	J1	J2	J3	J4	P1
1	FP-CR3-1				A7-J1-1
2	FP-SW4-8				A7-J1-2
3		RP-J1-40			A7-J1-3
4		RP-J1-19	RP-J1-11	RP-J1-3	A7-J1-4
5	FP-SW6-11	RP-J1-20	RP-J1-12	RP-J1-4	
6		RP-J1-18	RP-J1-10	RP-J1-2	A7-J1-6
7	FP-SW6-12	RP-J1-17	RP-J1-9	RP-J1-1	
8	A4-18	RP-J1-22	RP-J1-14	RP-J1-6	
9		RP-J1-21	RP-J1-13	RP-J1-5	
10		RP-J1-24	RP-J1-16	RP-J1 8	
11	FP-SW6-1	RP-J1-23	RP-J1-15	RP-J1-7	
12	FP-SW6-3	RP-J1-41			
13					
14	RP-J3-B				
15					
16	A3-18				



FRONT PANEL



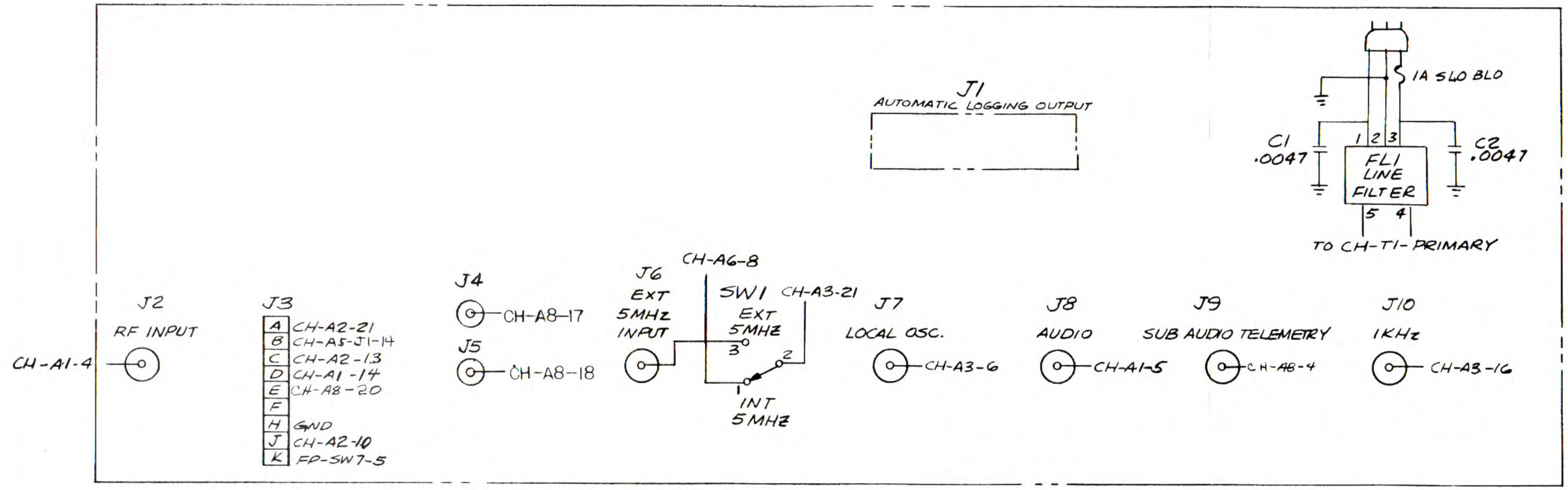
MODEL 713		
SCALE	APPROVED BY	DRAWN BY
DATE		REVISED
FRONT PANEL & CHASSIS WIRING		
FIG. 6-2		DRAWING NUMBER 6600-0012

A

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
REAR PANEL			
F1	1A Slo-blo Fuse	1900-0010	Little Fuse
FL1	Line Filter	1055-0001	CorCom
J1	50 Pin Ribbon Connector or	2250-1150	Amphenol
	2-5 way Binding Post Red	2200-0001	Pomona
	Black	2200-0002	Pomona
J2	BNC Connector	2200-7935	Kings
J3	9 Pin Plug	2220-0009	Amphenol
J4	5 Way Binding Post	2200-0001	Pomona
J5	5 Way Binding Post	2200-0001	Pomona
J6	BNC Connector	2200-7935	Kings
J7	BNC Connector	2200-7935	Kings
J8	BNC Connector	2200-7935	Kings
J9	BNC Connector	2200-7935	Kings
J10	BNC Connector	2200-7935	Kings
C1	$.0047\mu f \pm 20\%$ 1KV	1005-4749	Erie
C2	$.0047\mu f \pm 20\%$ 1KV	1005-4749	Erie
	Power Cord	1950-7239	Belden
	Strain Relief	1975-0504	Heyco
S1	SPDT Switch	1800-1020	Alco

J1 AUTOMATIC LOGGING OUTPUT

PIN		PIN		PIN	
1	CH-A5-J4-7	21	CH-A5-J2-9	41	CH-A5-J2-12
2	CH-A5-J4-6	22	CH-A5-J2-8	42	
3	CH-A5-J4-4	23	CH-A5-J2-11	43	
4	CH-A5-J4-5	24	CH-A5-J2-10	44	
5	CH-A5-J4-9	25		45	
6	CH-A5-J4-8	26	CH-A3-3	46	
7	CH-A5-J4-11	27		47	
8	CH-A5-J4-10	28		48	
9	CH-A5-J3-7	29		49	
10	CH-A5-J3-6	30		50	CH-A3-17
11	CH-A5-J3-4	31			
12	CH-A5-J3-5	32			
13	CH-A5-J3-9	33			
14	CH-A5-J3-8	34			
15	CH-A5-J3-11	35			
16	CH-A5-J3-10	36			
17	CH-A5-J2-7	37			
18	CH-A5-J2-6	38			
19	CH-A5-J2-4	39			
20	CH-A5-J2-5	40	CH-A5-J2-3		



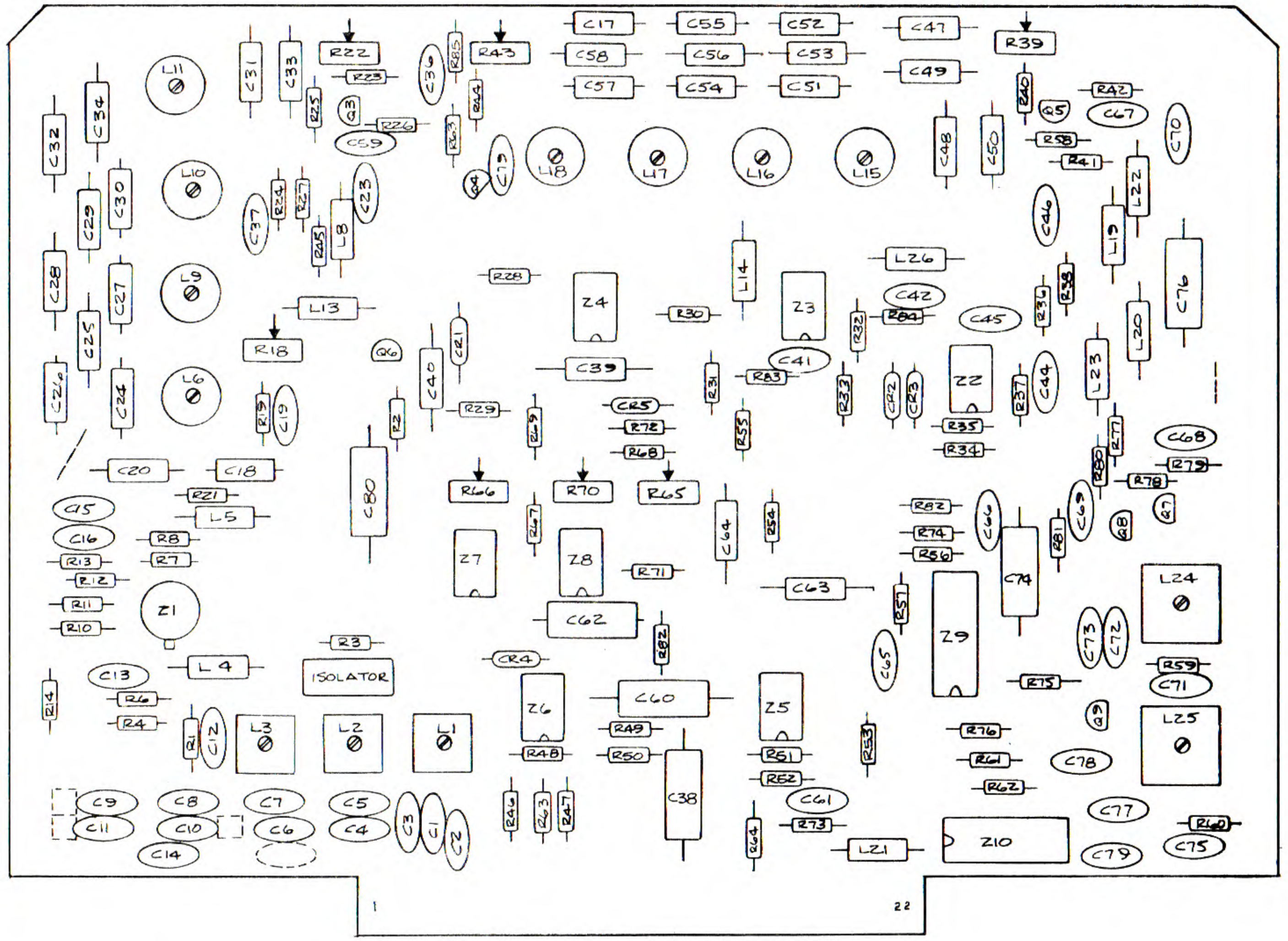
MODEL 713		
SCALE	APPROVED BY	DRAWN BY
DATE		REVISED
REAR PANEL WIRING		
FIG. 6-3		DRAWING NUMBER 6600-0010

A1-IF BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	CAPACITORS		
C1			
C2			
C3			
C4			
C5			
C6			
C7			
C8			
C9			
C10			
C11			
C12			
C13	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C14	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C15	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C16	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C17	75pF ±5%, 100V, Polystyrene		Centralab
C18	75pF ±5%, 100V, Polystyrene		Centralab
C19	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C20	820pF, ±5%, 100V, Polystyrene		Centralab
C21			
C22			
C23	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C24	43pF, ±5%, 100V, Polystyrene		Centralab
C25	820pF, ±5%, 100 V, Polystyrene		Centralab
C26	43pF, ±5%, 100V, Polystyrene		Centralab
C27	30pF, ±5%, 100V, Polystyrene		Centralab
C28	820pF, ±%, 100V, Polystyrene		Centralab
C29	43pF, ±5%, 100V, Polystyrene		Centralab
C30	43pF ±5%, 100V, Polystyrene		Centralab
C31	1000pF, ±5%, 100V, Polystyrene		Centralab
C32	1000pF ±5%, 100V, Polystyrene		Centralab
C33	750pF ±5%, 100V, Polystyrene		Centralab
C34	780fP ±5%, 100V, Polystyrene		Centralab
C35			
C36	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C37	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C38	15µF, 25V, Electrolytic	1010-0250	Sprague
C39	10µF, 450V, Electrolytic	1010-0100	Sprague
C40	10µF, 20V, Tantalum	1008-0100	Sprague
C41	1000pF, ±5%, 500V, Mica	1001-0102	Elmenco
C42	510pF, ±5%, 500V, Mica	1001-0511	Elmenco
C43			
C44	220pF, ±5%, 500V, Mica	1001-0221	Elmenco
C45	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C46	.2MF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie

A1-IF BOARD (Continued)

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	CAPACITORS (Continued)		
C47	750pF, ±5%, 100V, Polystyrene		Centralab
C48	750pF, ±5%, 100V, Polystyrene		Centralab
C49	1000pF, ±5%, 100V, Polystyrene		Centralab
C50	1000pF, ±5%, 100V, Polystyrene		Centralab
C51	43pF, ±5%, 100V, Polystyrene		Centralab
C52	43pF, ±5%, 100V, Polystyrene		Centralab
C53	820pF, ±5%, 100V, Polystyrene		Centralab
C54	30pF, ±5%, 100V, Polystyrene		Centralab
C55	43pF, ±5%, 100V, Polystyrene		Centralab
C56	820pF, ±5%, 100V, Polystyrene		Centralab
C57	43pF, ±5%, 100V, Polystyrene		Centralab
C58	820pF, ±5%, 100V, Polystyrene		Centralab
C59	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C60	25µF, 6 V, Electrolytic	1010-0250	Sprague
C61	1500pF, ±5%, 500V, Mica	1001-0152	Elmenco
C62	10µF, 20V, Tantalum	1008-0100	Sprague
C63	15µF, 25V, Electrolytic	1010-0150	Sprague
C64	10µF, 20V, Tantalum	1008-0100	Sprague
C65	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C66	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C67	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C68	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C69	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C70	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C71	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C72	1000pF, ±5%, 500V, Mica	1001-0102	Elmenco
C73	180pF, ±5%, 55V, Mica	1001-0181	Elmenco
C74	15µF, 25V, Electrolytic	1010-0250	Sprague
C75	.2µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C76	15µF, 25V, Electrolytic	1010-0150	Sprague
C77	6800pF, ±5%, 500V, Mica	1001-0682	Elmenco
C78	1500pF, ±5%, 500V, Mica	1001-0152	Elmenco
C79	.20µF, +80%-20%, 25V, Cer. Disc	1005-2029	Erie
C80	15µF, 25V, Electrolytic	1010-0150	Sprague
	RESISTORS		
R1			
R2	120Ω, 5%, 1/4W	1065-0120	ABR
R3	51Ω, 5%, 1/4W	1065-0051	ABR
R4	33K, 5%, 1/4W	1065-3302	ABR
R5			
R6	33K, 5%, 1/4W	1065-3302	ABR



A1-IF BOARD (Continued)

