TEK INSTRUCTION MANUAL

070-5391-00
Product Group 40

TRAINING LAB

Tektronix®
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Please Check for
CHANGE INFORMATION
at the Rear of This Manual

First Printing OCT 1986

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OPERATORS SAFETY SUMMARY

Power Source

This product is intended to operate from a power source that applies 120 volts ac at 60 Hz.

Use only the Step-Down Transformer with Tektronix part number that is listed in the Accessories section of this manual.

Refer the Power Source servicing to qualified service personnel.

Do Not Opeate in Explosive Atmospheres

5391-01

The CRS101 Basic Training Lab.

GENERAL INFORMATION

INTRODUCTION

The TEKTRONIX Training Lab family of circuit boards provide a source of typical problem signals that demonstrate the troubleshooting, timing and voltage measurement capabilities of a modern oscilloscopes. The signals may be used to develop measurement and analysis skills needed for the design and troubleshooting of modern electronic devices.

Two of the Training Lab circuit boards (CRS10 Power Unit and CRS30 General Purpose) are used in the CRS101 Basic Training Lab kit. The CRS30 General Purpose can be removed from the case and replaced with other Training Lab boards.

The CRS101 Basic Training Lab is shipped with the following standard accessories:

1	Carrying Case
1	CRS10 Power Unit Board
1	CRS30 General Purpose Board
1	Step-Down Transformer
1	Instruction Manual

Different circuit boards can be ordered with the CRS10 Power Unit board or with CRS101 that will allow the user to custom-design the Training Lab to meet their specific needs. A brief description of the Training Lab family of circuit boards are as follows.

CRS10 Power Unit Board

The CRS10 Power Unit board consists of power and clock circuitry. The power circuitry supplies three different levels of regulated voltages levels that are used to power other Training Lab boards. The clock circuitry provides three fixed crystal controlled digital signals of 1 MHz, 5 MHz, and 10 MHz, and a variable rate triangular waveform.

The CRS10 Power Unit board comes with a step-down transformer that plugs directly into 90 Vac to 130 Vac power source outlet.

CRS30 General Purpose Board

The CRS30 General Purpose board provides both digital and analog signals for laboratory demonstrations.

The digital signals are available at ECL, TTL, and CMOS levels. The signals consists of logic, a variable pulse train, low frequency square wave, variable stairstep generator (D to A converter), and fast trigger pulses.

The analog signals include a sine wave with a glitch, voltage to frequency converter, low frequency triangle signal, and waveform with variable frequency, amplitude, and slope.

CRS50 TV Signal Board

The CRS50 TV Signal board generates an NTSC interlaced video signal which demonstrates TV triggering capabilities of TEKTRONIX 2400 series oscilloscope. It is capable of operating a video monitor.

CRS70 Digital Pattern Board

The CRS70 Digital Pattern board is designed specifically to teach how to use the functions of the Word Recognizer, Delay by Events, and Boolean Trigger of the TEKTRONIX CTT optioned 2445 and 2465 Oscilloscopes.

The digital circuitry on the CRS70 Digital Pattern board generates a repeating series of 16-bit wide digital pattern words. The patterns can be single stepped or driven by a 1 MHz clock. A series length can be set in multiples of 256 bits, to a maximum of 4096 bits. Both the starting and ending addresses can be set in 256 increments, from their respective ends of the series.

CRS72 Digital Fault Board

The CRS72 Digital Fault board provide signals with timing errors.The timing errors are best viewed with an oscilloscope having a microchannel-plate (mcp) cathode-ray tube (crt) such as the TEKTRONIX 2467 oscilloscope.

CRS90 Builders Board

The CRS90 Builders Board consists of a circuit board that will allow the user to custom design their own circuits.

BOARD REPLACEMENT

To remove one or both Training Lab boards from the carrying case, disconnect the connectors from the board to be removed and pull up on the four mounting tabs located at each corner of the board. Remove the board from the carrying case.

To reinstall the Training Lab board, perform the reverse of the preceding steps.

SERVICING

Most electrical components can be obtained through a local commercial source. Before purchasing or ordering a part from a source other than Tektronix, Inc., please check the "Electrical Parts" list at the end of the information on the circuit board being serviced for proper value, rating, tolerance, and description.

When ordering replacement parts from Tektronix, Inc., be sure to include all of the following information:

1. Circuit board type.
2. Circuit board serial number.
3. A description of the part including its component number.
4. Tektronix part number.

REPACKAGING

If the instrument is shipped by commercial transportation, use the original packaging material. If the original packaging is unfit for use or is not available, repackage the instrument as follows:

1. Obtain a corrugated cardboard shipping carton having inside dimensions at least six inches greater than the circuit board or the step-down transformer dimensions and having a carton test strength of at least 200 pounds.

2. If the package is being shipped to a Tektronix Factory Service Center for Warranty service, attach a tag to the circuit board showing the following:

owner of the instrument (with address), the name of a person who can be contacted, complete instrument type and serial number, and a description of the service required.

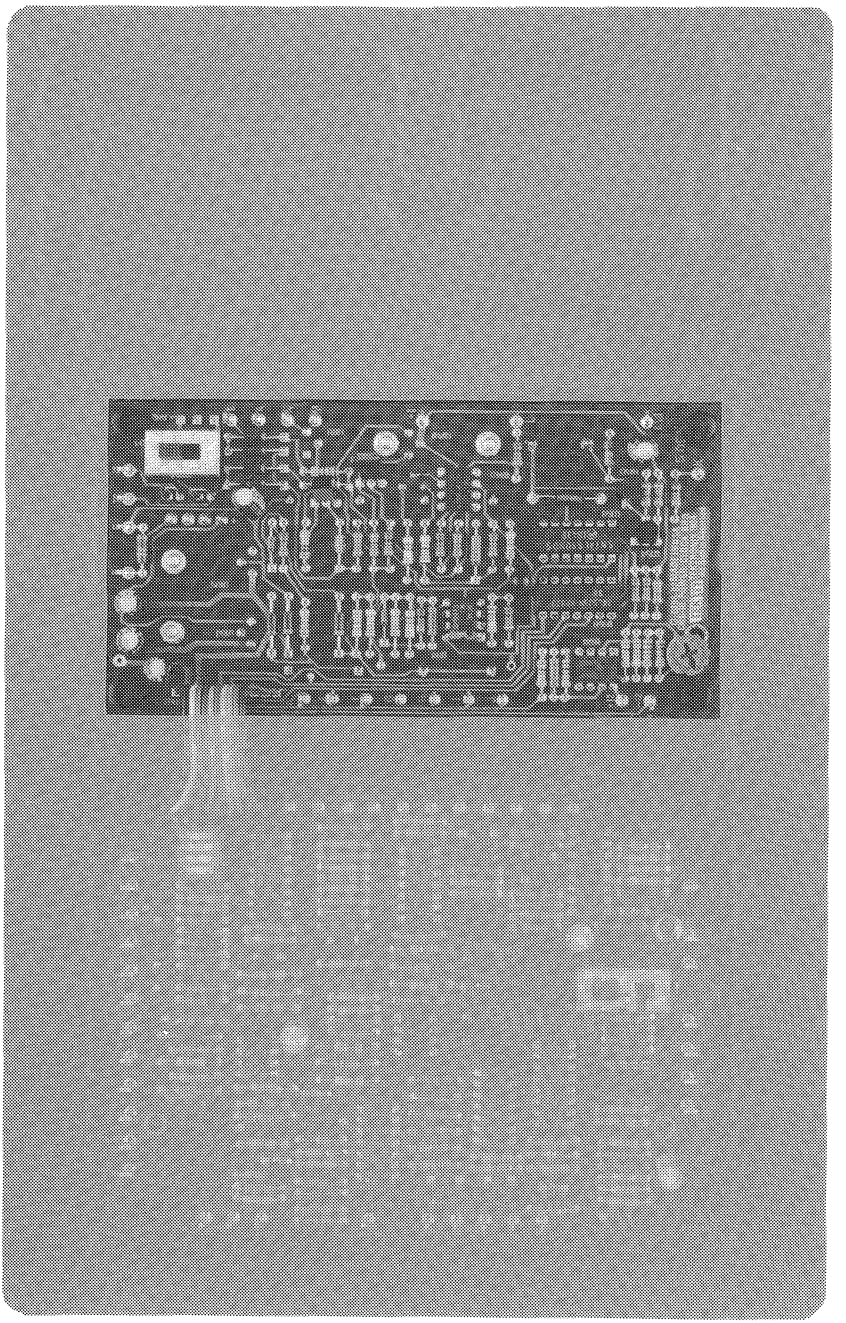
3. Wrap the instrument with polyethylene sheeting or equivalent to protect the outside finish and prevent entry of packing materials into the instrument.

4. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing three inches on each side.

5. Seal the carton with shipping tape or with an industrial stapler.

6. Mark the address of the Tektronix Service Center and the return address on the carton in one or more prominent locations.

CRS10 Power Unit Board—Training Labs



5391-02

The CRS10 Power Unit Board.

CRS10 POWER UNIT BOARD

INTRODUCTION

The CRS10 Power Unit Board incorporates three major circuits. They are the crystal-controlled 10 MHz reference clock circuit, a variable frequency triangle-wave generator, and a line-switching 5 V linear power supply. The power supply works equally well on either 50 Hz or 60 Hz power main frequencies.

STEP-DOWN TRANSFORMER

The step-down standard transformer supplied with the CRS10 Power Unit board requires 90 Vac to 130 Vac power-source outlet. The transformer provides an output voltage of 24 V center tapped to the CRS10 Power Unit board via a connecting cable. The connecting cable is plugged into the three square pins of J100 located next to the Power switch S100.

POWER SUPPLY LIMITS

The power supply is limited in the available current it can supply to the signal boards. When using the prebuilt circuit boards, the current is ample, but when using the CRS90 Builders Board to construct a circuit, the current limits must be observed. Maximum current for the +5 V supply is 350 mA with no load on the 12 V supplies; if the 12 V supplies have loads, the +5 V supply should be limited to an output current of no more than 250 ma. Each of the 12 V supplies can provide a load current of 100 ma with no load on the +5 V supply; if the +5 V supply is loaded, the output current on the 12 V supplies should be kept below 50 ma each.