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	RESISTORS (Continued)		
R7	51Ω, 5%, 1/4W	1065-0051	ABR
R8	4.7K, 5%, 1/4W	1065-4701	ABR
R9			
R10	51Ω, 5%, 1/4W	1065-0051	ABR
R11	51Ω, 5%, 1/4W	1065-0051	ABR
R12	1K, 5%, 1/4W	1065-1001	ABR
R13	1K, 5%, 1/4W	1065-1001	ABR
R14	1K, 5%, 1/4W	1065-1001	ABR
R15			
R16			
R17			
R18	1K Variable		
R19	5.6K, 5%, 1/4W	1065-5601	ABR
R20			
R21	1K, 5%, 1/4W	1065-1001	ABR
R22	1K Variable		
R23	3.3K, ±5%, 1/4W	1065-3301	ABR
R24	1K, ±5%, 1/4W	1065-1001	ABR
R25	5.6K, ±5%, 1/4W	1065-5601	ABR
R26	51Ω, ±5%, 1/4W	1065-0051	ABR
R27	12K, 5%, 1/4W	1065-1202	ABR
R28	100Ω, 5%, 1/4W	1065-0100	ABR
R29	2.7K, 5%, 1/4W	1065-2701	ABR
R30	47K, 5%, 1/4W	1065-4702	ABR
R31	47K, 5%, 1/4W	1065-4702	ABR
R32	10K, 5%, 1/4W	1065-1002	ABR
R33	10K, 5%, 1/4W	1065-1002	ABR
R34	2.2K, 5%, 1/4W	1065-2201	ABR
R35	10Ω, 5%, 1/4W	1065-0010	ABR
R36	1K, ±5%, 1/4W	1065-1001	ABR
R37	2.2K, 5%, 1/4W	1-65-2201	ABR
R38	1K, ±5%, 1/4W	1065-1001	ABR
R39	1K Variable		
R40	3.3K, 5%, 1/4W	1065-3301	ABR
R41	470Ω, 5%, 1/4W	1065-0470	ABR
R42	8.2K, 5%, 1/4W	1065-8201	ABR
R43	1K Variable		
R44	5.6K, ±5%, 1/4W	1065-5601	ABR
R45	10K, 5%, 1/4W	1065-1002	ABR
R46	560Ω, 5%, 1/4W	1065-0560	ABR
R47	560Ω, 5%, 1/4W	1065-0560	ABR
R48	15K, 5%, 1/4W	1065-1502	ABR
R49	10K, 5%, 1/4W	1065-1002	ABR

A1-IF BOARD (Continued)

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	RESISTORS (Continued)		
R50	10K, 5%, 1/4W	1065-1002	ABR
R51	3.9K, 5%, 1/4W	1065-3901	ABR
R52	1K, 5%, 1/4W	1065-1001	ABR
R53	1K* 5% 1/4W	1065-1001	ABR
R54	33K, 5%, 1/4W	1065-3301	ABR
R55	1K, 5%, 1/4W	1065-1001	ABR
R56	12K, 5%, 1/4W	1065-1202	ABR
R57	560Ω, 5%, 1/4W	1065-0560	ABR
R58	15K, 5%, 1/4W	1065-1502	ABR
R59	27K, 5%, 1/4W	1065-2702	
R60	27K, 5%, 1/4W	1065-2702	ABR
R61	1K, 5%, 1/4W	1065-1001	ABR
R62	10K, 5%, 1/4W	1065-1002	ABR
R63	75Ω, 5%, 1/4W	1065-0075	ABR
R64	220Ω, 5%, 1/4W	1065-0220	ABR
R65	1K Variable		
R66	100 Variable		
R67	270 , 5%, 1/4W	1065-0270	ABR
R68	33K, 5%, 1/4W	1065-3301	ABR
R69	220 , 5%, 1/4W	1065-0220	ABR
R70	100 Variable		
R71	2.2K, 5%, 1/4W	1065-2201	ABR
R72	10K, 5%, 1/4W	1065-1002	ABR
R73	10K, 5%, 1/4W	1065-1002	ABR
R74	2.2K, 5%, 1/4W	1065-2201	ABR
R75	3.3K, 5%, 1/4W	1065-3301	ABR
R76	1K, ±5%, 1/4W	1065-1001	ABR
R77	15K, 5%, 1/4W	1065-1502	ABR
R78	1.2K, 5%, 1/4W	1065-1201	ABR
R79	15K, 5%, 1/4W	1065-1502	ABR
R80	15K, 5%, 1/4W	1065-1502	ABR
R81	33K, 5%, 1/4W	1065-3302	ABR
R82	3.3K, 5%, 1/4W	1065-3301	ABR
R83	100Ω, 5%, 1/4W	1065-0100	ABR
R84	560K		
R85	6.8K		
	COILS		
L1			
L2			
L3			
L4	15 µH	1530-0150	Delevan
L5	15 µH	1530-0150	Delevan

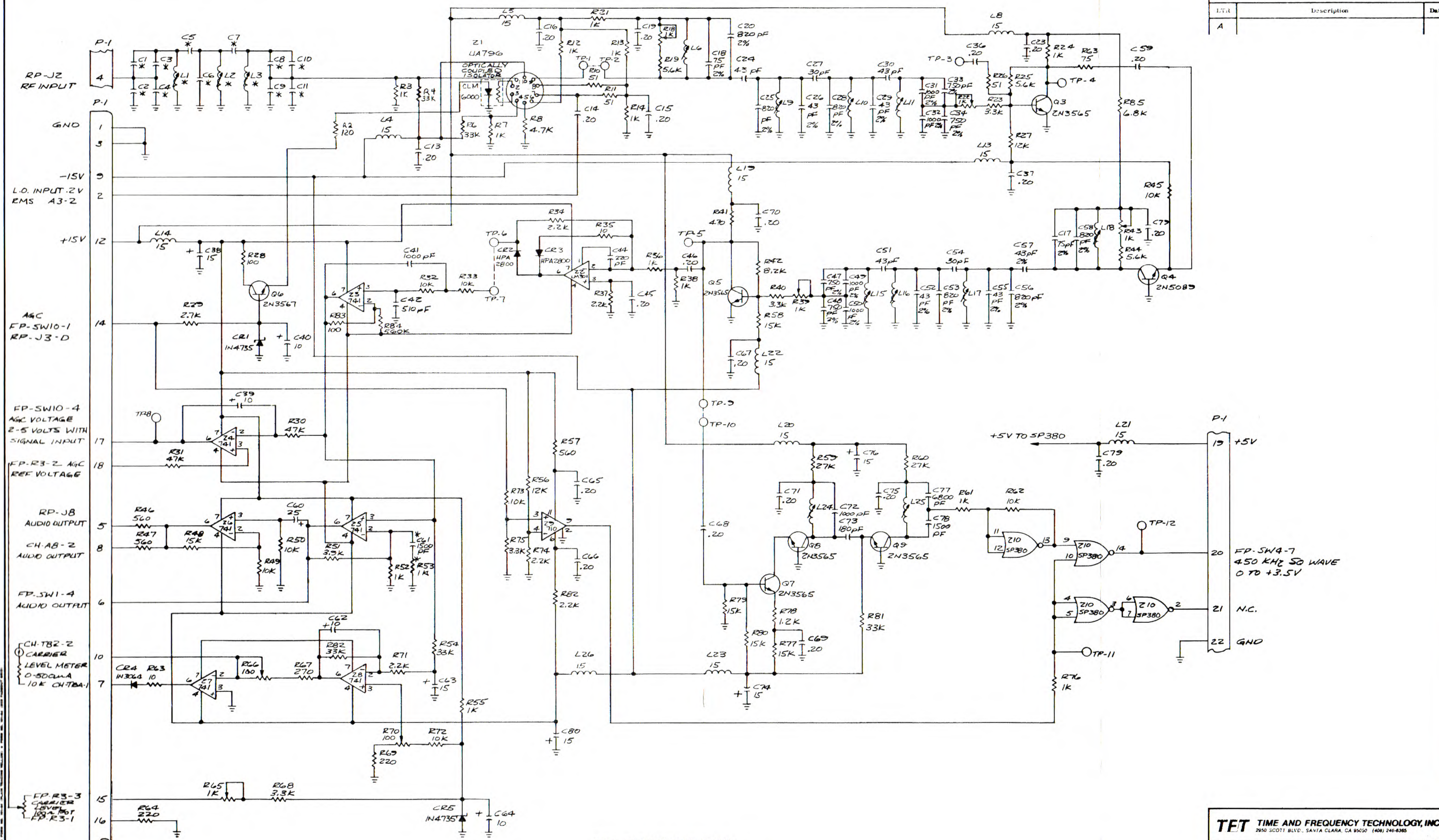
A1-IF BOARD (Continued)

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	COILS (Continued)		
L6	Variable		
L7			
L8	15 µH	1530-0150	Delevan
L9	Variable	1550-0455	
L10	Variable	1550-0455	
L11	Variable	1550-0455	
L12			
L13	15µH	1530-0150	Delevan
L14	15µH	1530-0150	Delevan
L15	Variable	1550-0455	
L16	Variable	1550-0455	
L17	Variable	1550-0455	
L18	Variable	1550-0455	
L19	15µH	1530-0150	Delevan
L20	15µH	1530-0150	Delevan
L21	15µH	1530-0150	Delevan
L22	15µH	1530-0150	Delevan
L23	15µH	1530-0150	Delevan
L24	Variable		
L25	Variable		
L26	15µH	1530-0150	Delevan
	DIODES		
CR1	IN4735	1283-4735	National
CR2	HP2800	1282-2800	H.P.
CR3	HP2800	1282-2800	H.P.
CR4	IN3064	1281-3064	Fairchild
CR5	IN4735	1283-4735	National
	INTEGRATED CIRCUITS		
Z1	UA796	1100-0796	National
Z2	LM301	1100-0301	National
Z3	LM741C	1100-0741	National
Z4	LM741C	1100-0741	National
Z5	LM741C	1100-0741	National
Z6	LM741C	1100-0741	National
Z7	LM741C	1100-0741	National
Z8	LM741C	1100-0741	National
Z9	LM710	1100-0710	National
Z10	SP380	1100-0380	Signetics
	10 Pin Spreader	1150-0010	
	14 Pin IC Sockets	2250-1014	Circuit Assembly

A1-IF BOARD (Continued)

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	TRANSISTORS		
Q1			
Q2			
Q3	2N3565	1271-3565	National
Q4	2N5089	1271-5089	Fairchild
Q5	2N3565	1271-3565	National
Q6	2N3567	1271-3567	National
Q7	2N3565	1271-3565	National
Q8	2N3565	1271-3565	National
Q9	2N3565	1271-3565	National
	Opitcally Coupled Isolator PT-001		Allen-Bradley
	P.C. Board		
	IF Board	1600-0030	

REVISIONS		
LTR	Description	Date
A		



NOTES; UNLESS OTHERWISE SPECIFIED:
1. RESISTORS - VALUES IN OHMS ±5%, 1/4 WATT.
2. CAPACITORS - VALUES IN MICROFARADS.
3. INDUCTORS - VALUES IN MICROHENRYS ±10%
4. *FACTORY SELECT VALUE. TYPICAL VALUE SHOWN.
5. VOLTAGES ARE DC CONDITIONS.

TFT TIME AND FREQUENCY TECHNOLOGY, INC.
2950 SCOTT BLVD., SANTA CLARA, CA 95050 (408) 246-6365

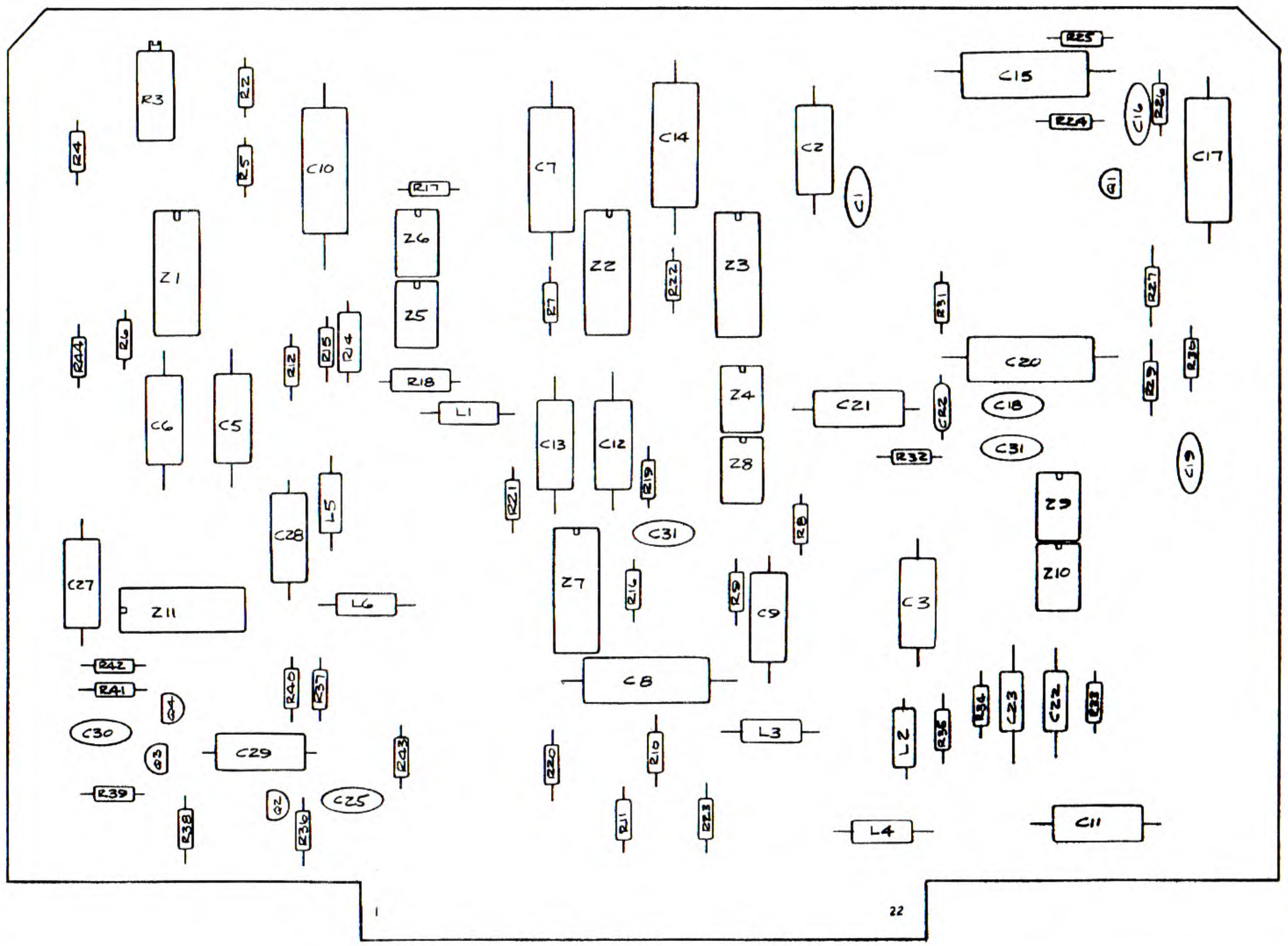
SCALE —	APPROVED BY	DRAWN BY D.S.
DATE 11-1-72		REVISED 11-15-72
SCHEMATIC - I.F. BOARD (A1)		
MODEL 713	FIG. 6-4	DRAWING NUMBER 6601-0046 A