POWER SUPPLY PROTECTION

The power supply on the CRS10 Power Unit board is protected by two 1-ohm, 1/4 watt resistors (R100 and R102) in series with the input supply voltage from the power step-down transformer. Should a major short circuit occur, one or both of these resistors will open.

CLOCK SIGNALS

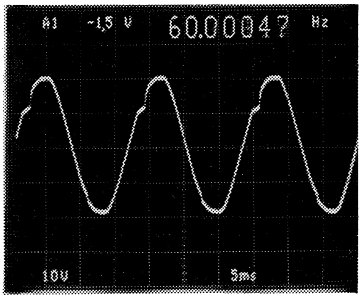
The clock section provides three fixed crystal controlled digital signals (10 MHz, 5 MHz, and 1 MHz) and a variable rate triangular waveform. All clock and power signals are connected to the signal board through a 10-pin harmonica connector and jumper cable.

TEST SIGNALS

This part of the section contains detailed description of the signals found at the test points. The schematic diagram and the circuit board illustration at the back of this section may be helpful in locating the test points.

TP L1 and TP L2

The 40 V peak-to-peak line frequency signal (see Figure 2-1) from the center-tapped transformer is the input to the +5 V, −12 V, and +12 V supplies. On the rising edge of the waveform there is a flat spot where the +5 V regulator turns on. These test points can be use to demonstrate line triggering or to show phase relationships between two signals.

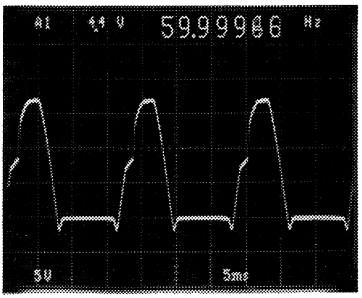


5391-03

Figure 2-1.

TP A and TP B

The 20 V signals at these test points are half-wave-rectified versions of the signals at L1 and L2 (see Figure 2-2). TP A is in phase with TP L2 and TP B is in phase with TP L1. The signal has a 1.65 V undershoot on the rising and falling edges. The small step in the waveform is at the conducting voltage of the LED and is kickback from the rectifier feeding the LED. The larger step is the conducting point of the +5 V regulator. These test points can be used to make power line phase measurements.

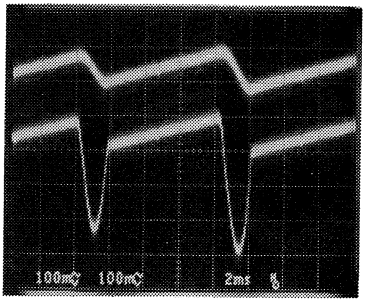


5391-04

Figure 2-2.

TP C and TP D

The two test points are on opposite ends of a 3 ohm resistor. Using ac input coupling, ADD mode and inverting CH 2, it is possible to measure the pulse current going into the −12 V regulator as shown in Figure 2-3. With the CRS30 General Purpose Board the current is approximately 85 mA. These signals are at twice the line frequency and have some jitter.



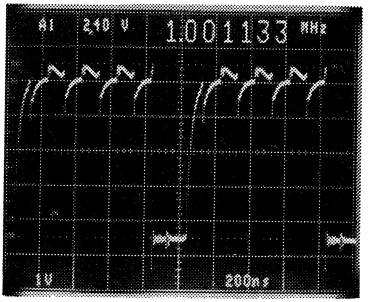
5391-05

Figure 2-3.

TP E and TP F

The frequency divider outputs in the reference clock circuit are used as drives for other boards plugged into the Basic Training Lab. These signals has relatively fast transition times and are suitable for rise and fall time measurements. The effect of bandwidth limiting can be demonstrated with these signals.

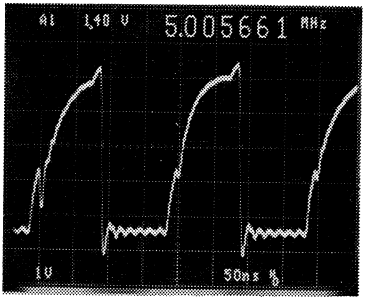
TP E—The signal is a 0-5 V, 1 MHz nonsymmetrical square wave with aberrations and ringing from the divide-by-five network riding on top and bottom of the waveform (see Figure 2-4). There is a 0.86 V undershoot on this signal also.



5391-06

Figure 2-4.

TP F—This is a 0-5 V, 5 MHz signal from the divide-by-two network. The signal has severe rounding as shown in Figure 2-5 on the rising edge and a 0.65 V undershoot.

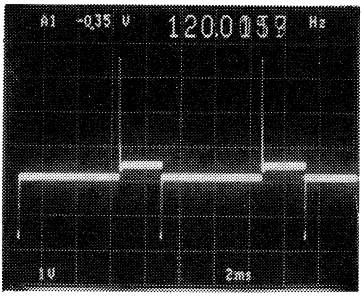


5391-07

Figure 2-5.

TP G

This test point is for troubleshooting the 5 V supply. The two times line frequency signal as shown in Figure 2-6 has a small amplitude, 0.35 V square wave with large amplitude spikes, +3.19 V and −1.8 V, that are related in time to the signals at L1 and L2.

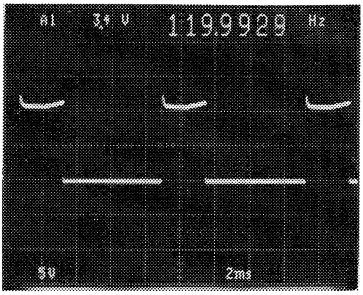


5391-08

Figure 2-6.

TP H

This signal is at twice the line frequency. It is in sync with the step in the signals at L1 and L2. The amplitude is 11.15 V with an overshoot of 1.56 V. See Figure 2-7.

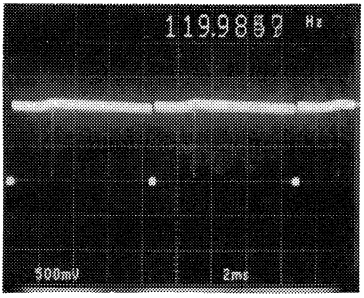


5391-09

Figure 2-7.

TP I

This two times line-frequency signal is for the line frequency switching regulator. It is an asymmetrical square wave as shown in Figure 2-8 with an amplitude of 1.13 V and a negative spike of 1.05 V 2.2 ns past the rising edge.

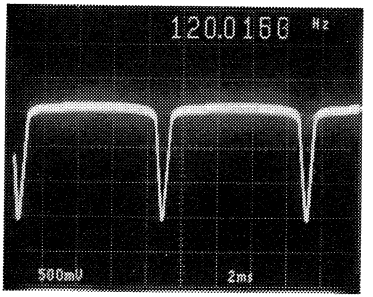


5391-10

Figure 2-8.

TP J

When this 2 V, line-related signal (see Figure 2-9) goes to ground, the 5 V switching regulator is activated.

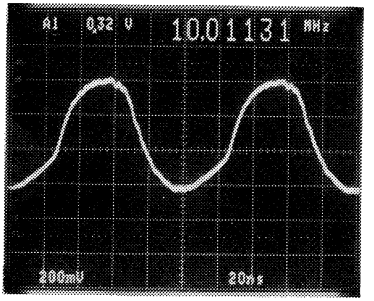


5391-11

Figure 2-9.

TP K

The test point can be use to check the 10 MHz clock frequency as shown in Figure 2-10. This test point is isolated from the clock by a 1kΩ resistor to prevent loading of the clock circuit. The 0.61 V sine wave has some aberrations on the top. The bandwidth limit feature of the oscilloscope can be use to removed aberrations from the sine wave.

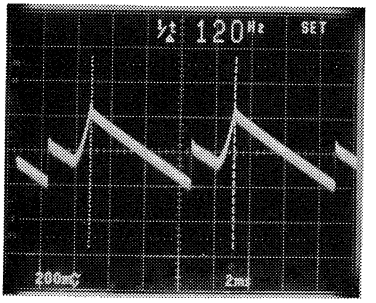


5391-12

Figure 2-10.

TP L

The two times line related signal can be used to measure ripple in the 5 V supply at the preregulator. There is a small ac signal (452 mV) with a large dc offset (6 V) as shown in Figure 2-11.

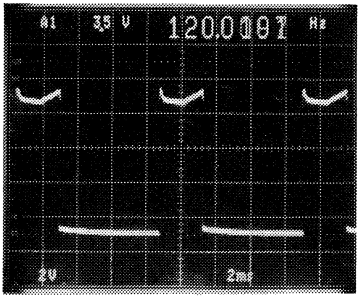


5391-13

Figure 2-11.

TP M

The waveform, an 8.45 V signal with 0.8 V of overshoot and 0.8 V of preshoot on the top, is an intermediate step in the 5 V regulator (see Figure 2-12).

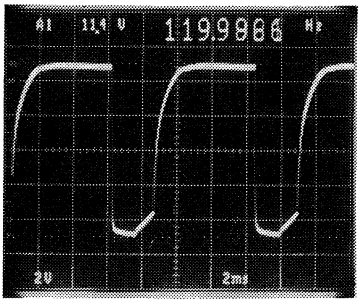


5391-14

Figure 2-12.

TP N

The 9.6 V, 120 Hz square wave is riding on a 8.7 V dc offset. This waveform has preshoot and considerable rounding on the rising edge. See Figure 2-13.

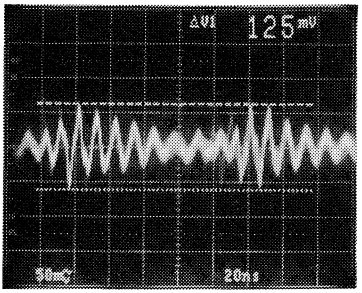


5391-15

Figure 2-13.