A2-PEAK FLASHER &METER AMP

CKT. REF	DESCRIPTION	TFT STOCK NO.	MFR.
	CAPACITORS		
C1	.05MF, +80%-20%, 25V, CER. Disc	1005-5039	Erie
C2	15MF, 25V, Electrolytic	1010-0150	Sprague
C3	100MF, 15V, Electrolytic	1010-0101	Sprague
C4			
C5	15MF, 25V, Electrolytic	1010-0150	Sprague
C6	15MF. 25V, Electrolytic	1010-0150	Sprague
C7	250MF, 6V, Electrolytic	1010-0251	Sprague
C8	100MF, 15V, Electrolytic	1010-0101	Sprague
C9	1MF, 25V, Electrolytic	1010-0010	Sprague
C10	100MF, 15V, Electrolytic	1010-0101	Sprague
C11	100MF, 15V, Electrolytic	1010-0101	Sprague
C12	15MF, 25V, Electrolytic	1010-0150	Sprague
C13	15MF, 25V. Electrolytic	1010-0150	Sprague
C14	250MF, 6V, Electrolytic	1010-0251	Sprague
C15	100MF, 15V, Electrolytic	1010-0101	Sprague
C16	820PF, ±5%, 500V, Mica	1001-0821	Elmenco
C17	100MF, 15V, Electrolytic	1010-0101	Sprague
C18	15PF, ±5%, 500V, Mica	1001-0150	Elmenco
C19	.015MF, 10%, 100V, Poly	1002-1539	Sprague
C20	100MF, 15V, Electrolytic	1010-0101	Sprague
C21	6.8MF, 10%, 20V, Tant.	1008-0068	Kemet
C22	5.6MF, 10%, 20V, Tant.	1008-0056	Kemet
C23	5.6MF, 10%, 20V, Tant.	1008-0056	Kemet
C24			
C25	.2MF, +80-20%, 25V, Cer. Disc	1005-2029	Erie
C26	.05MF, +80-20%, 25V, Cer. Disc	1005-5039	Erie
C27	25MF, 20V, Electrolytic	1010-0250	Sprague
C28	10MF, 20V, Tant.	1008-0100	Sprague
C29	10MF, 20V, Tant.	1008-0100	Sprague
C30	.05MF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C31	51PF, ±5%, 500V, Mica	1001-0510	Elmenco
	RESISTORS		
R1			
R2	6.8K, ±5%, 1/4W	1065-6801	ABR
R3	500Ω, Variable	1069-0500	Beckman
R4	6.8K, ±5%, 1/4W	1065-6801	ABR
R5	560Ω, ±5%, 1/4W	1065-0560	ABR
R6	2.2K, ±5%, 1/4W	1065-2201	ABR
R7	6.8K, ±5%, 1/4W	1065-6801	ABR
R8	12K, ±5%, 1/4W	1065-1202	ABR
R9	2.2K, ±5%, 1/4W	1065-2201	ABR
R10	1.5K, ±1%, 1/8W	1065-1501	ABR

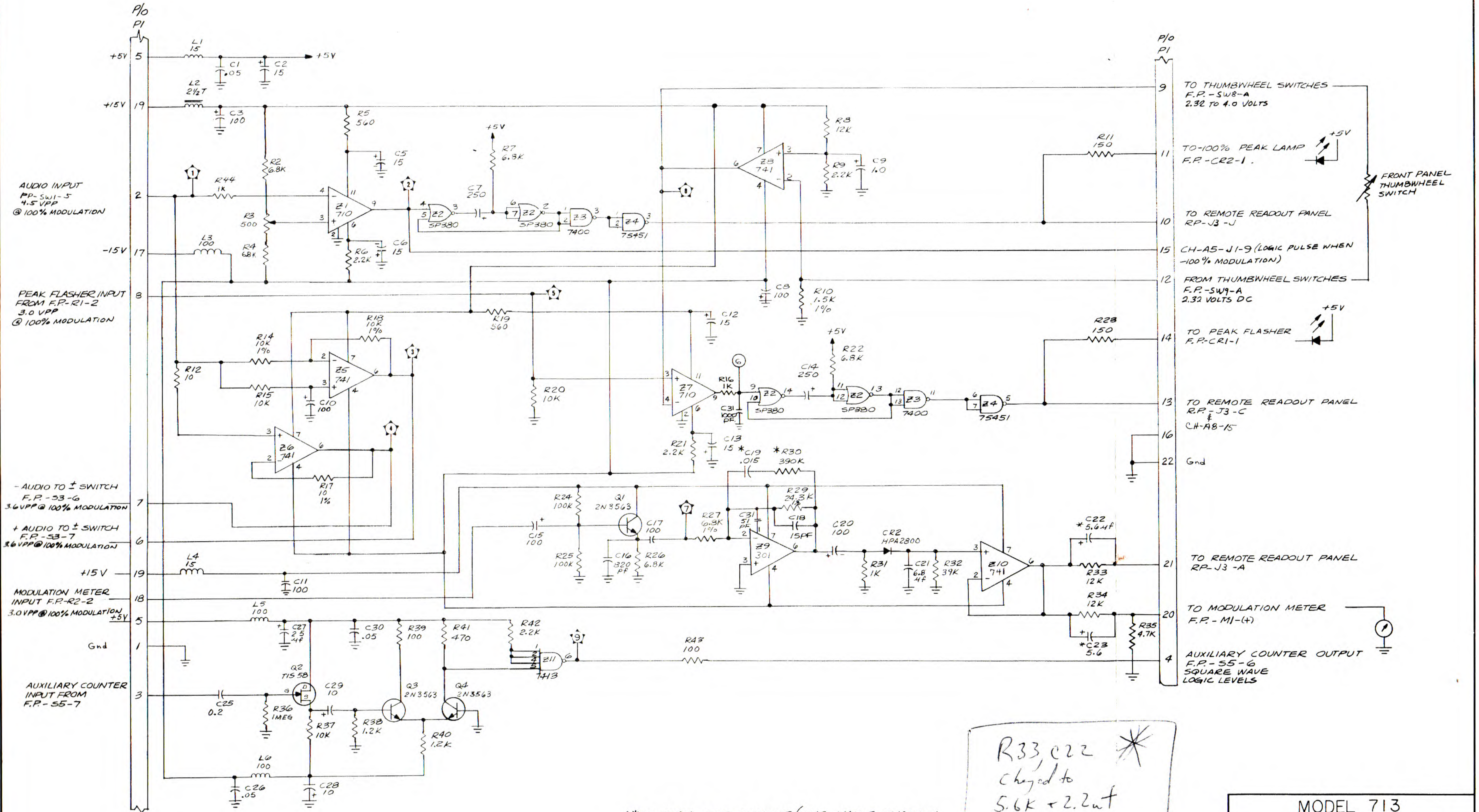
A2-PEAK FLASHER & METER AMP (cont'd.)

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	RESISTORS (continued)		
R11	150Ω, ±5%, 1/4W	1065-0150	ABR
R12	10K, 1%, 1/8W	1061-1002	Dale
R13			
R14	10K, 1%, 1/8W	1061-1002	Dale
R15	10K, 5%, 1/4W	1065-1002	Dale
R16			
R17	10K, 1%, 1/8W	1061-1002	Dale
R18	10K, 1%, 1/8W	1061-1002	Dale
R19	560Ω, ±5%, 1/4W	1065-0560	ABR
R20	10K	1065-1002	ABR
R21	2.2K, ±5%, 1/4W	1065-2201	ABR
R22	6.8K, ±5%, 1/4W	1065-6801	ABR
R23	150Ω, ±5%, 1/4W	1065-0150	ABR
R24	100K, ±5%, 1/4W	1065-1003	ABR
R25	100K, ±5%, 1/4W	1065-1003	ABR
R26	6.8K, ±5%, 1/4W	1065-6801	ABR
R27	6.8K, ±5%, 1/4W	1065-6801	ABR
R28			
R29	24.3K, 1%, 1/8W	1061-2432	Dale
R30	390K, ±5%, 1/4W	1065-3903	ABR
R31	1K, ±5%, 1/4W	1065-1001	ABR
R32	39K, ±5%, 1/4W	1065-3907	ABR
R33	12K, ±5%, 1/4W	1065-1202	ABR
R34	12K, ±5%, 1/4W	1065-1202	ABR
R35	4.7K, ±5%, 1/4W	1065-4701	ABR
R36	1 MEG ±10%, 1/4W	1066-1004	ABR
R37	10K, ±5%, 1/4W	1066-1002	ABR
R38	1.2K, ±5%, 1/4W	1065-1201	ABR
R39	100Ω, ±5%, 1/4W	1065-0100	ABR
R40	1.2K, ±5%, 1/4W	1065-1201	ABR
R41	470Ω, ±5%, 1/4W	1065-0470	ABR
R42	2.2K, ±5%, 1/4W	1065-2201	ABR
R43	100Ω, ±5%, 1/4W	1065-0100	ABR
R44	1K, ±5%, 1/4W	1065-1001	ABR
	COILS		
L1	15μH, ±10%	1530-0150	Delevan
L2	2-1/2 T Choke	1530-0025	
L3	100μ H, ±10%	1530-0101	Delevan
L4	15μ H, ±10%		Delevan
L5	100μ H, ±10%	1530-0101	Delevan
L6	100μ H, ±10%	1530-0101	Delevan



A2-PEAK FLASHER & METER AMP (Continued)

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	DIODES		
CR1			
CR2	HPA2800	1282-2800	H-P
	INTEGRATED CIRCUITS		
Z1	LM710	1100-0710	National
Z2	SP380	1100-0380	Signetics
Z3	SN7400	1100-7400	National
Z4	SN75451	1100-7551	National
Z5	LM741C	1100-0741	National
Z6	LM741C	1100-0741	National
Z7	LM710	1100-0710	National
Z8	LM741C	1100-0741	National
Z9	LM301A	1100-0301	National
Z10	LM741C	1100-0741	National
Z11	SN7413	1100-7413	TI
	TRANSISTORS		
Q1	2N3563	1271 3563	National
Q2	TIS58	1271-0058	TI
Q3	2N3563	1271-3563	National
Q4	2N3563	1271-3563	National
	P.C. Boards		
	Peak Flasher Board	1600-0029	
	14 Pin IC Socket	2250-1014	
	16 Pin IC Socket	2250-1016	



4.*FACTORY SELECT VALUE (TYP. VALUE SHOWN)
3. INDUCTOR VALUES IN MICROHENRYS; ±10%
2. CAPACITOR VALUES IN MICROFARADS.
1. RESISTOR VALUES IN OHMS; 1/4 W 5%.
NOTES; UNLESS OTHERWISE SPECIFIED:

R33, C22 *
Changed to
5.6K + 2.2uf
to accomodate
400ua remote meter

MODEL 713

SCALE: | APPROVED BY: | DRAWN BY C.K.
DATE: 1-16-72 | | REVISED 11-9-72

PEAK FLASHER & METER AMP (A2)

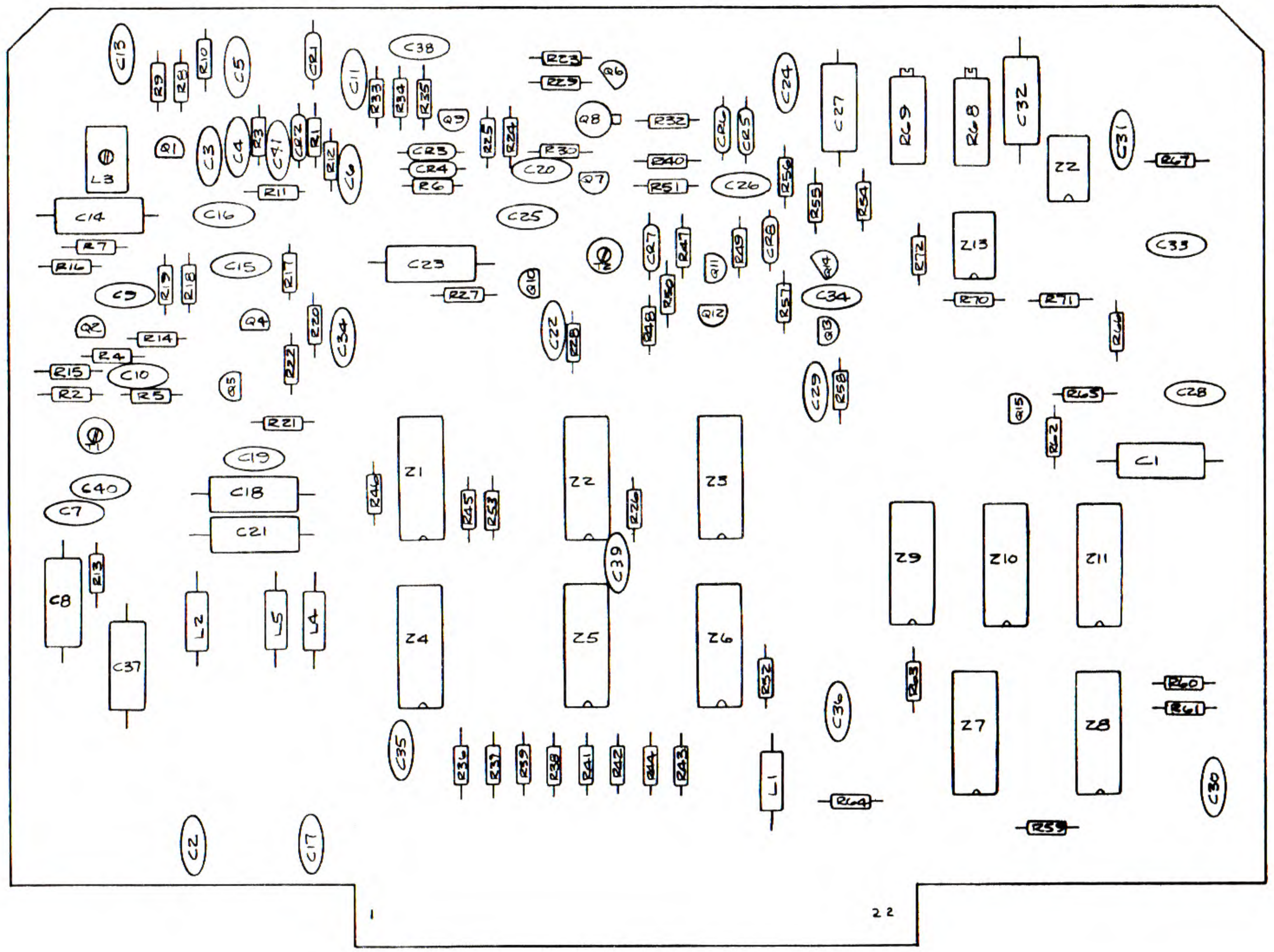
FIG. 6-5 | DRAWING NUMBER 6601-0047 E

A-3 L. O. BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	CAPACITORS		
C1	10μF, 20V, Tant.	1008-0100	Sprague
C2	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C3	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C4	56PF, ±5%, 500V, Mica	1001-0560	Elmenco
C5	1500PF, ±5%, 500V, Mica	1001-0152	Elmenco
C6	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C7	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C8	10μF, 20V, Tant.	1008-0100	Sprague
C9	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C10	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C11	2000PF, ±5%, 500V, Mica	1001-0202	Elmenco
C12	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C13	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C14	10μF, 20V, Tant.	1008-0100	Sprague
C15	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C16	1500PF, ±5%, 500V, Mica	1001-0152	Elmenco
C17	.05μF, +80%-20%, 25V, Cer Disc	1005-5039	Erie
C18	10μF, 20V, Tant.	1008-0100	Sprague
C19	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C20	10PF, ±5%, 500V, Mica	1001-0100	Elmenco
C21	10μF, 20V, Tant.	1008-0100	Sprague
C22	10PF, ±5%, 500V, Mica	1001-0100	Elmenco
C23	10μF, 20V, Tant.	1008-0100	Sprague
C24	.0027μF, ±10%, 100V, Poly.	1002-2749	Sprague
C25	.01μF, +10%, 100V, Poly.	1005-1039	Erie
C26	510PF, +5%, 500V, Mica	1001-0511	Elmenco
C27	10μF, 20V, Tant.	1008-0100	Sprague
C28	.027μF, ±10%, 100V, Poly	1002-2739	Sprague
C29	10PF, ±5%, 500V, Mica	1001-0100	Elmenco
C30	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C31	.001μF, Dip Mica		
C32	10μF, 20V, Tant.	1008-0100	Sprague
C33	.15μF, ±10%, 200V		Sprague
C34	.01μF, +80%-20%, 25V, Cer. Disc	1005-1039	Erie
C35	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C36	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C37	10μF, 20V, Tant.	1008-0100	Sprague
C38	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C39	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C40	.05μF, +80%-20%, 25V, Cer. Disc	1005-5039	Erie
C41	240PF, ±5%, 500V, Mica	1001-0241	Elmenco
	RESISTORS		
R1	33K, 5%, 1/4W	1065-3302	ABR
R2	100Ω, 5%, 1/4W	1065-0100	ABR