TP +5 V

This +5 V dc level is used to power boards plugged into the CRS10 Power Unit board. Current of 350 mA can be supplied to the other board if no load is on the 12 V supplies, only 250 mA with a load on the 12 V supplies. There are 125 mV of 60 Hz and 10 MHz components riding on this signal, which can be used to demonstrate the bandwidth limit feature of the oscilloscope (see Figure 2-14).

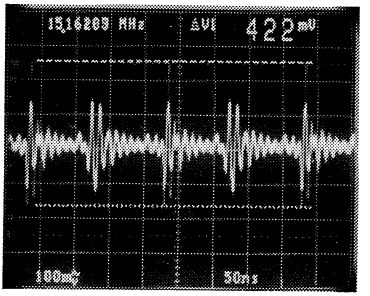


5391-16

Figure 2-14.

TP +12 and TP −12

These two test points are the +12 V and −12 V supplies that feed other boards plugged into the Basic Training Lab. Current of 100mA can safely be drawn if there is no load on the +5 V supply, 50 mA when there is a load on the +5 V supply. There are high-frequency, small-amplitude (40 mV) ac signals riding on the dc offsets as shown in Figure 2-15. Spikes close to half a volt are also found on both 12 V supplies.

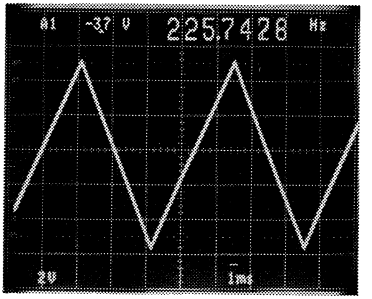


5391-17

Figure 2-15.

Pin 7 on Ribbon Cable

The 2 kΩ resistor R180 near TP J, along the left edge of the board, is an alternate point to probe for this signal. The triangle wave's frequency can be adjusted by the variable resistor R174 in the lower left corner of the CRS10 Power Unit Board. The frequency range is 225 Hz to 3.49 kHz with an amplitude of 10.5 V as shown in Figure 2-16. This signal can be used to demonstrate trigger slope and trigger level controls.



5391-18

Figure 2-16.

ADJUSTMENTS PROCEDURE

The only test equipment required to adjust and to verify the board performance is an Oscilloscope with a vertical bandwidth of 50 Mhz or greater with a 10X probe.

1. Connect the step-down transformer into an ac power source outlet and observe that LED DS124 is on. If LED DS124 is not on, set the Power switch S100 to On position, LED DS124 should be on.

2. Set the test oscilloscope vertical input to 1 V/div with 10X probe, and dc coupled.

3. Connect the 10X probe ground lead to TP GND (lower right corner of the board and 10X probe signal lead to TP +5.

4. ADJUST—Variable resistor R145 (back of the board) for +5 V (5 divisions vertical display).

5. Set the test oscilloscope vertical input to 50 mV/div with 10X probe, and ac coupled.

6. CHECK—That the noise and ripple does not exceed 150 mV p-p (less than 3 divisions).

7. Set the test oscilloscope vertical input to 5 V/div with 10X probe, and dc coupled.

8. Set the 10X probe signal lead to TP −12.

9. CHECK—The voltage at TP −12 is between −11 V and −13 V.

10. Set the 10X probe signal lead to TP +12.

11. CHECK—THE voltage at TP +12 is between +11 V and +13 V.

12. CHECK—Pin 6 of the ribbon cable J102 for a 10 Mhz signal approximately 2 V p-p in amplitude.

13. CHECK—The signals at TP A, TP B, TP E, TP I, TP J, TP L, and TP M, see "Test Signals" part in this section for description of these signals.

14. Disconnect the test oscilloscope from the CRS10 board.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
07716	TRW INC TRW ELECTRONICS COMPONENTS TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
14301	ANDERSON ELECTRONICS INC	310 PENN ST	HOLLIDAYSBURG PA 16648
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507
50434	HEWLETT-PACKARD CO OPTOELECTRONICS DIV	640 PAGE MILL RD	PALO ALTO CA 94304
55285	BERGQUIST CO INC THE	5300 EDINA INDUSTRIAL BLVD	MINNEAPOLIS MN 55435
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
73743	FISCHER SPECIAL MFG CO	446 MORGAN ST	CINCINNATI OH 45206
76493	BELL INDUSTRIES INC MILLER J M DIV	19070 REYES AVE P O BOX 5825	COMPTON CA 90224

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
82389	SWITCHCRAFT INC SUB OF RAYTHEON CO	5555 N ELSTRON AVE	CHICAGO IL 60630
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61101
TK0020	UNITED CHEMI-CON INC	1128 LEXINGTON AVE	ROCHESTER NY 14606

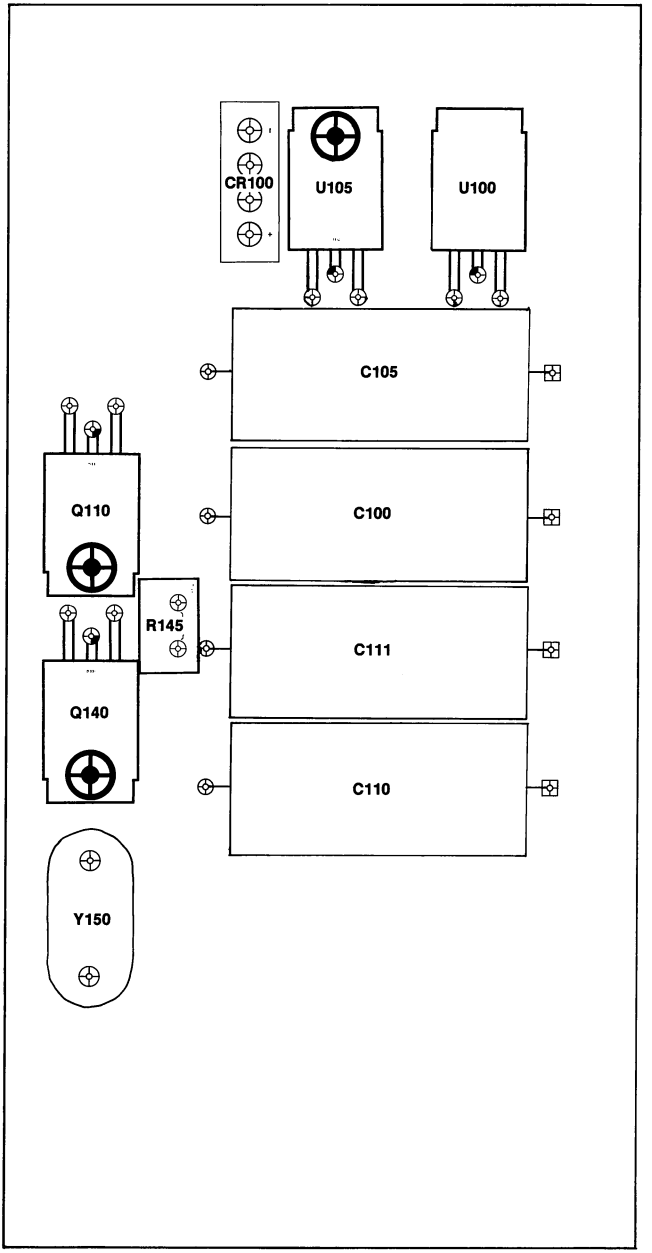
Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C100	290-0984-00			CAP,FXD,ELCTLT:1000UF,20%,50V	55680	TLB1H102M
C102	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
C104	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
C105	290-0984-00			CAP,FXD,ELCTLT:1000UF,20%,50V	55680	TLB1H102M
C106	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
C110	290-0807-00			CAP,FXD,ELCTLT:1000UF,+100 -10%,10VDC	TK0020	SL10T102M12X30LL
C111	290-0807-00			CAP,FXD,ELCTLT:1000UF,+100 -10%,10VDC	TK0020	SL10T102M12X30LL
C112	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C135	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C140	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
C141	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
C170	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
CR100	152-0488-00			SEMICOND DVC,DI:RECT,SI,200V,0.5A	04713	SDA317
CR101	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR102	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR104	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR105	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR106	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR108	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR110	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
DS124	150-1001-02			LT EMITTING DIO:RED,660NM,50MA MAX	50434	HLMP3000
G1	348-0849-00			GROMMET,FSTNR:0.187 ID,NYLON BLACK	80009	348-0849-00
GD7	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
G08	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
I0	342-0355-00			INSULATOR,PLATE:TRANSISTOR,SILICONE RUBBER (UNDER Q110,Q140,U100,U105 BACK OF BOARD)	55285	7403-09FR-51
I1	342-0725-00			INSULATOR,PLATE:CAPACITORS,FIBER SHEET (BACK OF BOARD)	80009	342-0725-00
J100	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 3)	22526	48283-036
L150	108-0226-00			COIL,RF:FIXED,100UH	76493	B4257
P1	214-3732-00			PLUNGER,FSTNR:0.187 DIA,NYLON BLACK	80009	214-3732-00
Q110	151-0482-00			TRANSISTOR:PNP,SI,TO-220	04713	SJE1977
Q112	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
Q138	151-0622-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8956(MPSM51A)
Q140	151-0482-00			TRANSISTOR:PNP,SI,TO-220	04713	SJE1977
Q150	151-1005-00			TRANSISTOR:FET,N-CHAN,SI,TO-106	04713	SPF685
Q154	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
R100	307-0889-00			RES,FXD,FILM:1 OHM,5%,0.25W	19701	5043CX1R000J
R102	307-0889-00			RES,FXD,FILM:1 OHM,5%,0.25W	19701	5043CX1R000J
R105	307-0110-00			RES,FXD,CMPSN:3 OHM,5%,0.25W	80009	307-0110-00
R110	315-0621-00			RES,FXD,FILM:620 OHM,5%,0.25W	57668	NTR25J-E620E
R112	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R114	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R116	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R120	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K

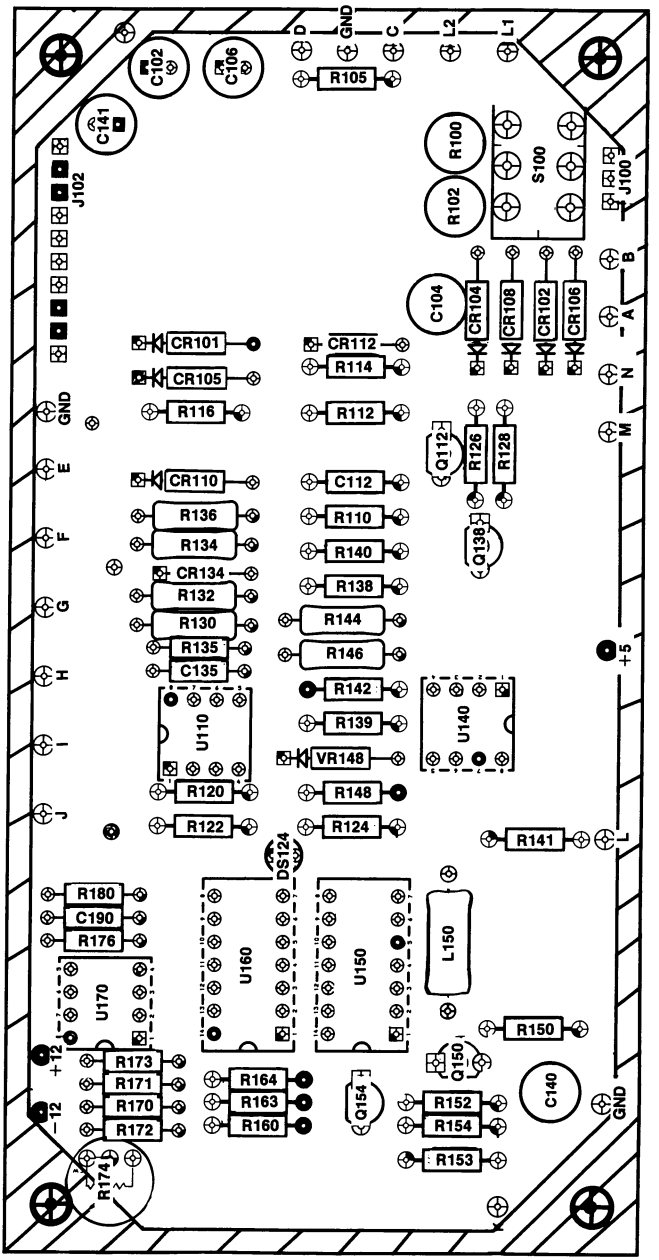
Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R122	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R124	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R126	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R128	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R130	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R132	321-0201-00			RES,FXD,FILM:1.21K OHM,1%,0.125W,TC=T0	19701	5043ED1K210F
R134	321-0201-00			RES,FXD,FILM:1.21K OHM,1%,0.125W,TC=T0	19701	5043ED1K210F
R135	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R136	321-0270-00			RES,FXD,FILM:6.34K OHM,1%,0.125W,TC=T0	19701	5043ED6K340F
R138	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R139	315-0621-00			RES,FXD,FILM:620 OHM,5%,0.25W	57668	NTR25J-E620E
R140	315-0621-00			RES,FXD,FILM:620 OHM,5%,0.25W	57668	NTR25J-E620E
R141	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R142	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R144	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R145	311-1237-00			RES,VAR,NONWW:1K OHM,10%,0.50W	32997	3386X-DY6-102
R146	321-0185-00			RES,FXD,FILM:825 OHM,1%,0.125W,TC=T0	07716	CEAD825R0F
R148	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R150	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R152	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R153	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R154	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R160	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R162	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R164	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R170	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R171	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R172	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R173	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R174	311-1554-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3352T-1-204
R176	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R180	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
S100	260-1811-00			SWITCH,SLIDE:DPDT,0.5A,125VAC-DC	82389	11P-1137
U100	156-0285-00			MICROCKT,LINEAR:VOLTAGE REGULATOR	04713	MC7812CT
U105	156-0872-00			MICROCKT,LINEAR:VOLTAGE REGULATOR	04713	MC7912CT
U110	156-1225-00			MICROCKT,LINEAR:DUAL COMPARATOR	01295	LM393P
U140	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
U150	156-0656-02			MICROCKT,DGTL:DECADE COUNTER,SCRN	01295	SN74LS90NP3
U160	156-0724-02			MICROCKT,DGTL:HEX INV W/OC OUT,SCRN,	01295	SN74LS05NP3
U170	156-0158-00			MICROCKT,LINEAR:DUAL OPNL AMPL	04713	MC1458P1/MC1458U
VR148	152-0461-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZG25002K2
W102	175-9651-00			CA ASSY,SP,ELEC:10 22 AWG,2.5 L,RIBBON	80009	175-9651-00
Y150	158-0031-01			XTAL UNIT,QTZ:10MHZ 0.01%, SERIES	14301	011-558-01939

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
	210-0406-00			NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL (QUANTITY OF 4)	73743	12161-50
	211-0008-00			SCREW,MACHINE:4-40 X 0.25,PNH,STL (QUANTITY OF 4)	93907	ORDER BY DESCR
	214-0579-00			TERM,TEST POINT:BRS CD PL (QUANTITY OF 19)	80009	214-0579-00

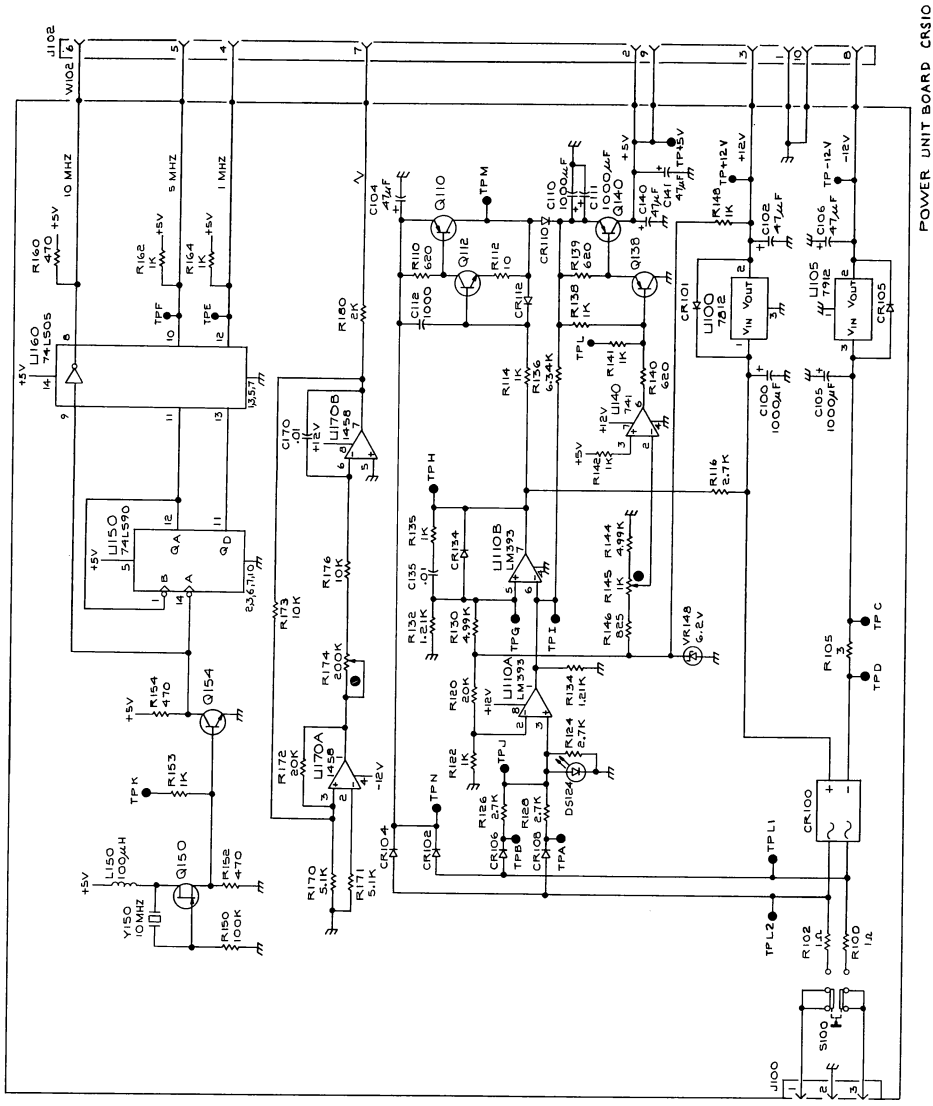


Bottom view of CRS10 Power Unit board.