A3-L.O. BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	RESISTORS (cont'd.)		
R3	100K, 5%, 1/4W	1065-1003	ABR
R4	470Ω, 5%, 1/4W	1065-0470	ABR
R5	100Ω, 5%, 1/4W	1065-0100	ABR
R6	10K, 5%, 1/4W	1065-1002	ABR
R7	1.8K, 5%, 1/4W	1065-1801	ABR
R8	15K, 5%, 1/4W	1065-1502	ABR
R9	470Ω, 5%, 1/4W	1065-0470	ABR
R10	4.7K, 5%, 1/4W	1065-4701	ABR
R11	10Ω, 5%, 1/4W	1065-0010	ABR
R12	150Ω, 5%, 1/4W	1065-0150	ABR
R13	100Ω, 5%, 1/4W	1065-0100	ABR
R14	6.8K, 5%, 1/4W	1065-6801	ABR
R15	220Ω, 5%, 1/4W	1065-0220	ABR
R16	3.3K, 5%, 1/4W	1065-3301	ABR
R17	100Ω, 5%, 1/4W	1065-0100	ABR
R18	1K, 5%, 1/4W	1065-1001	ABR
R19	2.2K, 5%, 1/4W	1065-2201	ABR
R20	100Ω, 5%, 1/4W	1065-0100	ABR
R21	820Ω, 5%, 1/4W		
R22	1.8K, 5%, 1/4W	1065-1801	ABR
R23	390Ω, 5%, 1/4W	1065-0390	ABR
R24	100Ω, 5%, 1/4W	1065-0100	ABR
R25	47K, 5%, 1/4W	1065-4702	ABR
R26	1K, 5%, 1/4W	1065-1001	ABR
R27	1K, 5%, 1/4W	1065-1001	ABR
R28	2.2K, 5%, 1/4W	1065-2201	ABR
R29	15K, 5%, 1/4W	1065-1502	ABR
R30	15K, 5%, 1/4W	1065-1502	ABR
R31			
R32	100Ω, 5%, 1/4W	1065-0100	ABR
R33	27K, 5%, 1/4W	1065-2702	ABR
R34	15K, 5%, 1/4W	1065-1502	ABR
R35	15K, 5%, 1/4W	1065-1502	ABR
R36	2.2K, 5%, 1/4W	1065-2201	ABR
R37	2.2K, 5%, 1/4W	1065-2201	ABR
R38	2.2K, 5%, 1/4W	1065-2201	ABR
R39	2.2K, 5%, 1/4W	1065-2201	ABR
R40	12K, 5%, 1/4W	1065-2201	ABR
R41	2.2K, 5%, 1/4W	1065-2201	ABR
R42	2.2K, 5%, 1/4W	1065-2201	ABR
R43	2.2K, 5%, 1/4W	1065-2201	ABR
R44	2.2K, 5%, 1/4W	1065-2201	ABR
R45	2.2K, 5%, 1/4W	1065-2201	ABR
R46	2.2K, 5%, 1/4W	1065-2201	ABR

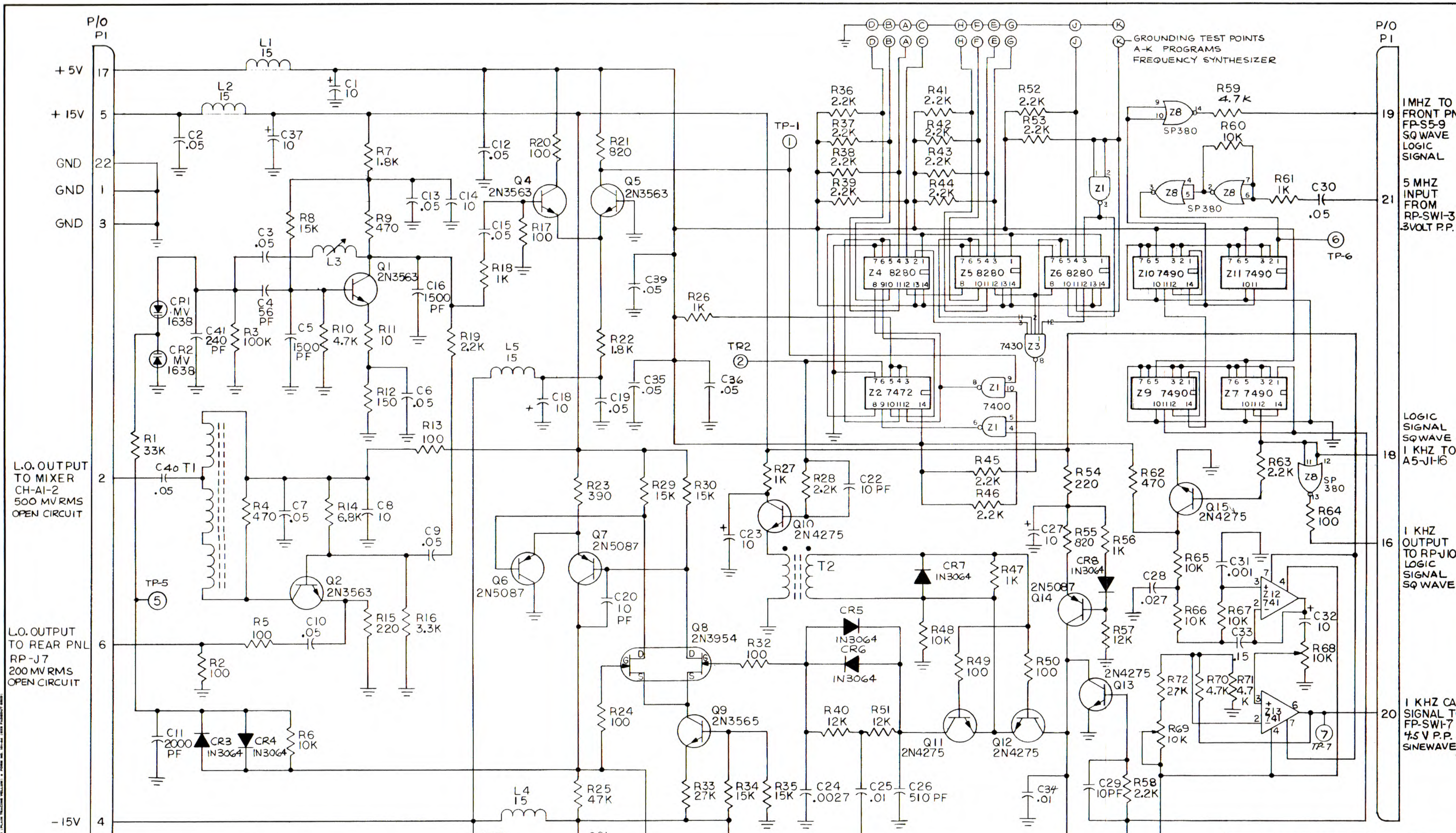


A3-L.O. BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	RESISTORS (cont'd.)		
R47	1K, 5%, 1/4W	1065-1001	ABR
R48	10K, 5%, 1/4W	1065-1002	ABR
R49	100Ω, 5%, 1/4W	1065-0100	ABR
R50	100Ω, 5%, 1/4W	1065-0100	ABR
R51			
R52	2.2K, 5%, 1/4W	1065-2201	ABR
R53	2.2K, 5%, 1/4W	1065-2201	ABR
R54	220Ω, 5%, 1/4W	1065-0220	ABR
R55	820Ω, 5%, 1/4W	1065-0820	ABR
R56	1K, 5%, 1/4W	1065-1001	ABR
R57	12K, 5%, 1/4W	1065-1202	ABR
R58	2.2K, 5%, 1/4W	1065-2201	ABR
R59	4.7K, 5%, 1/4W	1065-0100	ABR
R60	10K, 5%, 1/4W	1065-1002	ABR
R61	1K, 5%, 1/4W	1065-1001	ABR
R62	470Ω, 5%, 1/4W	1065-0470	ABR
R63	2.2K 5%, 1/4W	1065-2201	ABR
R64	100Ω, 5%, 1/4W	1065-0100	ABR
R65	10K, 5%, 1/4W	1065-1002	ABR
R66	10K, 5%, 1/4W	1065-1002	ABR
R67	10K, 5%, 1/4W	1065-1002	ABR
R68	10K, Variable	1069-1002	Beckman
R69	10K, Variable	1069-1002	Beckman
R70	4.7K, 5%, 1/4W	1069-1002	Beckman
R70	4.7K, 5%, 1/4W	1065-4701	ABR
R71	4.7K, 5%, 1/4W	1065-4701	ABR
R72	27K, 5%, 1/4W	1065-2702	ABR
	COILS		
L1	15μH, ±10%	1530-0150	Delevan
L2	15μH, ±10%	1530-0150	Delevan
L3	80T Variable	1550-0800	TRW
L4	15μH, ±10%	1530-0150	Delevan
L5	15μH, ±10%	1530-0150	Delevan
	DIODES		
CR1	MV1638	1285-1638	Motorola
CR2	MV1638	1285-1638	Motorola
CR3	IN3064	1281-3064	Fairchild
CR4	IN3064	1281-3064	Fairchild
CR5	IN3064	1281-3064	Fairchild
CR6	IN3064	1281-3064	Fairchild
CR7	IN3064	1281-3064	Fairchild

A3-L.O. BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	DIODES (cont'd.)		
CR8	IN3064	1281-3064	Fairchild
	INTEGRATED CIRCUITS		
Z1	SN7400	1100-7400	National
Z2	SN7472	1100-7472	Signetics
Z3	SN7430	1100-7430	National
Z4	DM8280	1100-8280	National
Z5	DM8280	1100-8280	National
Z6	DM8280	1100-8280	National
Z7	SN7490	1100-7490	National
Z8	SP3800	1100-0380	National
Z9	SN7490	1100-7490	National
Z10	SN7490	1100-7490	National
Z11	SN7490	1100-7490	National
Z12	LM741C	1100-0741	National
Z13	LM741C	1100-0741	National
	TRANSISTORS		
Q1	2N3563	1271-3563	National
Q2	2N3563	1271-3563	National
Q3			
Q4	2N3563	1271-3563	National
Q5	2N3563	1271-3563	National
Q6	2N5087	1271-5087	Fairchild
Q7	2N5087	1271-5087	Fairchild
Q8	2N3954	1271-3954	National
Q9	2N3565	1271-3565	National
Q10	2N4275	1271-4275	NSC
Q11	2N4275	1271-4275	NSC
Q12	2N4275	1271-4275	NSC
Q13	2N4275	1271-4275	NSC
Q14	2N5087	1271-5087	FSC
Q15	2N4275	1271-4275	NSC
	TRANSFORMERS		
T1	Trifilar	1501-0001	
T2	Trifilar	1501-0001	
	P.C. BOARD		
	L. O. Board	1600-0043	
	14 Pin I.C. Socket	2250-1014	



NOTES; UNLESS OTHERWISE SPECIFIED:

1. *RESISTORS 1/4 W, 5% VALUE IN OHMS.*
2. *CAPACITORS VALUE IN MICROFARADS.*
3. *ALL VOLTAGES ARE DC.*

MODEL 713

L.O. GENERATOR (A3)

FIG. 6-6

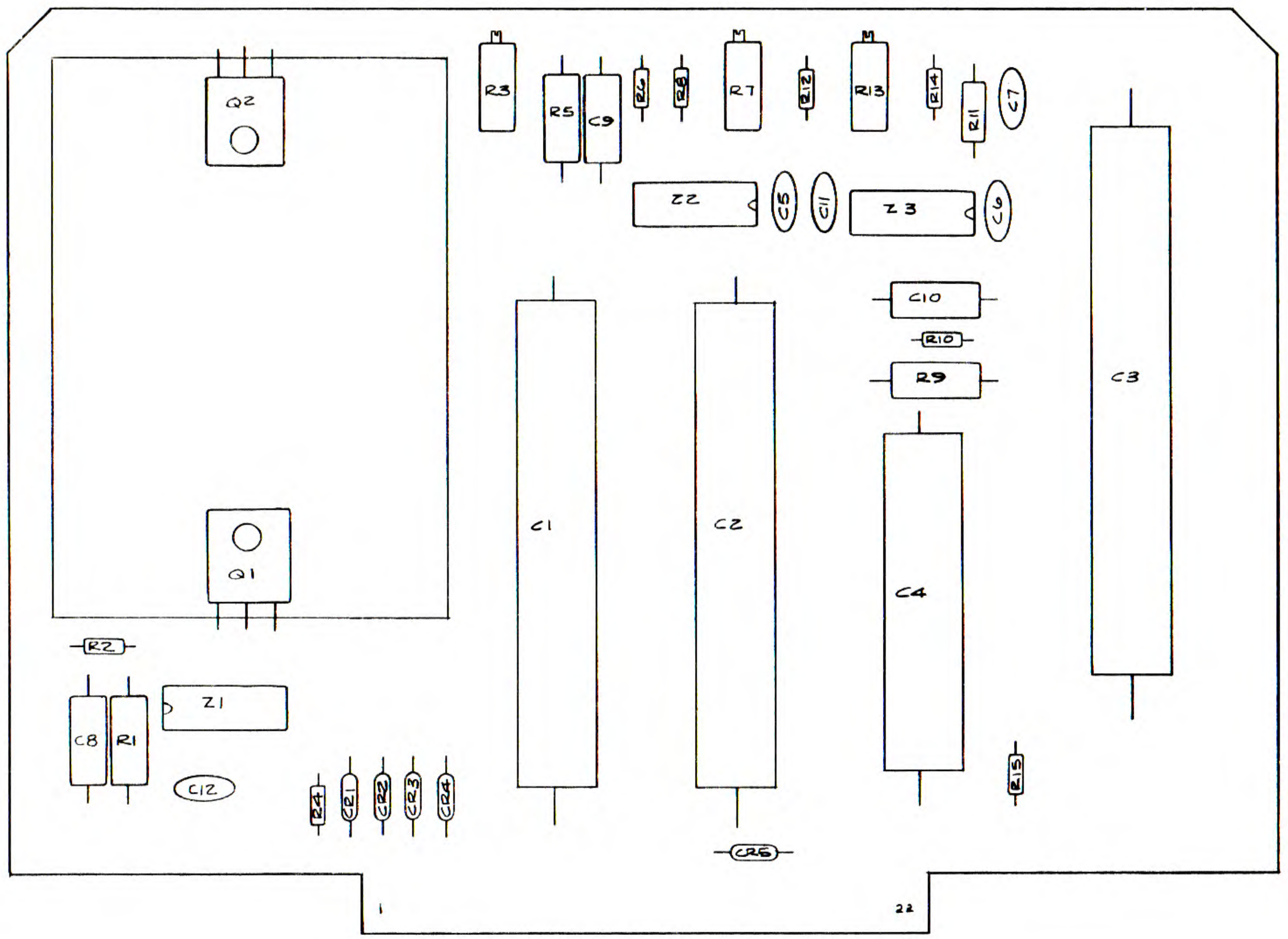
DRAWING NUMBER 6601-0048

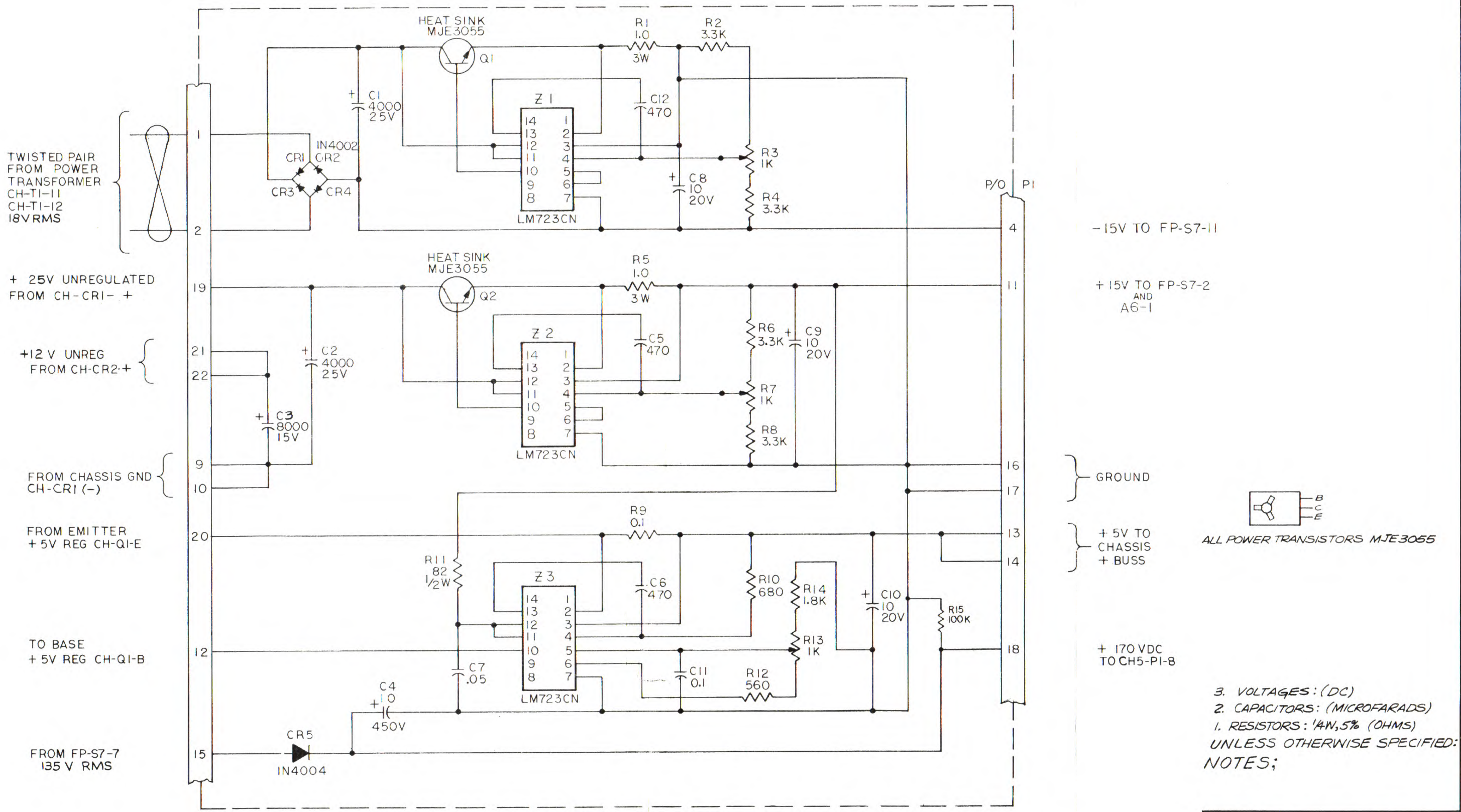
A-4 POWER SUPPLY BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	CAPACITORS		
C1	Electro., 4000 µF +20%, 25V	1010-0402	Sprague
C2	Electro., 4000 µF +20%, 25V	1010-0402	Sprague
C3	Electro., 8000 µF +20%, 15V	1010-0802	Sprague
C4	Electro., 10 µF +20%, 450V	1010-0100	Sprague
C5	Mica, 470 pF ±5%	1001-0471	Elmenco
C6	Mica, 470 pF ±5%	1001-0471	Elmenco
C7	Cer., .05 µF +80% -20%, 25V	1005-5039	Erie
C8	Tant., 10 µF ±10%, 20V	1008-0100	Kemet
C9	Tant., 10 µF ±10%, 20V	1008-0100	Kemet
C10	Tant., 10µ F ±10%, 20V	1008-0100	Kemet
C11	Cer., .01 µF +80% -20%, 25V	1005-1039	Erie
C12	470, 5%, 1/4W	1065-0470	ABR
	RESISTORS		
R1	Wirewound, 1Ω ±5%, 3W	1068-0001	Ohmite
R2	Comp, 3.3K ±5%, 10 turns	1065-3301	Allen-Bradley
R3	Vari., 1K ±10%, 1/4W	1069-1001	Beckman
R4	Comp, 3.3K ±5%, 1/4W	1065-3301	Allen-Bradley
R5	Wirewound, 1Ω ±5%, 3W	1068-0001	Ohmite
R6	Comp, 3.3K ±5%, 1/4W	1065-3301	Allen-Bradley
R7	Vari., 1K ±10%, 10 turns	1069-1001	Beckman
R8	Comp, 3.3K ±5%, 1/4W	1068-0191	Ohmite
R9	Wirewound, 0.1Ω ±5%, 3W	1068-0191	Ohmite
R10	Comp, 680Ω ±5%, 1/4W	1065-0680	Allen-Bradley
R11	Comp, 82Ω ±5%, 1/4W	1065-0082	Allen-Bradley
R12	Comp, 560Ω ±5%, 1/4W	1065-0560	Allen-Bradley
R13	Vari., 1KΩ ±10%, 10 turns	1069-1001	Beckman
R14	Comp, 1.8KΩ, ±5%, 1/4W	1065-1801	Allen-Bradley
R15	100K 5%, 1/4W	1065-1003	ABR
	TRANSISTORS		
Q1	Si, Power NPN, MJE 3055	1272-3055	Motorola
Q2	Si, Power NPN, MJE 3055	1272-3055	Motorola
	INTEGRATED CIRCUITS		
Z1	LM723CN Regulator	1100-0723	National
Z2	LM723CN Regulator	1100-0723	National
Z3	LM723CN Regulator	1100-0723	National

A-4 POWER SUPPLY BOARD

CKT. REF.	DESCRIPTIONS	TFT STOCK NO.	MFR.
	RECTIFIERS		
CR1	1N4002, 1A, 200V PIV	1284-4002	Motorola
CR2	1N4002, 1A, 200V PIV	1284-4002	Motorola
CR3	1N4002, 1A, 200V PIV	1284-4002	Motorola
CR4	1N4002, 1A, 200V PIV	1284-4002	Motorola
CR5	1N4004, 1A, 400V PIV	1284-4004	Motorola





MODEL 713

SCALE:	APPROVED BY:	DRAWN BY
DATE: 1-17-72		REVISED

POWER SUPPLY (A4)

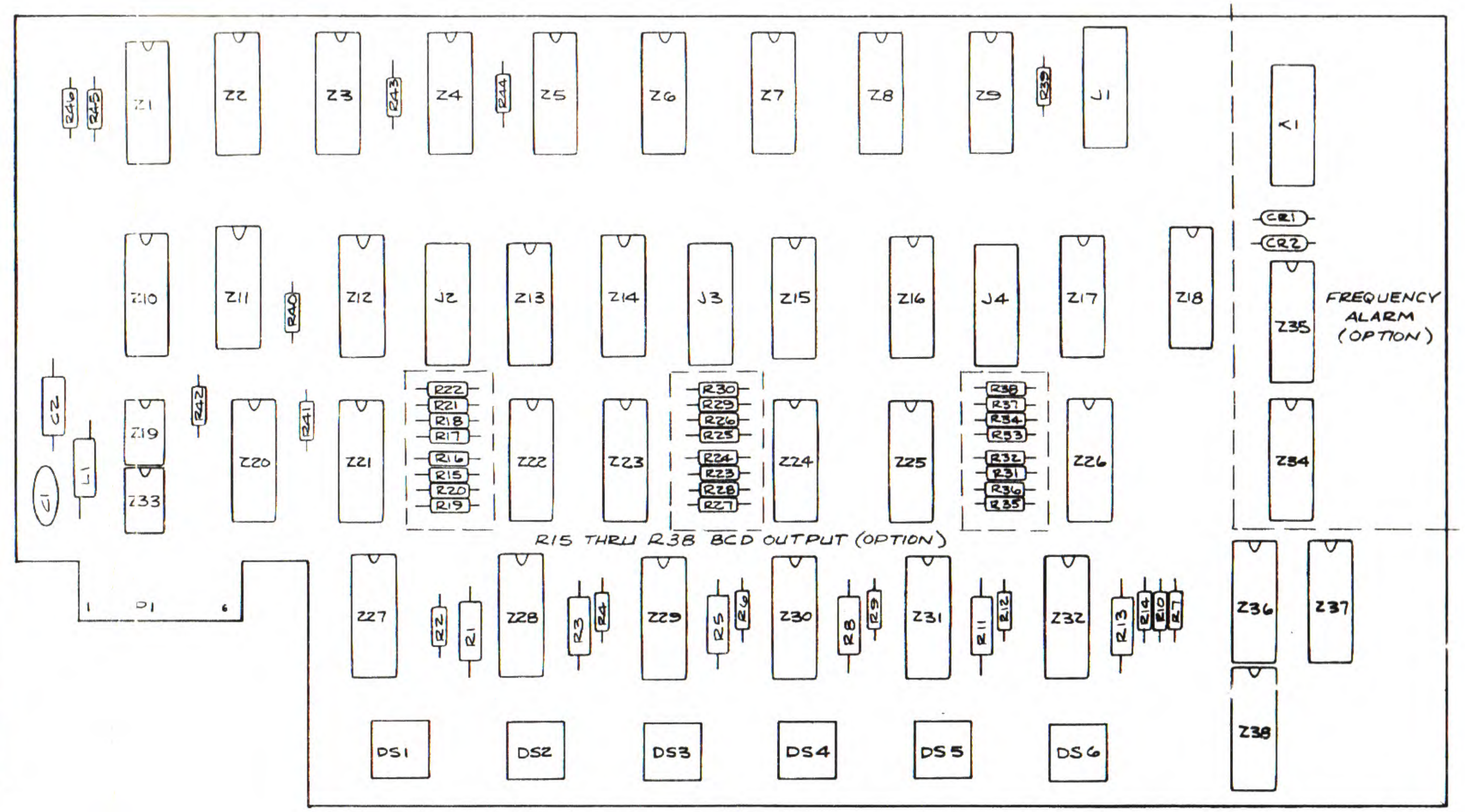
FIG. 6-7 — DRAWING NUMBER 6601-0049

A-5 COUNTER-DISPLAY BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	CAPACITORS		
C1	.05 µF +80 - 20% 25V Cer. Disc	1005-5039	Erie
C2	1 µF 25V Electrolytic	1010-0010	Sprague
	RESISTORS		
R1	15K, 10%, 1/2W	1067-1502	ABR
R2	10 MEG 10%, 1/4W	1066-1005	ABR
R3	15K, 10%, 1/2W	1067-1502	ABR
R4	10 MEG 10%, 1/4W	1066-1005	ABR
R5	15K, 10%, 1/2W	1067-1502	ABR
R6	10 MEG 10%, 1/4W	1066-1005	ABR
R7	150K, 5%, 1/4W	1065-1503	ABR
R8	15K, 10%, 1/2W	1067-1502	ABR
R9	10 MEG 10%, 1/4W	1066-1005	ABR
R10	150K, 5%, 1/4W	1065-1503	ABR
R11	15K, 10%, 1/2W	1067-1502	ABR
R12	10 MEG 10%, 1/4W	1066-1005	ABR
R13	15K, 10%, 1/2W	1067-1502	ABR
R14	10 MEG 10%, 1/4W	1066-1005	ABR
R40	1K, 5%, 1/4W	1065-1001	ABR
R41	100Ω, 5%, 1/4W	1065-0100	ABR
R42	100Ω, 5%, 1/4W	1065-0100	ABR
R43	1K, 5%, 1/4W	1065-1001	ABR
R44	1K, 5%, 1/4W	1065-1001	ABR
R45	1K, 5% 1/4W	1065-1001	ABR
R46	150Ω, 5%, 1/4W	1065-0150	ABR
	COILS		
L1	2-1/2 Turn Choke	1530-0025	ABR
	INTEGRATED CIRCUITS		
Z1	SN 7476 16 pin	1100-7476	National
Z2	SN 7400 14 pin	1100-7400	National
Z3	SN 7400	1100-7400	National
Z4	SN 7490 14 pin	1100-7490	National
Z5	SN 7490	1100-7490	National
Z6	SN 7490	1100-7490	National
Z7	SN 7400	1100-7400	National
Z8	SN 7490	1100-7490	National
Z9	SN 7400	1100-7400	National
Z10	SN 7476	1100-7476	National
Z11	SN 7400	1100-7400	National
Z12	SN 74190 16 pin	1100-7491	TI