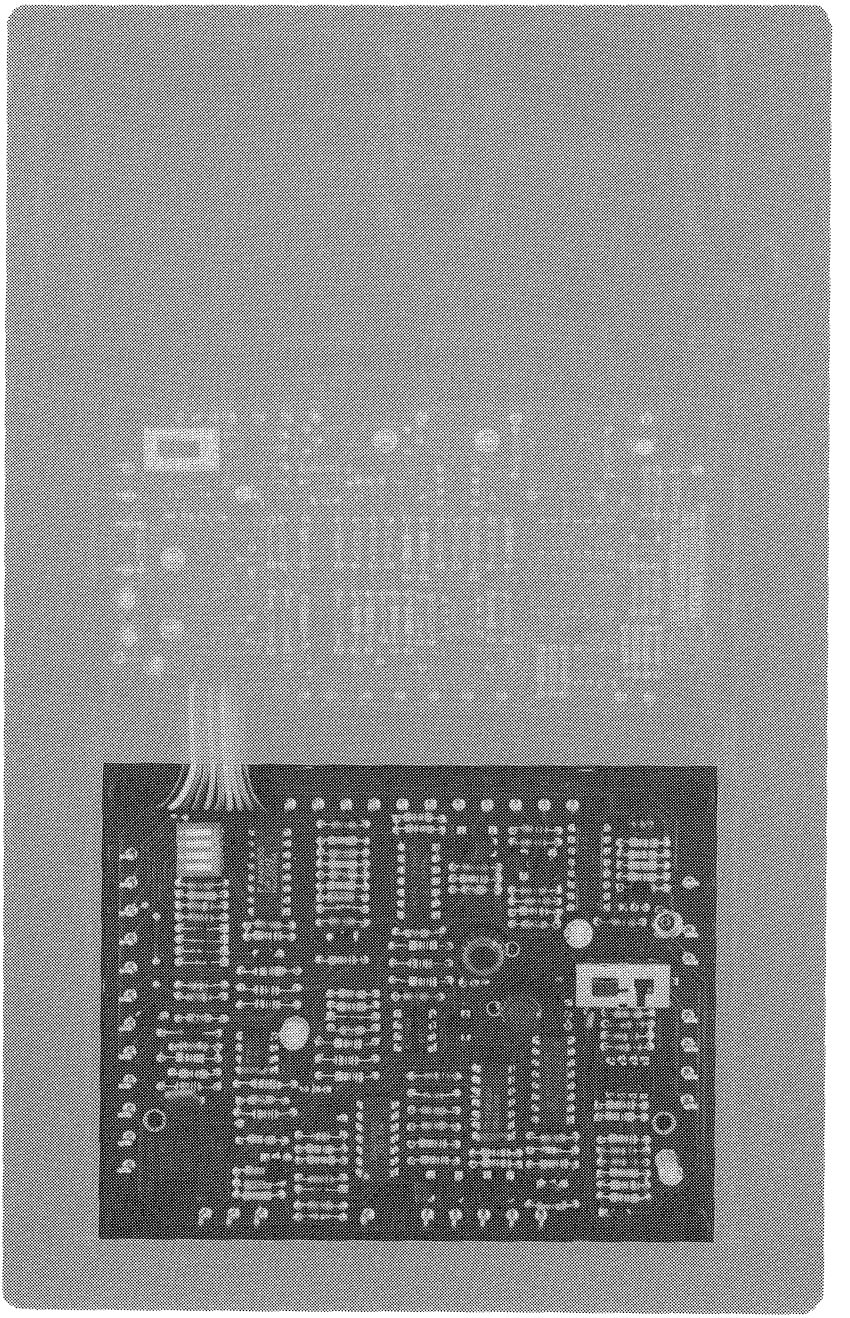


5391-19

CRS10 Power Unit board.


POWER UNIT BOARD CRS10
J102
W102
10 MHZ
5 MHZ
1 MHZ
R160 470 +5V
R162 1K +5V
R164 1K +5V
TPF
TPE
U160 74LS05
U150 74LS90
QA
QD
R154 470
Q154
R153 1K
TPK
U150 100μH
Y150 10MHZ
Q150
R152 470
R150 100K
R173 10K
R174 200K
R176 10K
U170A 456
R172 20K
R171 5.1K
R170 5.1K
-12V
C170 .01 +12V
U170B 456
R140 2K
C104 47μF
Q110
Q112
Q136
Q140
TPM
C110 1000μF
C111 1000μF
C140 47μF
C141 47μF
TP+5V
TP+12V
TP-12V
R148 1K +12V
C102 47μF
C106 47μF
U105 7912
U101 7812
CR101
CR105
R110 680
R112 10
R139 680
R138 1K
R114 1K
R136 6.34K
R140 620
R141 1K
U140 741
TPL
TPH
TPG
TPI
TPJ
TPN
TPB
TPA
TP L1
TP L2
R148 1K +5V
R116 2.7K
C100 1000μF
C105 1000μF
U110B LM393
U110A LM393
C135 .01
R135 1K
CR134
R132 1.21K
R130 4.99K
R120 20K
R182 1K
R126 2.7K
R128 2.7K
R124 2.7K
DS124
R134 1.21K
R144 4.99K
R145 1K
R146 825
VR148 6.2V
R105
TP C
TP D
CR100
CR102
CR104
CR106
CR108
R102 1Ω
R100 1Ω
S100
J100

CRS30 General Purpose Board—Training Labs



5391-21

The CRS30 General Purpose Board.

CRS30 GENERAL PURPOSE BOARD

INTRODUCTION

On the General Purpose Board there are three independent circuits. The first of these begins at TP 1 and evolves to a complex pulse train at TP 6. The circuitry on Test Points 7 through 24 have frequencies derived from the 10 MHz crystal on the Power Unit Board. The remaining test points: Test Points 25 TP 27, V1 through V3, and F1 F4, are associated with the development signal at TP F4. The various test points include ECL, TTL, and CMOS signals, as well as a digital-to-analog converter and a voltage-to-frequency converter.

CONTROLS

Making random adjustments to the controls may or may not have an effect, depending on whether or not the control is in the circuit being probed. The user controls only work within the circuit they are associated with. The controls are straightforward and are easy to use.

The schematic diagram and the circuit board illustration at the back of this section may be helpful in locating the test points, controls, and switches.

On the General Purpose Board there is a three-position slide switch near the front edge of the board. Behind the slide switch are two potentiometers, typically a red knob closest to the slide switch and a gray knob slightly farther from it. In the center of the board is a jumper that can be configured in any of three positions. Alongside the ribbon cable connector is a four-bit DIP (dual in-line package) switch. These are all the user-adjustable controls.

The slide switch S240 and the variable resistor R244 closest to it are used to adjust the frequency of the clock at TP 1 and the frequencies of the signals on Test Points 2 through 6. The switch steps the base frequency from 710 Hz in the slow position to 6.9 kHz in the middle to 220 kHz in the high position. The R244 acts as a variable multiplier of the frequency set by the switch. In the lower two switch settings, the variable will have a gain of about 13. In the high position, the gain is only about four.

The INT VAR control R271, works ONLY when the small jumper in the middle of the board is attached to INT. This control allows the user to adjust a voltage level within a 0-to-5 Vdc range.

The jumper in the middle of the board has a focus labeled V1. When the jumper is connected to the pin labeled SWP, a 0.00-to-0.75 Vdc swept signal is applied to V1. When the jumper is connected to the INT pin, the internal 5 V signal can be adjusted by the gray pot. The third position, EXT, is used with TP 25 to apply a 0 Vdc to +5 Vdc signal to externally sweep the circuit.

At the upper right corner is the four-bit DIP switch that controls the waveform at TP 9. With all switches closed the waveform is a more or less symmetrical staircase. WITH ALL SWITCHES OPEN THERE IS NO OUTPUT. Any other of the possible sixteen settings changes the sequence of the steps on the ramp. There are several switching glitches at the major transitions that lend themselves to demonstrations with either a digital storage oscilloscope or an analog oscilloscope with high-writing-rate crt.

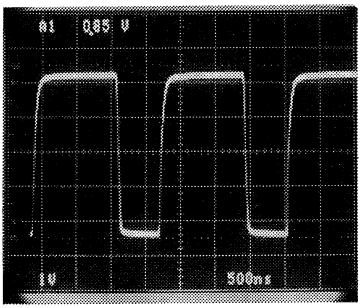
TEST SIGNALS

The test signal specifications given here are representative of typical output signals and may be considered close approximations of what you can expect to find, allowing for tolerances in the different test boards and measurement methods. Dc offsets are expressed as a voltage difference between ground and closest signal peak.

TP 1 Through TP 6

These test points show stages in the development of the complex waveform appearing at TP 6. The frequency of the carrier wave at all six Test Points can be adjusted using the slide switch S240 and the VAR PULSE control R244.

TP 1—The clock signal at this test point is used for Test Points 2 through 6 (see Figure 3-1). The clock frequencies at counterclockwise and clockwise positions of the VAR PULSE control are given in Table 3-1. With S240 in FAST and VAR PULSE control in clockwise positions, the signal rolls off and becomes nonlinear.



5391-22

Figure 3-1.

Table 3-1
Clock Frequencies

VAR PULSE Control	S240 Switch Positions		
	SLOW	MED	FAST
CCW	710.0 Hz	6.9 kHz	220 kHz
CW	10.2 kHz	92.0 kHz	855 kHz

TP 2—The signal is a 5 V, fast-rise trigger pulse as shown in Figure 3-2. The frequency of this pulse is 1/10 of the clock frequency. This pulse can be used to make rise and fall time measurements. The rise time is 12 ns, the fall time is 260 ns. The period is 808 ns.

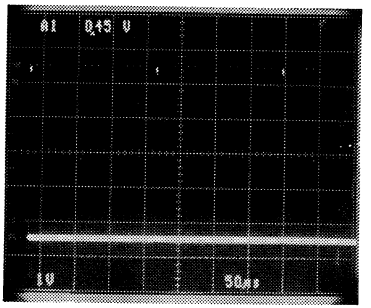


Figure 3-2. 5391-23

TP 3—The double burst signal is good for showing the use of cursors, B Sweep and X10 MAG capabilities of an oscilloscope (see Figure 3-3). The last pulse in the burst can be used to demonstrate the capability of a high performance digital storage oscilloscope.

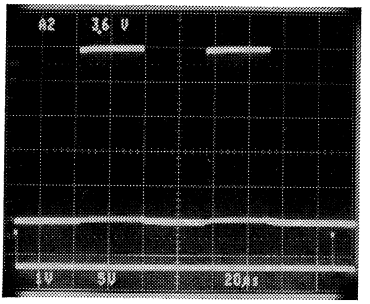
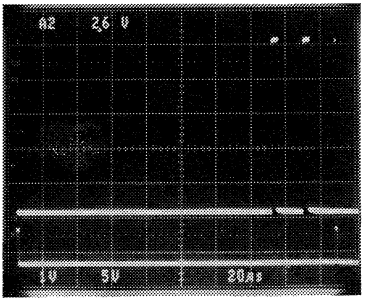


Figure 3-3. 5391-24

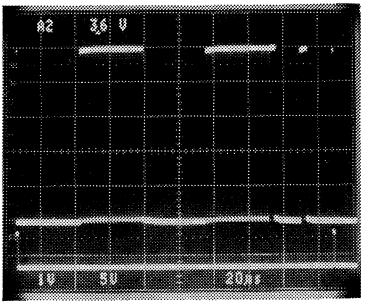
TP 4—The signal at this test point is a double pulse as shown in Figure 3-4. A spike may also be found on this test point. At the lower frequencies, this signal has a repetition rate low enough to require either a digital storage oscilloscope or a high-writing-rate crt oscilloscope to see the spike behind the second pulse.