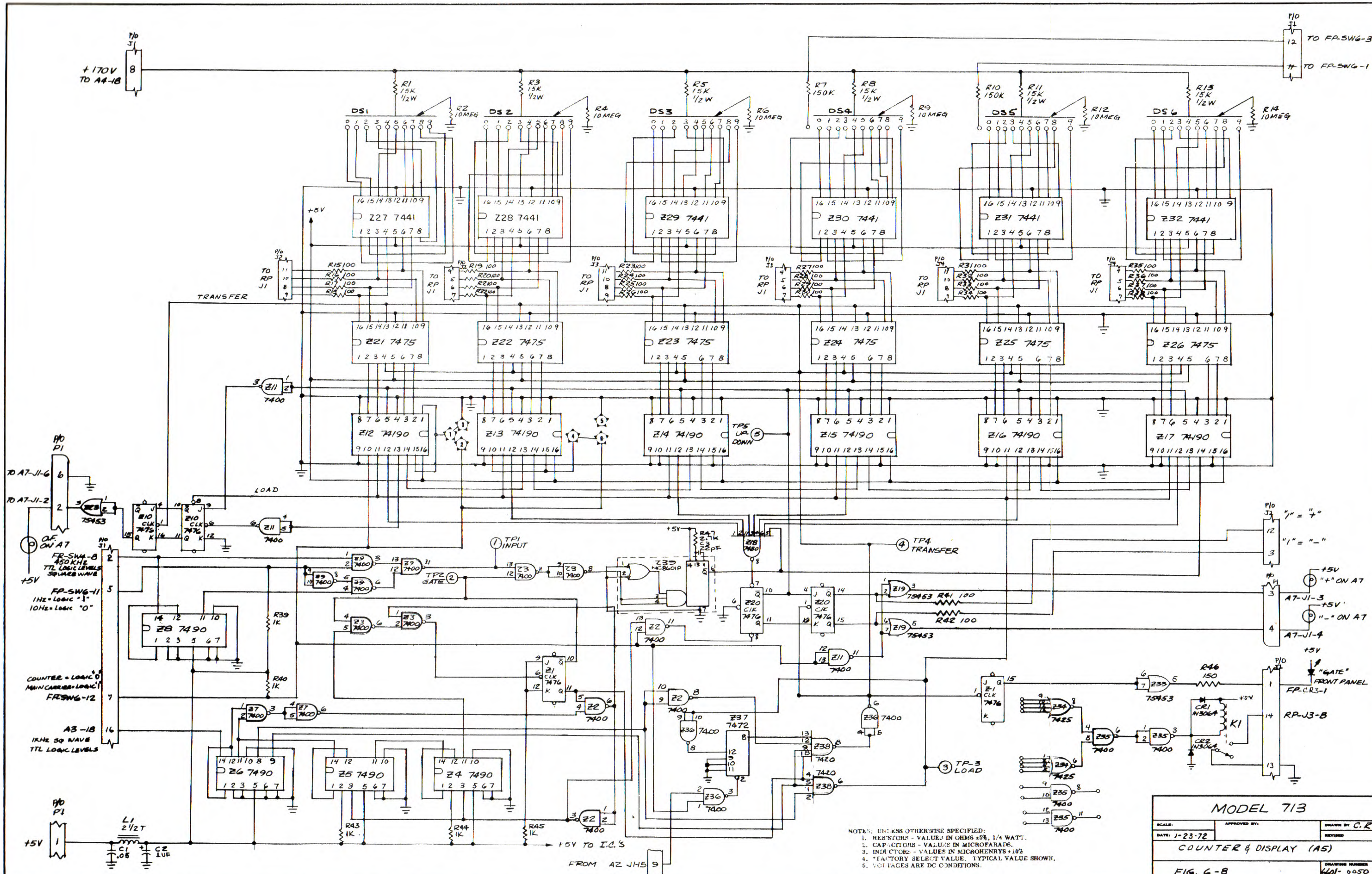
A-5 COUNTER-DISPLAY BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
Z13	SN 74190	1100-7491	TI
Z14	SN 74190	1100-7491	TI
Z15	SN 74190	1100-7491	TI
Z16	SN 74190	1100-7491	TI
Z17	SN 74190	1100-7491	TI
Z18	SN 7430 14 pin	1100-7430	National
Z19	SN 75453 8 pin	1100-7553	National
Z20	SN 7476	1100-7426	National
Z21	SN 7475 16 pin	1100-7475	National
Z22	SN 7475	1100-7475	National
Z23	SN 7475	1100-7475	National
Z24	SN 7475	1100-7475	National
Z25	SN 7475	1100-7475	National
Z26	SN 7475	1100-7475	National
Z27	SN 7441	1100-7441	National
Z28	SN 7441 16 pin	1100-7441	National
Z29	SN 7441	1100-7441	National
Z30	SN 7441	1100-7441	National
Z31	SN 7441	1100-7441	National
Z32	SN 7441	1100-7441	National
Z23	SN 75453	1100-7553	National
Z36	SN 7400	1100-7400	National
Z37	SN 7472 14 pin	1100-7422	National
Z38	SN 7420	1100-7400	National
	MISCELLANEOUS		
	14 pin IC Sockets	2250-1014	
	16 Pin IC Sockets	2250-1016	TI
	PC Boards	1600-0022	
CR1	1N 3064 Sil-Diode	1281-3064	Fairchild
CR2	1N 3064 Sil-Diode	1281-3064	Fairchild
K1	Relay - PRB-3510	1300-0001	Clare
Z34	SN 7425	1100-7425	National
Z35	SN 7400	1100-7400	National



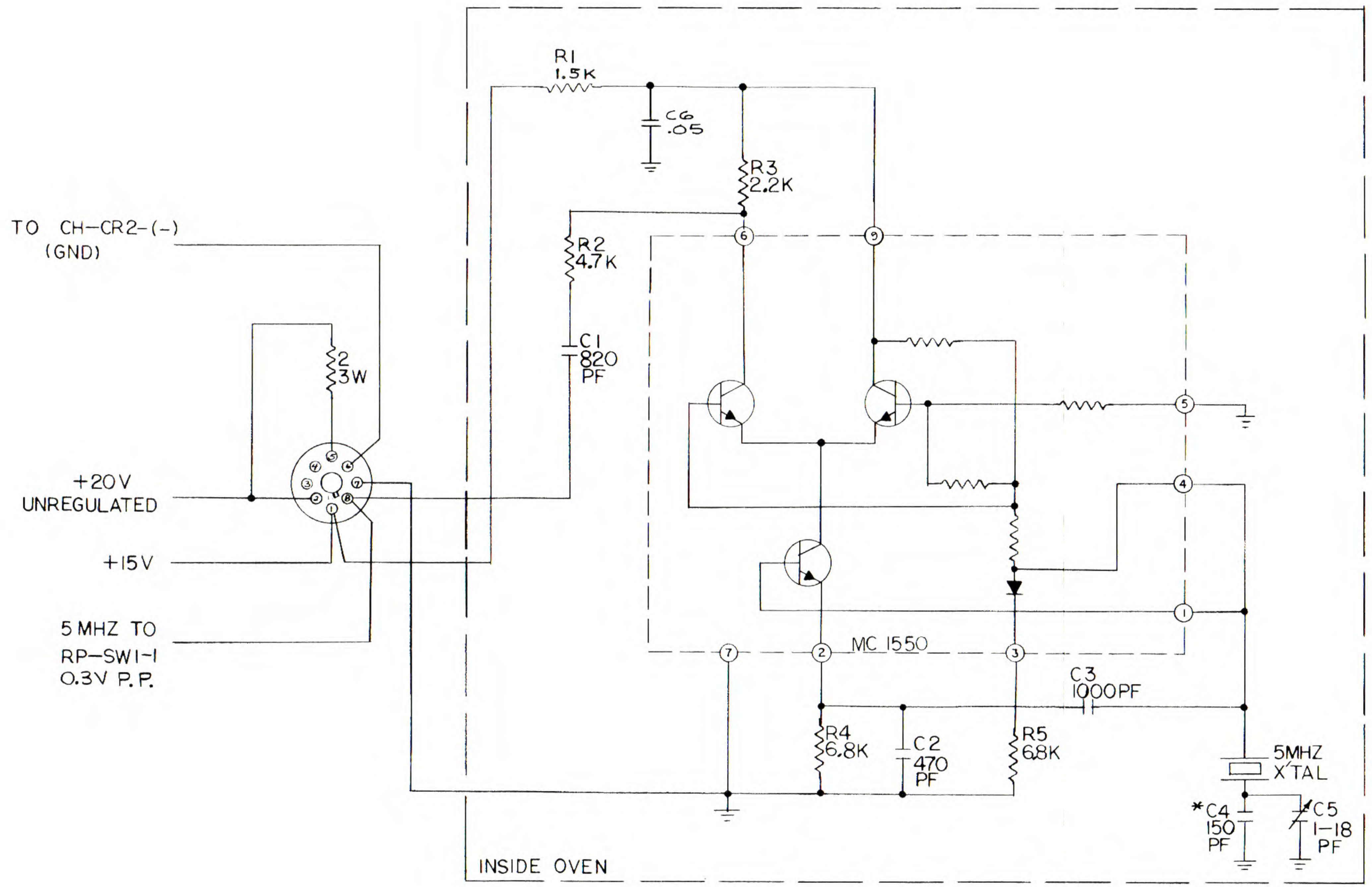
A-5 COUNTER DISPLAY BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
R15	1K, ±5%, 1/4W	1065-1001	ABR
R16	1K, ±5%, 1/4W	1065-1001	ABR
R17	1K, ±5%, 1/4W	1065-1001	ABR
R18	1K, ±5%, 1/4W	1065-1001	ABR
R19	1K, ±5%, 1/4W	1065-1001	ABR
R20	1K, ±5%, 1/4W	1065-1001	ABR
R21	1K, ±5%, 1/4W	1065-1001	ABR
R22	1K, ±5%, 1/4W	1065-1001	ABR
R23	1K, ±5%, 1/4W	1065-1001	ABR
R24	1K, ±5%, 1/4W	1065-1001	ABR
R25	1K, ±5%, 1/4W	1065-1001	ABR
R26	1K, ±5%, 1/4W	1065-1001	ABR
R27	1K, ±5%, 1/4W	1065-1001	ABR
R28	1K, ±5%, 1/4W	1065-1001	ABR
R29	1K, ±5%, 1/4W	1065-1001	ABR
R30	1K, ±5%, 1/4W	1065-1001	ABR
R31	1K, ±5%, 1/4W	1065-1001	ABR
R32	1K, ±5%, 1/4W	1065-1001	ABR
R33	1K, ±5%, 1/4W	1065-1001	ABR
R34	1K, ±5%, 1/4W	1065-1001	ABR
R35	1K, ±5%, 1/4W	1065-1001	ABR
R36	1K, ±5%, 1/4W	1065-1001	ABR
R37	1K, ±5%, 1/4W	1065-1001	ABR
R38	1K, ±5%, 1/4W	1065-1001	ABR
R39	1K, ±5%, 1/4W	1065-1001	ABR



NOTES: UNLESS OTHERWISE SPECIFIED:
1. RESISTORS - VALUES IN OHMS ±5%, 1/4 WATT.
2. CAPACITORS - VALUES IN MICROFARADS.
3. INDUCTORS - VALUES IN MICROHENRYS ±10%
4. *FACTORY SELECT VALUE. TYPICAL VALUE SHOWN.
5. VOLTAGES ARE DC CONDITIONS.

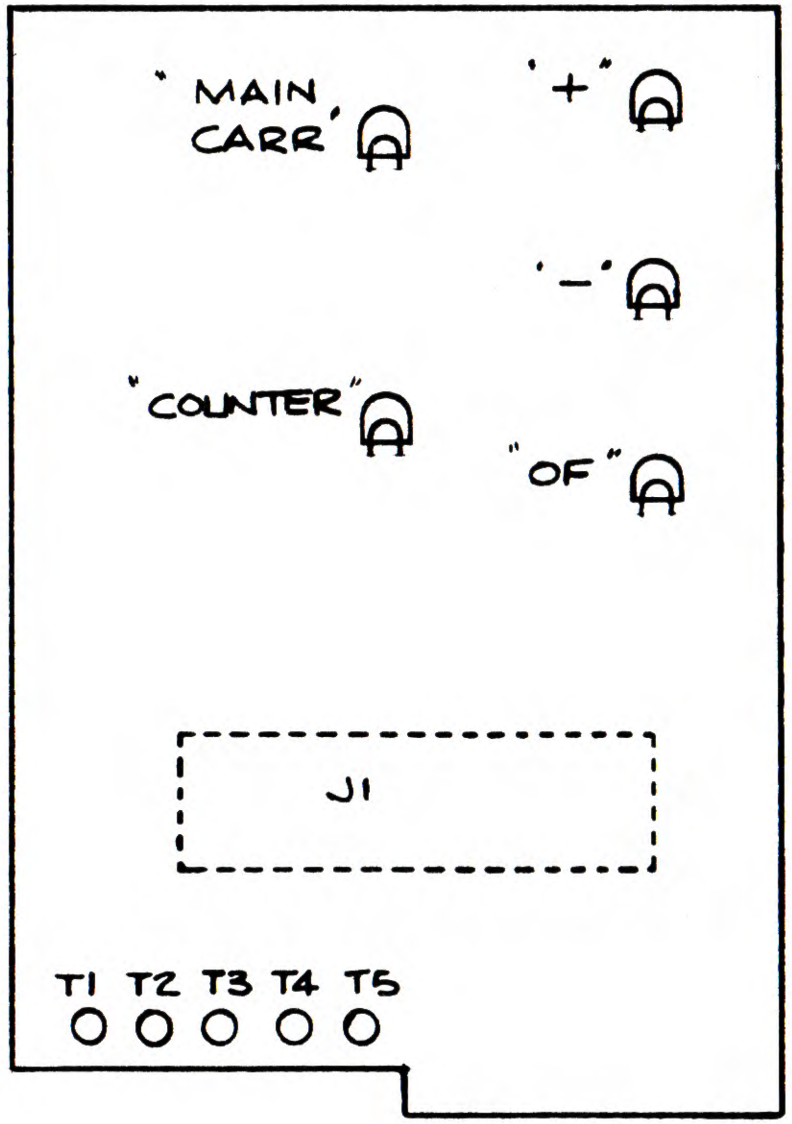
MODEL 713		
SCALE:	APPROVED BY:	DRAWN BY C.R
DATE: 1-23-72		REVISED
COUNTER & DISPLAY (A5)		
FIG. 6-8		DRAWING NUMBER 6601-0050