5391-25

Figure 3-4.

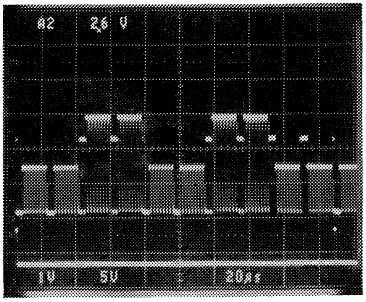
TP 5—The summation of test signals of TP 3 and TP 4 are found at this test point as shown in Figure 3-5. The first pulse from TP 4 is the last cycle in the second burst of TP 3. There is a timing glitch at the summation point along with some attendant modulation from the final stage. This waveform is fairly nonsymmetrical at the high frequencies.



5391-26

Figure 3-5.

TP 6—A pulse train is found at this test point with different voltages and shapes as shown in Figure 3-6. This complex waveform can be used to demonstrate oscilloscope features of cursors, B Sweep, delay time, and X10 MAG. The bursts on the signal are running at the clock frequency. in the high switch setting this signal becomes nonsymmetrical at the upper end of the variable range.



5391-27

Figure 3-6.

NOTE

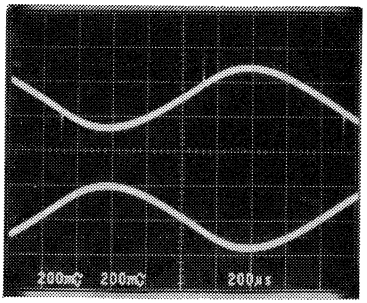
The frequencies on Test Points 7 through 24 are derived from a 10 MHz crystal on the CRS10 Power Unit Board. They should be fairly stable and consistent.

TP 7 and TP 8

The signals at these two test points contain 10 MHz noise that can be remove by using the Bandwidth Limit circuit of the Oscilloscope. With different dc offsets, the two Test Points can be used to show the difference between ac and dc input coupling. Use the oscilloscope ADD Mode to cancel the signals from TP 7 and TP 8 leaving only the spikes from TP 7. By inverting one of the channels, the signal amplitude doubles.

TP 7—This test point has a sine-wave signal of 610 Hz, 0.358 p-p amplitude with 3,92 Vdc offset and ±0.2 spike on the waveform (upper waveform in Figure 3-7).

TP 8—The sine wave is a complimentary signal to the one at TP 7 but with a 0.61 Vdc offset and no spike (lower waveform in Figure 3-7).



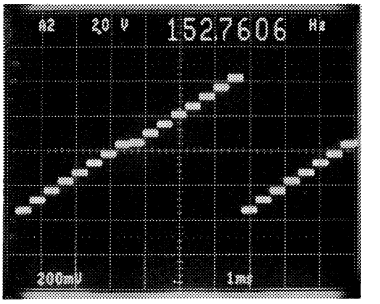
5391-28

Figure 3-7.

NOTE

The DAC (digital-to-analog converter) output at TP 9 is controlled by the four-bit DIP switch S230. There are 16 switch settings, with all the switch settings closed the output is a symmetrical staircase waveform. With all the switch settings open there is no output waveform. Any other switch settings will change the step sequence.

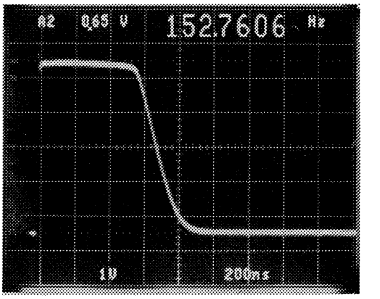
TP 9—The DAC output is a 152 Hz, 0.75 V ramp signal with steps 410 us in duration (see Figure 3-8). This is a noisy signal that is good for showing the use of Bandwidth Limit capabilities of the oscilloscope. There are switching glitches at the major transitions. These are useful for demonstrating glitch catching using either a digital storage oscilloscope or an analog oscilloscope with a high-writing-rate crt. The steps lend themselves to coupled-cursor (Volts and Time cursors tracking together) demonstrations for voltage or time measurements.



5391-29

Figure 3-8.

TP 10—This 152 Hz trigger pulse (see Figure 3-9) should be used to trigger the probe at TP 9. The signal output of TP 10 has low repetition rate (about 7 ms) that may be used to demonstrate the effects of display writing rate.



5391-30

Figure 3-9.

TP 11 Through TP 14

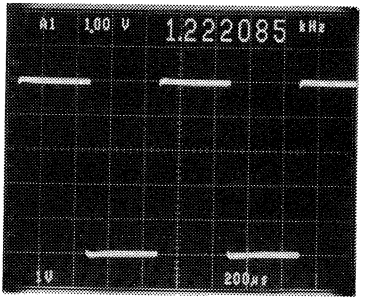
These four test points are a series of CMOS divide-by-two networks that feed the DAC at TP 9. These symmetrical square waves are good for CMOS voltage level and rise- and fall-time measurements. Figure 3-10 shows the waveform at TP 11. Waveforms at TP 12, TP 13, and TP 14 may be displayed in the same manner by setting the test oscilloscope time base to a different sweep speed.

TP 11—The signal is a 1.22 kHz, 0 to 5 V, having a rise time of 62 ns and a fall time of 54.8 ns.

TP 12—The signal is a 610 Hz, 0 V-to-5 V, having a rise time of 66.8 ns and a fall time of 63.2 ns.

TP 13—The signal is a 305 Hz, 0 V-to-5 V, having a rise time of 56 ns and a fall time of 57.5 ns.

TP 14—The signal is a 153 Hz, 0 V-to-5 V, having a rise time of 78.3 ns and a fall time of 166 ns.



5391-31

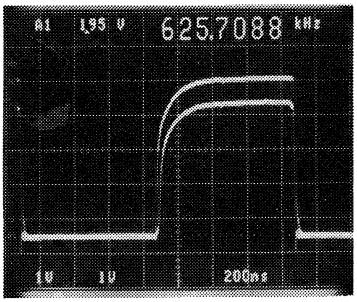
Figure 3-10.

TP 15 and TP 16

Using these two LSTTL (low-power Schottky transistor-transistor logic) test points in a dual channel mode, you can make delay-time measurements using Delta Time mode. Figure 3-11 display both signal waveforms from TP 15 and TP 16. The signal from TP 15 is delayed approximately 20 ns from the signal at TP 16.

Adjust both TP 15 and TP 16 signals for an exact 5-division display. Set the time base until both signals are spread out as shown in Figure 3-12. Using cursors, measure the time difference at the 50% point of the waveforms.

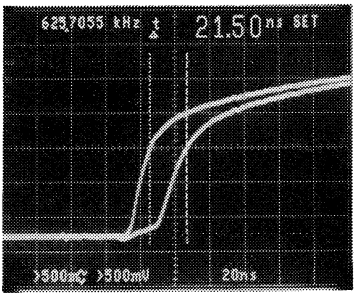
TP 15—The signal is 625 kHz, 3.6V, 0.1 us in duration, with ringing on the baseline.



5391-32

Figure 3-11.

TP 16—The signal is 4.5 V, 0.1 us in duration, reference signal for TP 15. This signal has similar ringing on the baseline as TP 15 and it also has some undershoot.



5391-33

Figure 3-12.

TP 17 Through TP 19

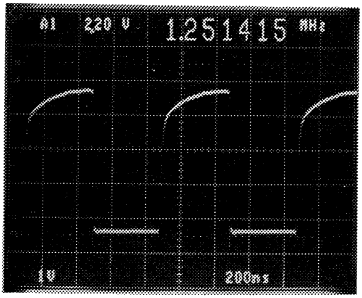
These three test points are LSTTL (Low-Power Schottky Transistor-Transistor-Logic) square waves that are useful for measuring transition times for LSTTL signals. All three of the signals have some undershoot and ringing on the bottom of the waveform.

Figure 3-13 shows the waveform as it appears at TP 18 and TP 19.

TP 17—The square wave is a 625 kHz signal with a fall time of 19.25 ns.

TP 18—The square wave is a 1.25 MHz signal with a fall time of 19.4 ns.

TP 19—The square wave is a 1.25 MHz signal with a fall time of 20 ns. This signal has 0.5 V undershoot and more ringing on the bottom of the waveform than the signals on TP 17 and TP 18.



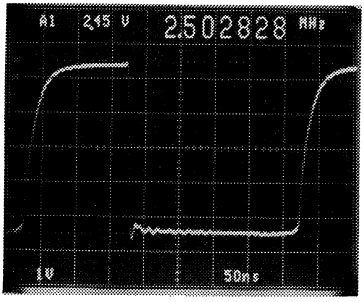
5391-34

Figure 3-13.

TP 20 Through TP 24

These five test points are ECL (Emitter-Coupled Logic) signals with appropriate levels and transition speeds. The voltage swings are ECL, but the dc offset is not a true ECL level. The signals at these test points contains ringing and aberrations on both high and low levels, as well as overshoot and undershoot.

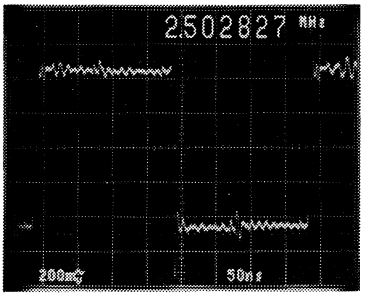
TP 20—This signal is converted from a ECL voltage level to to a TTL voltage level. Figure 3-14 shows a non-symmetrical square wave at 2.5 MHz with a rise time of 36.8 ns and a fall time of 20.26 ns.