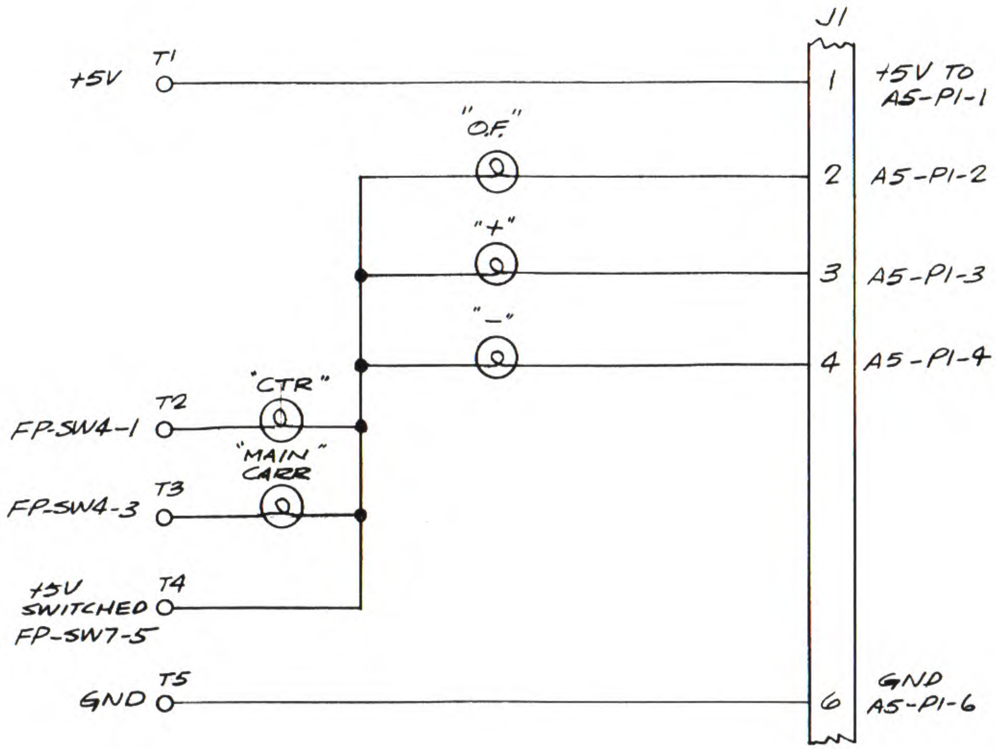


MODEL 713		
SCALE	APPROVED BY	DRAWN BY CWE
DATE		REVISED
5 MHZ X'TAL OSC, (A6)		
FIG 6-9		DRAWING NUMBER 6601-0051

A7-LIGHT-PANEL

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	SIGNAL DEVICES		
DS1	Lamp, 5V, 60mA	2300-0560	Oshino
DS2	Lamp, 5V, 60mA	2300-0560	Oshino
DS3	Lamp, 5V, 60mA	2300-0560	Oshino
DS4	Lamp, 5V, 60mA	2300-0560	Oshino
DS5	Lamp, 5V, 60mA	2300-0560	Oshino
	PLUG		
J1	6 Pin Socket	2250-1106	Viking
	MISCELLANEOUS		
	P.C. Board	1600-0031	
	Lamp Housing	3000-0001	





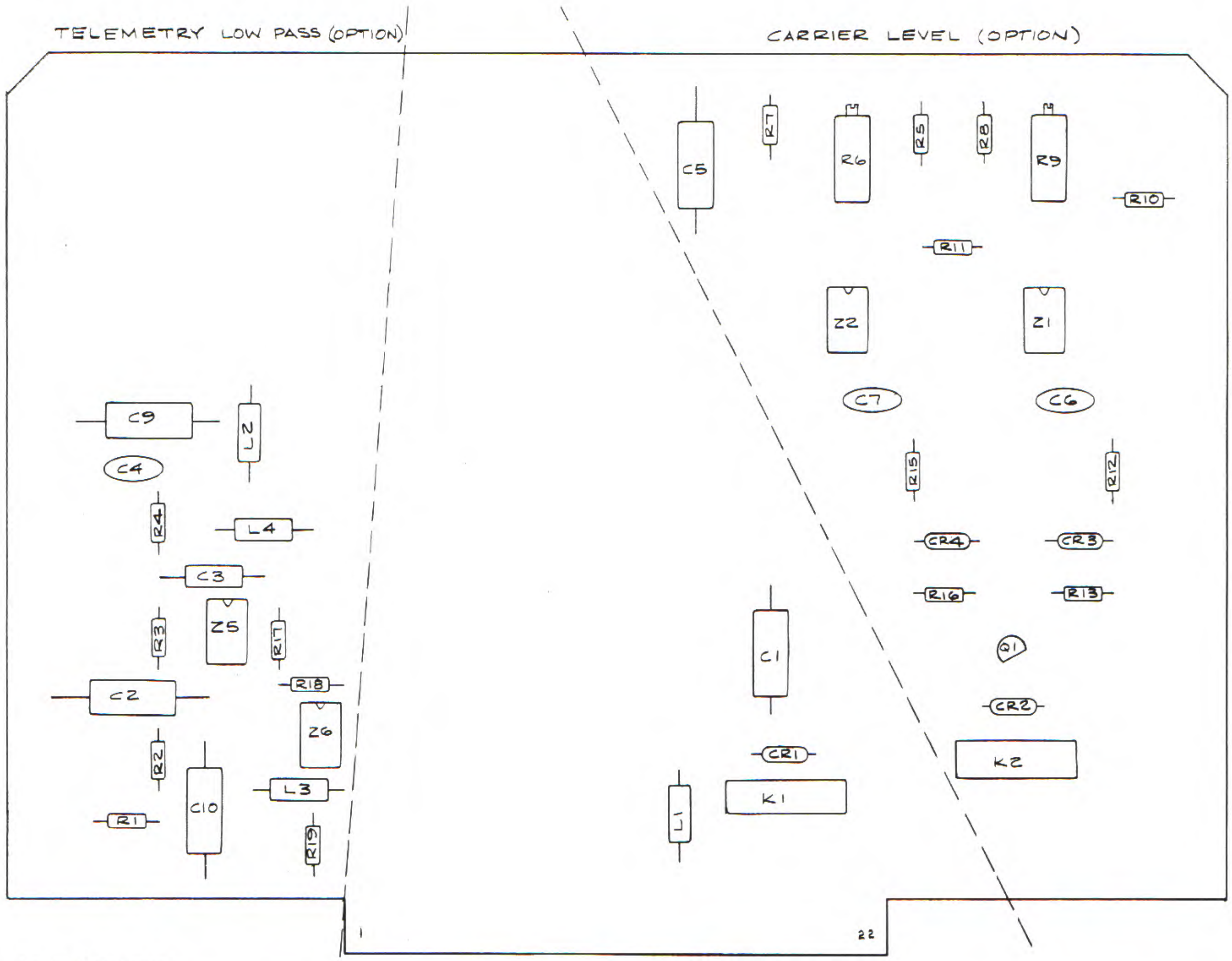
MODEL 713

SCALE:	APPROVED BY:	DRAWN BY
DATE:		REVISED

LAMP PANEL (A7)

FIG. 6-10

DRAWING NUMBER 6601-0052



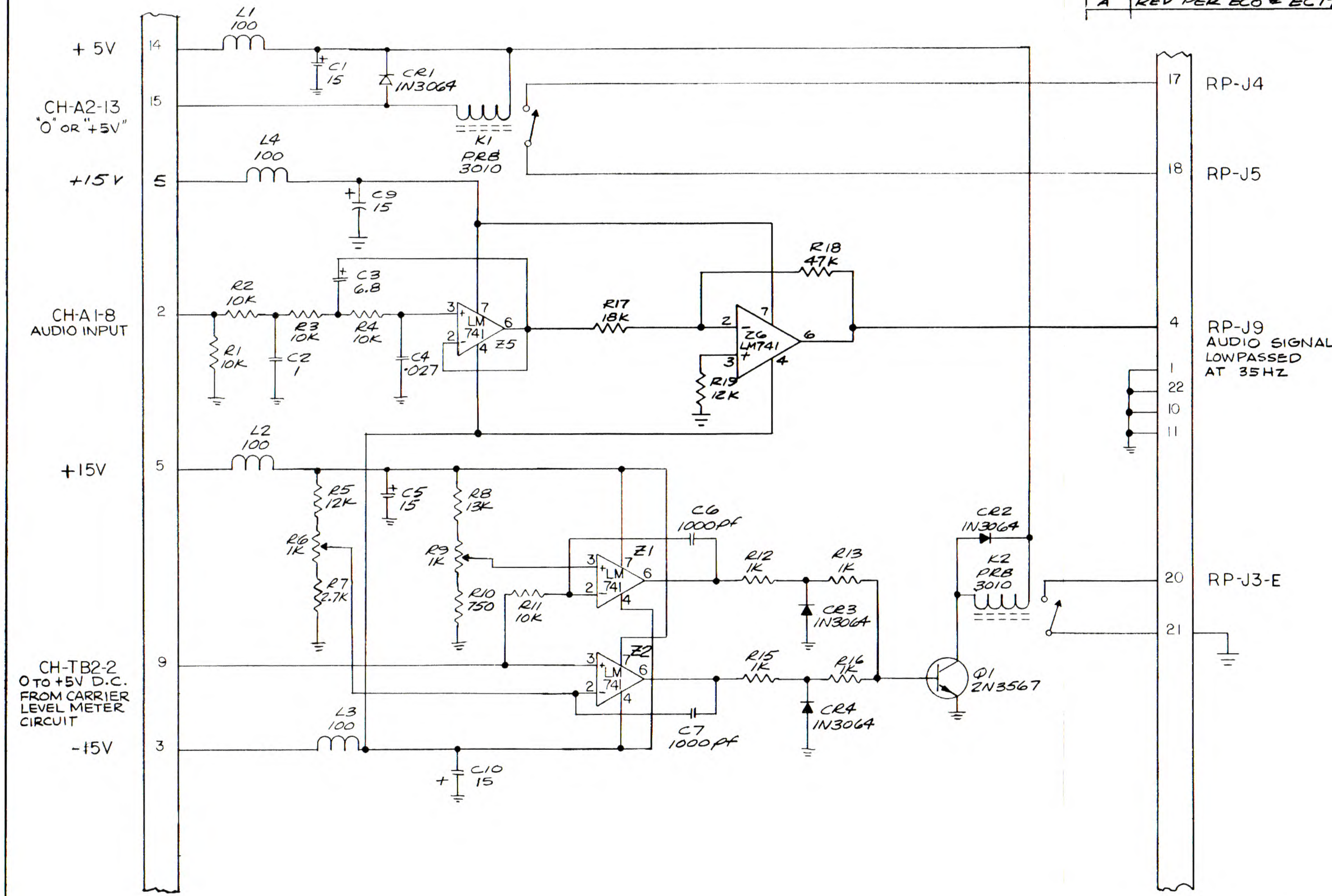
A-8 TELEMETRY BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
C1	1.5 µF, 25V, Electrolytic capacitor	1010-0150	Sprague
CR1	1N3064 Silicon Diode	1281-3064	Fairchild
K1	Relay PRB-3510	1300-0001	Clare
	PC Board	1600-0032	TFT
L1	100 µHy ±20% Molded RF Coil	1530-0101	Delevan
CARRIER POWER ALARM OPTION			
	CAPACITORS		
C5	15 µF, 25V, Electrolytic	1010-0150	Sprague
C6	1000 pf ±5% 500V, Dipped Mica	1001-0100	Elmenco
C7	1000 fp ±5% 500V, Dipped Mica	1001-0100	Elmenco
	RESISTORS		
R5	12K ±5%, 1/4W Carbon Comp. Res.	1065-1202	Allen-Bradley
R6	1K Cermet Pot	1069-1001	Beckman
R7	2.7K ±5% 1/4W Carbon Comp. Res.	1065-2701	Allen-Bradley
R8	13K ±5% 1/4W Carbon Comp. Res.		Allen-Bradley
R9	1K Cermet Pot	1069-1001	Beckman
R10	750Ω ±5% 1/4W Carbon Comp. Res.		
R11	10K ±5% 1/4W Carbon Comp. Res.	1065-1002	Allen-Bradley
R12	1K ±5% 1/4W Carbon Comp. Res.	1065-1001	Allen-Bradley
R13	1K ±5% 1/4W Carbon Comp. Res.	1065-1001	Allen-Bradley
R15	1K ±5% 1/4W Carbon Comp. Res.	1065-1001	Allen-Bradley
R16	1K ±5% 1/4W Carbon Comp. Res.	1065-1001	Allen-Bradley
	MISCELLANEOUS		
L2	100 µHy ±20% Molded RF Choke	1530-0101	Delevan
L3	100 µHy ±20% Molded RF Choke	1530-0101	Delevan
CR2	1N3064 Silicon Diode	1281-3064	Fairchild
CR3	1N3064 Silicon Diode	1281-3064	Fairchild
CR4	1N3064 Silicon Diode	1281-3064	Fairchild
K2	PRB-3510 Relay	1300-0001	Clare
Q1	2N3567 NPN Silicon Transistor		Fairchild
Z1	LM741 OP-Amp	1100-0741	Fairchild
Z2	LM741 OP-Amp	1100-0741	Fairchild

A-8 TELEMETRY BOARD

CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.
LOW PASS OPTION			
	CAPACITORS		
C2	1 µf ±10%, 100V Mylar		
C3	6.8 µf, 35V Tantalum Electrolytic	1008-0068	Kemet
C4	.027 µf ±10%, 100V Polyester		Sprague
C9	15 µf, 25V, Electrolytic	1010-0150	Sprague
C10	15 µf, 25V, Electrolytic	1010-0150	Sprague
	RESISTORS		
R1	10K ±5%, 1/4W Carbon Comp. Res.	1065-1002	Allen-Bradley
R2	10K ±5%, 1/4W Carbon Comp Res.	1065-0150	Allen-Bradley
R3	10K ±5%, 1/4W Carbon Comp Res.	1065-0150	Allen-Bradley
R4	10K ±5%, 1/4W Carbon Comp Res.	1065-0150	Allen-Bradley
R17	18K ±5%, 1/4W	1065-1802	Allen-Bradley
R18	47K ±5%, 1/4W	1065-4702	Allen-Bradley
R19	12K ±5%, 1/4W	1065-1202	Allen-Bradley
	INDUCTORS		
L2	100 µHy ±20%, Molded RF Coil	1530-0101	Delevan
L3	100 µHy ±20%, Molded RF Coil	1530-0101	Delevan
L4	100 µHy ±20%, Molded RF Coil	1530-0101	Delevan
	INTEGRATED CIRCUITS		
Z5	LM741 OP-Amp	1100-0741	National
Z6	LM741 OP-Amp	1100-0741	National

REVISIONS		
LTR	Description	Date
A	REV PER ECO # EC17	10-?-?