5391-35

Figure 3-14.

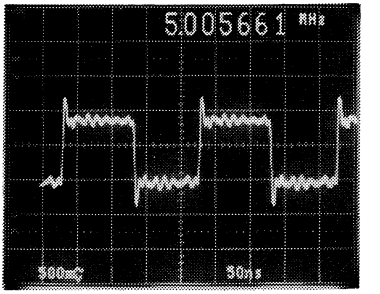
TP 21 and TP 22—The two signals are ECL Gates with logic level opposite to each other. The frequency of the two signals are 2.5 MHz and 180° out of phase with each other. The dc offset is not true ECL, while the voltage swing is ECL. They can be used to show the effects of different ground-lead lengths, which start becoming important at these frequencies. TP 21 has a rise time of 2.4 ns and a fall time of 3.8 ns. TP 22 has a rise time of 3.35 ns and a fall time of 2.3 ns. Figure 3-15 shows the signals found at TP 21 and TP 22.



5391-36

Figure 3-15.

TP 23 and TP 24—The two signals are ECL Gates with logic level opposite to each other. The frequency of the two signals are 5 MHz and 180° out of phase of each other. This signal is useful to show the full effect of bandwidth limit features of the oscilloscope. The rise time for TP 23 is 2.14 ns, and the fall time is 2.34 ns. For TP 24 the rise time is 1.86 ns, and the fall time is 2.04 ns. Figure 3-16 shows the signals found at TP 23 and TP 24.

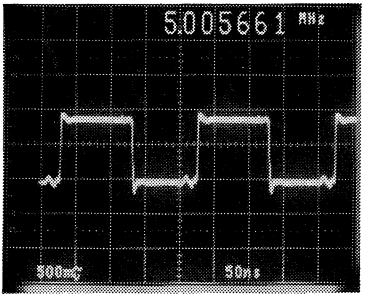


5391-37

Figure 3-16.

Probe Socket

The Probe Socket J210 is in parallel with TP 23 and may be used to demonstrate proper grounding and ground lead-length effects at high frequencies. Figure 3-17 shows the signal found at the Probe Socket J210.



5391-38

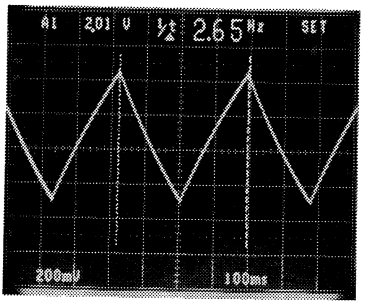
Figure 3-17.

TP 25

This Test Point (EXT VIN) can be used to apply an input signal to the V-to-F Converter circuitry. For the input signal to be use in the circuit, the small jumper P270 in the middle of the General Purpose board must be connected between TP 25 (EXT VIN) TP and V1 (input to the circuit). The signal from the first V test points to the last of the F test points will be modulated by the input signal. Using a jumper wire, the input signal could come from one of the other test points on the board.

TP 26

The triangle wave signal at this test point is 0.7 V p-p, 2.65 Hz, with a 1.23 V dc offset (see Figure 3-18). This signal is useful in showing the effects of the Trigger Level and Slope controls. When the Plug P270 is connected between SWP and VIN of J270, the signal output at this test point is the sweep voltage that appears at TP V1.

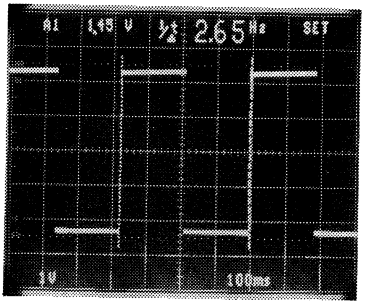


5391-39

Figure 3-18.

TP 27

The signal at this test point is a 0 to +5 V, 2.65 Hz square wave (see Figure 3-19). Set the test oscilloscope trigger to normal for a stable trigger. Use the Vertical dc input coupling to view this low frequency square wave.



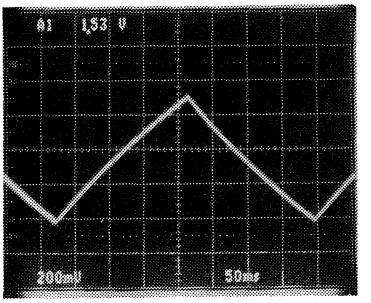
5391-40

Figure 3-19.

TP V1 Through TP V3 and TP F1 Through TP F4

This group of test points show the various stages in the development of the am-fm signal at TP F4. The jumper P270 in the middle of the circuit board is used to control which source will feed the input at TP V1. All measurements given are made with the jumper P270 connected in the SWP position.

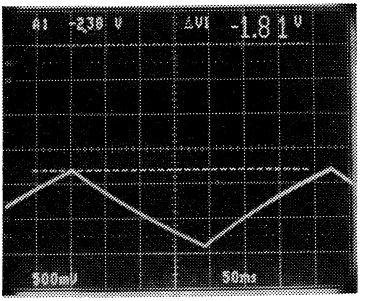
TP V1—This is the input to the voltage-to-frequency converter. With the jumper supplying the SWP signal, there is a 0.75 V p-p, 2.65 Hz signal on a 1.19 V dc offset (see Figure 3-20).



5391-41

Figure 3-20.

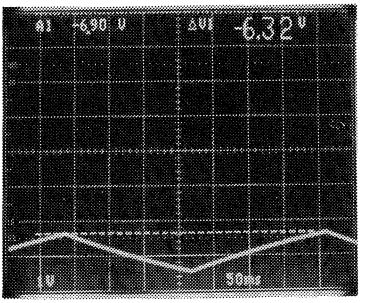
TP V2—This is an intermediate step in the V to F Converter. The signal is still at 2.65 Hz with a 1.13 V p-p amplitude on a −1.81 V dc offset (see Figure 3-21).



5391-42

Figure 3-21.

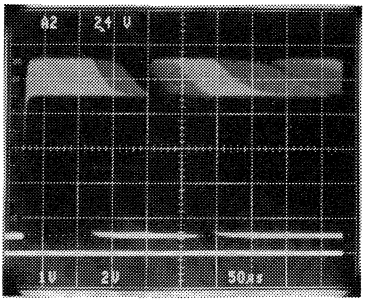
TP V3—This is an inverted version of the same signal on TP V2. The signal is 1.05 V p-p at 2.65 Hz, but the dc offset is now −6.34 V (see Figure 3-22).



5391-43

Figure 3-22.

TP F1—The am-fm waveform at this stage is nonsymmetrical and riding on a 12 V dc offset (see Figure 3-23). The am envelope varies from 4.6 V to 5.1 V. The fm excursions are from 3.88 kHz to 5.64 kHz.

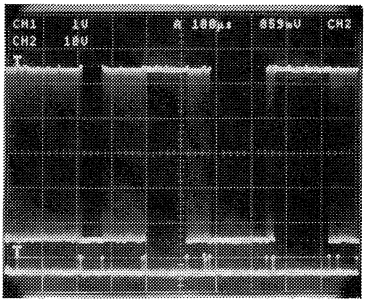


5391-44

Figure 3-23.

TP F2—This is the fm trigger pulse for TP F4. The pulse is coincident with every negative transition of TP F1. The fm envelope is 3.88 kHz to 5.64 kHz.

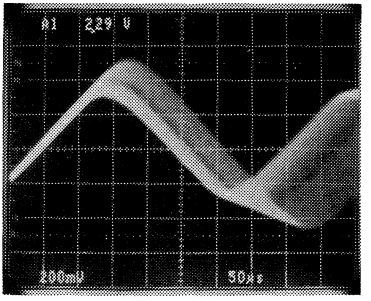
TP F3—The square wave at this test point (see Figure 3-24) is generated by the pulses at TP F2. It does not change amplitude, just frequency: 1.96 kHz to 2.8 kHz. This signal is applied to a high frequency filter (low pass).



5391-45

Figure 3-24.

TP F4—This signal is the resulting am-fm waveform that starts at V1 (see Figure 3-25). A 0.675 V-to-1 V am envelope and a 1.96 kHz to 2.8 kHz fm envelope are generated with the jumper in the SWP position. When in INT position, the rotation of the INT VAR control R271 modulates the signal. With the jumper across V1 and V IN and the proper signal fed in, the waveform can be modulated by an external source.



5391-46

Figure 3-25.

ADJUSTMENTS PROCEDURE

The only test equipment required to adjust and to verify the board performance is an Oscilloscope with a vertical bandwidth of 50 Mhz or greater with two 10X probe.

1. Connect Channel 1 10X probe ground lead to TP GND and signal lead to TP F4 and set the test oscilloscope sweep speed to 0.2 ms.

2. Set plug P270 between VIN and INT pins.

3. Rotate INT VAR (R271) control fully clockwise position.

4. ADJUST—Variable Resistor R286 (located on the bottom of the board) for 1 cycle per division.

5. Rotate Int Var (R271) fully counterclockwise position.

6. CHECK—For approximately 1 cycle per 4 division.

7. Set the plug P270 between SWP and VIN pins.

8. CHECK—Signals at test points TP V3 and TP F4, see Figures 3-22 and 3-25 in the "Test Signals" part of this section.

9. Connect Channel 1 10X probe signal lead to TP 1 and oscilloscope sweep speed to 1 ms.

10. Set the Switch S240, set the switch to SLOW position.

11. Rotate VAR PULSE (R244) control fully counterclockwise.

12. bserve the number of square wave pulses on the crt screen for step 14.

13. Rotate the VAR PULSE control R244 fully clockwise and set the oscilloscope sweep speed to 0.1 μs.

14. CHECK—That the number of square wave pulses is 10 times or greater as in step 12.

15. Set S240 to MED position, and repeat steps 11 through 14 using sweep speeds 0.1 ms and 10 μs.

16. Set S240 to FAST position, and repeat steps 11 through 13 using sweep speeds 10 μs and 2 μs.

17. CHECK—That the number of square wave pulses is 4 times or greater as in step 12. The signal at the upper end rolls off and becomes nonlinear. Return S240 to MED position.