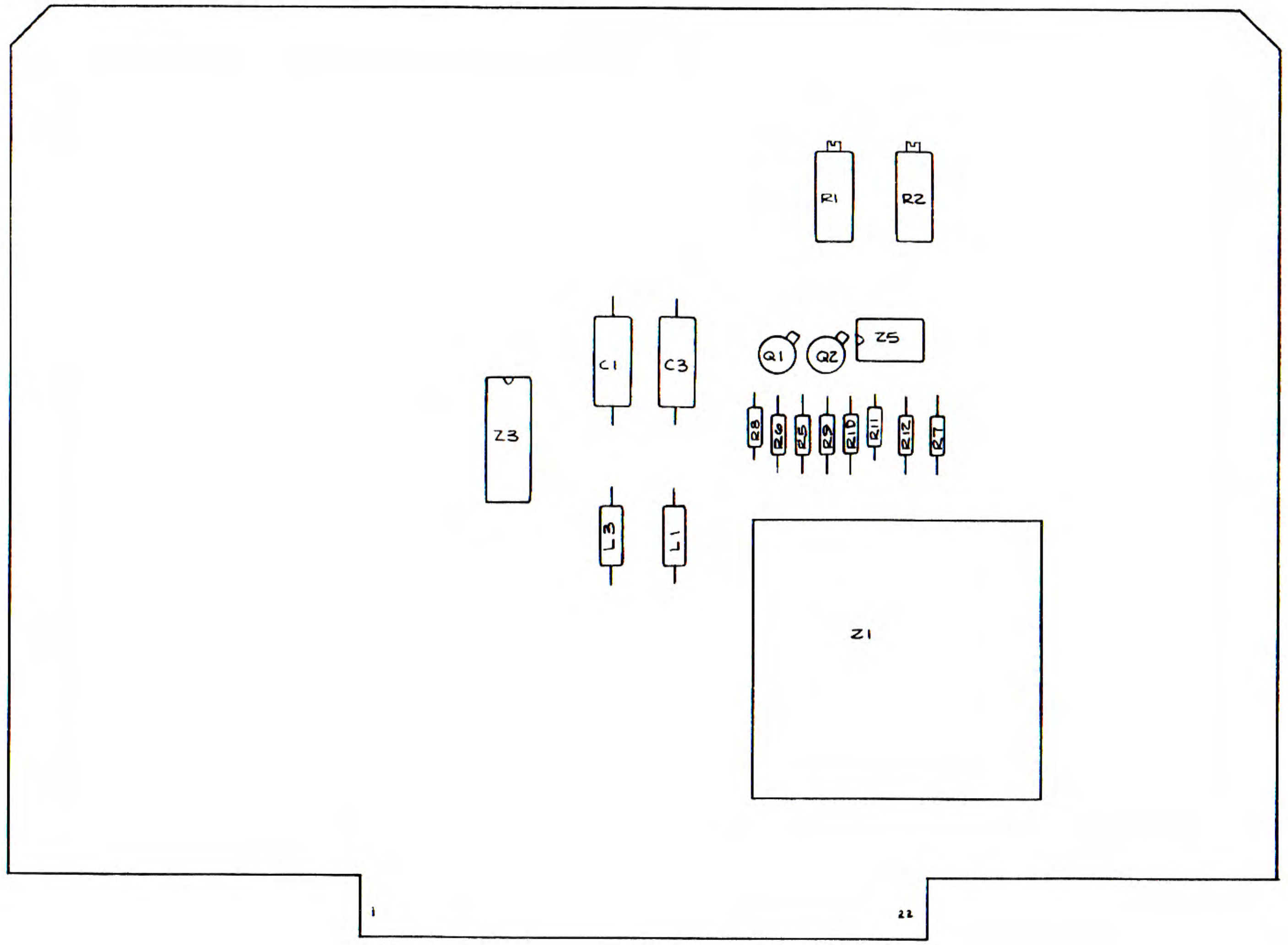
NOTES: UNLESS OTHERWISE SPECIFIED:
1. RESISTORS - VALUES IN OHMS ±5%, 1/4 WATT.
2. CAPACITORS - VALUES IN MICROFARADS.
3. INDUCTORS - VALUES IN MICROHENRYS ±10%
4. *FACTORY SELECT VALUE, TYPICAL VALUE SHOWN.
5. VOLTAGES ARE DC CONDITIONS.

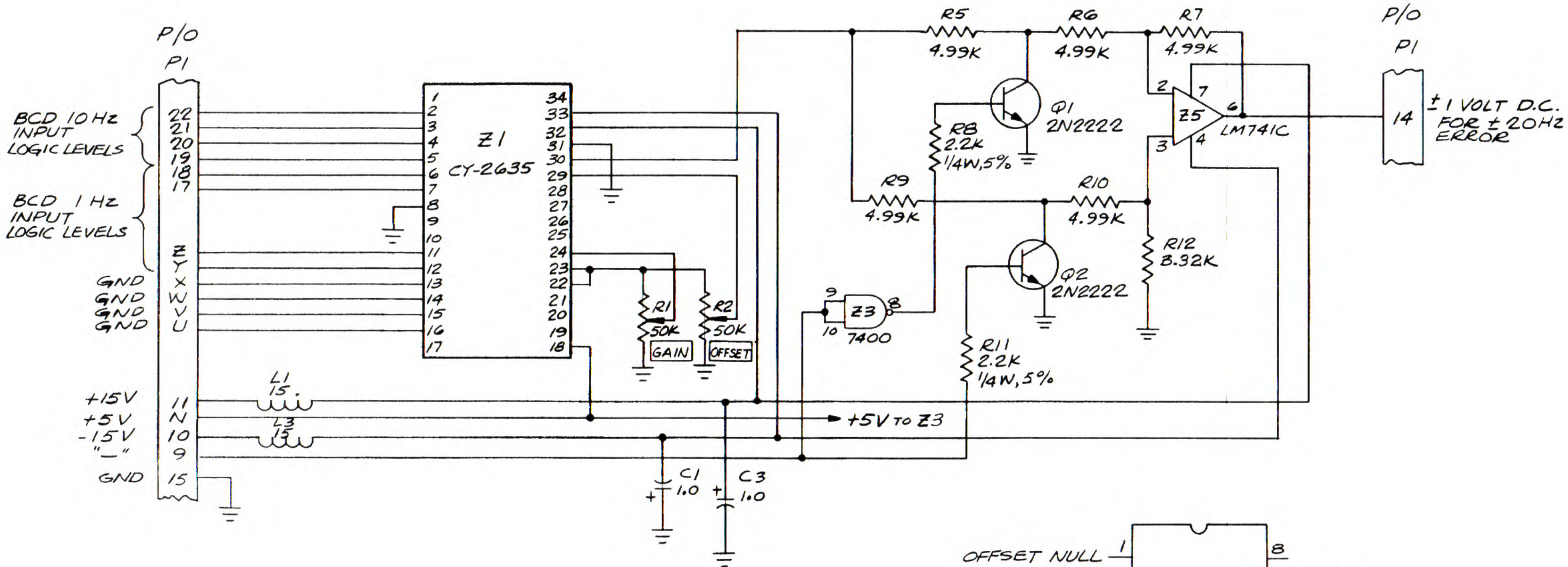
TFT TIME AND FREQUENCY TECHNOLOGY, INC.
2950 SCOTT BLVD., SANTA CLARA, CA 95050 (408) 246-6365

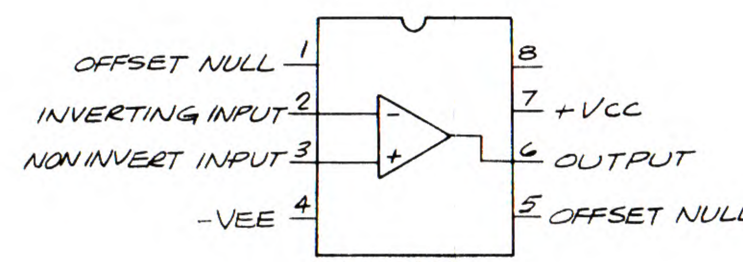
APPROVED CWE 6-13-72 5/2/72	MODEL 713	CWE
TELEMETRY BOARD - (A8)		
FIG 6-11		6601-0053 A

A-9 DIGITAL-TO-ANALOG CONVERTER

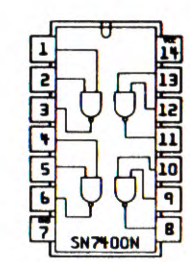
CKT.REF.	DESCRIPTION	TFT STOCK NO.	MFR.
	CAPACITORS		
C1	1.0 μf 25V, Electrolytic	1010-0010	Sprague
C3	1.0 μf 25V, Electrolytic	1010-0010	Sprague
	RESISTORS		
R1	50K, Variable, Cermet Pot	1069-5002	Beckman
R2	50K, Variable, Cermet Pot	1069-5002	Beckman
R5	4.99K ±1% 1/8W, Metal Film	1069-4991	Dale
R6	4.99K ±1% 1/8W, Metal Film	1069-4991	Dale
R7	4.99K ±1% 1/8W, Metal Film	1065-2201	Allen-Bradley
R8	2.2K ±5% 1/4W, Carbon Comp.	1065-2201	Allen-Bradley
R9	4.99K ±1% 1/8W, Metal Film	1069-4991	Dale
R10	4.99K ±1% 1/8W, Metal Film	1069-4991	Dale
R11	2.2K ±5% 1/4W, Carbon Comp.	1065-2201	Allen-Bradley
R12	3.32K ±1% 1/8W, Metal Film	1061-3301	Dale
	MISCELLANEOUS		
Z1	D/A Converter, CY2635	1122-2635	CYCON
Z5	LM741 OP-Amp	1100-0741	National
Z3	SN7400 Gate Package	1100-7400	National
L1	15 μHy ±10% RF Choke	1530-0150	Delevan
L3	15 μHy ±10% RF Choke	1530-0150	Delevan
Q1	2N2222 Transistor	1271-2222	National
Q2	2N2222 Transistor	1271-2222	National







LM741C
8PIN
DIP



P1 SOCKET CONNECTION TABLE

PIN NO.	CONNECTED TO	PIN NO.	CONNECTED TO
1		A	
2		B	
3		C	
4		D	
5		E	
6		F	
7		H	
8		J	
9	A5-J2-3	K	
10	-15 V	L	
11	+15 V	M	
12		N	+5V
13		P	
14	RP-J1-A	R	
15	GND	S	
16		T	
17	A5-J4-6	U	GND
18	A5-J4-7	V	GND
19	A5-J4-10	W	GND
20	A5-J4-11	X	GND
21	A5-J4-8	Y	A5-J4-5
22	A5-J4-9	Z	A5-J4-4

NOTES; UNLESS OTHERWISE SPECIFIED:
1. RESISTORS - VALUES IN OHMS ±1%, 1/8 WATT.
2. CAPACITORS - VALUES IN MICROFARADS.
3. INDUCTORS - VALUES IN MICROHENRYS ±10%
4. *FACTORY SELECT VALUE. TYPICAL VALUE SHOWN.
5. VOLTAGES ARE DC CONDITIONS.

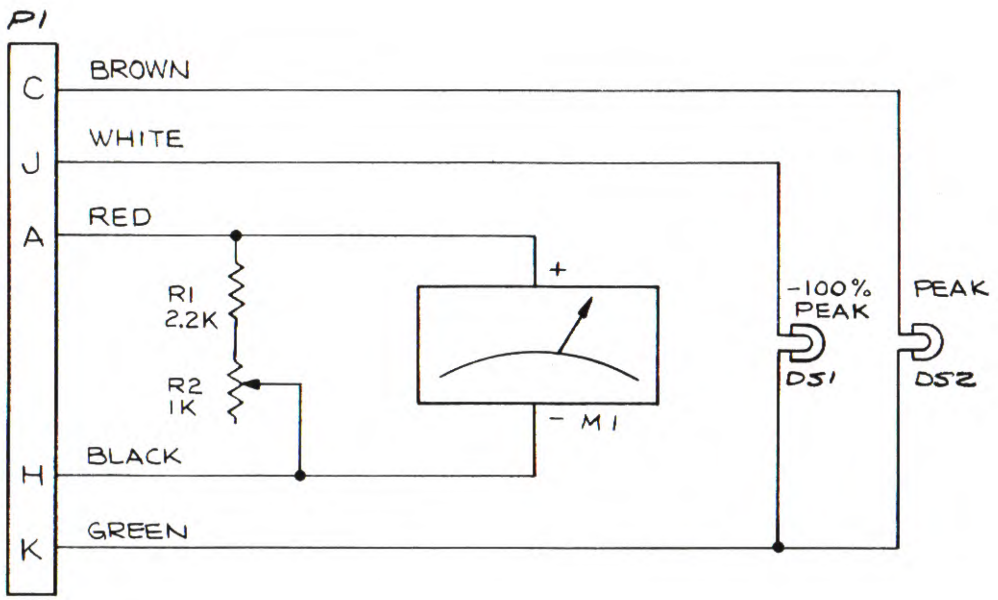
MODEL 713

SCALE	APPROVED BY	DRAWN BY
DATE		REVISED

DIGITAL TO ANALOG CONVERTER (A9)

FIG. 6-12

DRAWING NUMBER 6601-0054



R1	2.2K 1/4W 5% CARBON COMP RES.	1065-2201	A.B.
R2	1K 10TURN TRIMMER POTENTIOMETER	1069-1001	BECKMAN
M1	400μA FULL SCALE MODULATION METER	1400-7045	A.P.I.
P1	9 PIN PLUG	2220-0009	AMPHENOL
DS1	6 VOLT 40 MA LAMP	2300-0640	I.E.E.
DS2	6 VOLT 40 MA LAMP	2300-0640	I.E.E.
CKT. REF.	DESCRIPTION	TFT STOCK NO.	MFR.

MODEL-704A

SCALE: | APPROVED BY: | DRAWN BY

DATE: 11-9-72 | REVISED 11-9-72

REMOTE METER & PEAK FLASHERS

FIG. 6-13

DRAWING NUMBER 6601-0030

11X17 PRINTED ON NO. 1000H CLEARPRINT