18. Connect Channel 1 X10 probe to TP 2.

19. CHECK—The Signal at TP 2 and see "Test Signals" part in this section for description of it.

20. Set test oscilloscope trigger mode to Channel 1 and Channel 2 X10 probe ground lead to TP GND and the signal lead to TP 6.

21. CHECK—The signal at TP 6 with Channel 2 X10 probe and see "Test Signals" part in this section for description of it.

22. Set all switch positions of S230 to closed.

23. CHECK—The signals at TP7 through TP16 with Channel 1 X10 probe, see "Test Signals" part of this section for a signal description at these test points. If the signals are correct at these test points, it can be assumed that the signals from TP 17 through 24 are correct.

24. Disconnect the test oscilloscope from the CRS30 board.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
01121	ALLEN-BRADLEY CO	1201 SOUTH 2ND ST	MILWAUKEE WI 53204
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
02735	RCA CORP SOLID STATE DIVISION	ROUTE 202	SOMERVILLE NJ 08876
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
07716	TRW INC TRW ELECTRONICS COMPONENTS TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
12697	CLAROSTAT MFG CO INC	LOWER WASHINGTON ST	DOVER NH 03820
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
27014	NATIONAL SEMICONDUCTOR CORP	2900 SEMICONDUCTOR DR	SANTA CLARA CA 95051
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507
50434	HEWLETT-PACKARD CO OPTOELECTRONICS DIV	640 PAGE MILL RD	PALO ALTO CA 94304

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195
56289	SPRAGUE ELECTRIC CO	87 MARSHALL ST	NORTH ADAMS MA 01247
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
73743	FISCHER SPECIAL MFG CO	446 MORGAN ST	CINCINNATI OH 45206
79727	C-M INDUSTRIES	550 DAVISVILLE RD P O BOX 96	WARMINSTER PA 18974
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
81073	GRAYHILL INC	561 HILLGROVE AVE P O BOX 373	LA GRANGE IL 60525

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C200	290-0804-01			CAP,FXD,ELCTLT:10UF,20%,25V	55680	ULB1E100MAA1TD
C210	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C220	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C221	281-0814-00			CAP,FXD,CER DI:100 PF,10%,100V	04222	MA101A101KAA
C230	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C231	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C232	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C233	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C234	281-0814-00			CAP,FXD,CER DI:100 PF,10%,100V	04222	MA101A101KAA
C240	285-0685-00			CAP,FXD,PLASTIC:0.0068UF,10%,100V	56289	192P68292
C243	283-0195-00			CAP,FXD,CER DI:680PF,5%,50V	04222	SR205A681JAA
C249	281-0814-00			CAP,FXD,CER DI:100 PF,10%,100V	04222	MA101A101KAA
C267	290-0776-01			CAP,FXD,ELCTLT:22UF,+50%-10%,10V	55680	ULB1A220MAA1TD
C278	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C280	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C283	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C284	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C285	283-0177-05			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR302E105ZAATR
C286	290-0804-00			CAP,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
C288	281-0814-00			CAP,FXD,CER DI:100 PF,10%,100V	04222	MA101A101KAA
C293	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C296	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C297	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
CR221	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V	03508	DA2527 (1N4152)
CR222	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V	03508	DA2527 (1N4152)
CR223	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V	03508	DA2527 (1N4152)
CR224	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V	03508	DA2527 (1N4152)
CR240	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
CR280	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V	03508	DA2527 (1N4152)
CR291	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V	03508	DA2527 (1N4152)
DS210	150-1001-02			LT EMITTING DIO:RED,660NM,50MA MAX	50434	HLMP3000
G2	348-0849-00			GROMMET,FSTNR:0.187 ID,NYLON BLACK	80009	348-0849-00
GD1	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
GD2	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
GD3	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
GD4	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
GD5	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
J202	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 10)	22526	48283-036
J210	131-1436-00			RCPT,COAX CABLE:CKT BD MT,3-PRONG,BRS	80009	131-1436-00
J270	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 4)	22526	48283-036
K0	366-1023-01			KNOB:GY,0.127 ID X 0.392 OD X 0.531 H	80009	366-1023-01
K1	366-1031-02			KNOB:RED,VAR,0.127 ID X 0.392 OD X 0.466 H	80009	366-1031-02
P2	214-3732-00			PLUNGER,FSTNR:0.187 DIA,NYLON BLACK	80009	214-3732-00
P270	131-0993-00			BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005

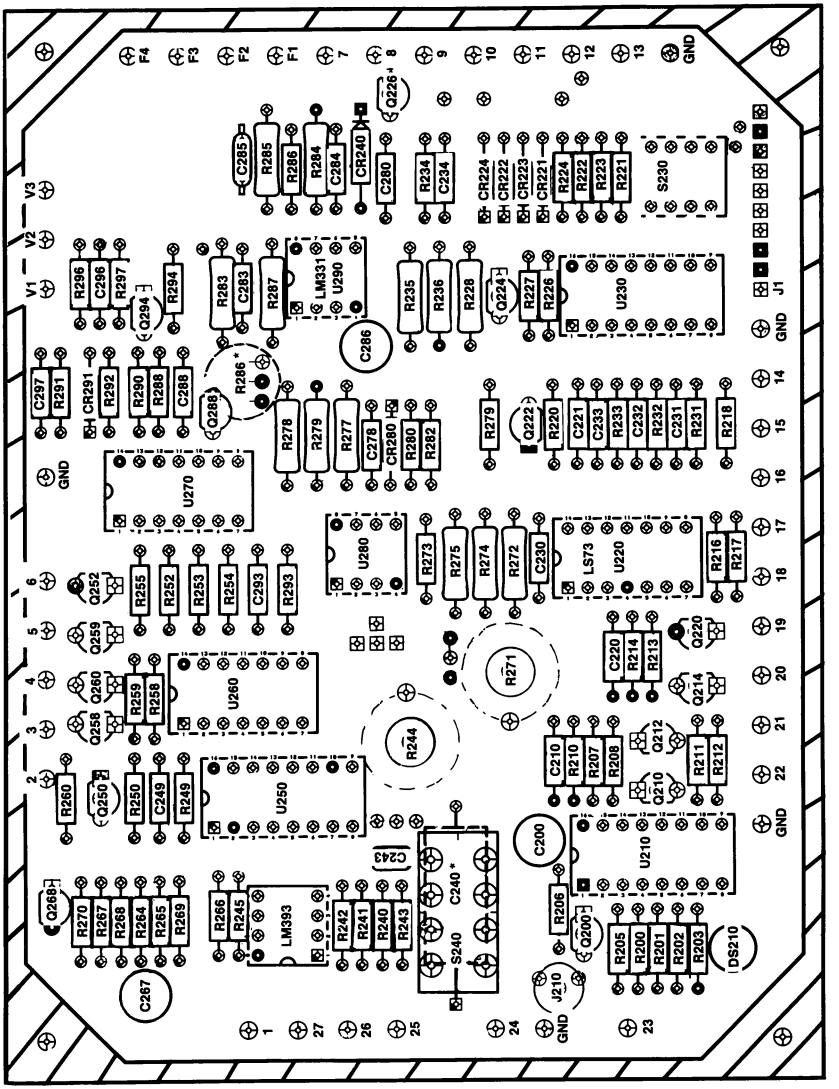
Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
Q200	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q210	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q212	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q214	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q220	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q222	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q224	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q226	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q250	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q252	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q258	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q259	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q260	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q268	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q288	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q294	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
R200	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R201	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
R202	315-0241-00			RES,FXD,FILM:240 OHM,5%,0.25W	19701	5043CX240R0J
R203	315-0241-00			RES,FXD,FILM:240 OHM,5%,0.25W	19701	5043CX240R0J
R205	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
R206	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
R207	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R208	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
R210	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R211	315-0121-00			RES,FXD,FILM:120 OHM,5%,0.25W	19701	5043CX120R0J
R212	315-0121-00			RES,FXD,FILM:120 OHM,5%,0.25W	19701	5043CX120R0J
R213	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R214	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R216	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R217	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R218	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R220	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R221	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R222	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R223	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R224	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R227	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R228	321-0191-00			RES,FXD,FILM:953 OHM,1%,0.125W,TC=T0	07716	CEAD953R0F
R229	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R231	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R232	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R233	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R234	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R235	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R236	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R240	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R241	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R242	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R243	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R244	311-2306-00			RES,VAR,NONWW:PNL,100K OHM,20%,0.5W	12697	CM43489
R245	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R250	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R252	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R253	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R254	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
R255	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R258	315-0182-00			RES,FXD,FILM:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
R259	315-0122-00			RES,FXD,FILM:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
R260	315-0911-00			RES,FXD,FILM:910 OHM,5%,0.25W	57668	NTR25J-E910E
R264	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R265	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R266	315-0204-00			RES,FXD,FILM:200K OHM,5%,0.25W	19701	5043CX200K0J
R267	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R268	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R269	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R270	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R271	311-2035-00			RES,VAR,NONWW:PNL,1K OHM,10%,0.5 W	01121	MA1G032S102UA
R272	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R273	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R274	321-0306-00			RES,FXD,FILM:15.0K OHM,1%,0.125W,TC=T0	19701	5033ED15J00F
R275	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R277	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R278	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R279	321-0306-00			RES,FXD,FILM:15.0K OHM,1%,0.125W,TC=T0	19701	5033ED15J00F
R280	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R282	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R283	321-0385-00			RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R284	321-0273-00			RES,FXD,FILM:6.81K OHM,1%,0.125W,TC=T0	07716	CEAD68100F
R285	321-0385-00			RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R286	311-1560-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3352T-1-502
R286	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R287	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R288	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R290	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R291	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R292	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R293	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R294	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R296	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R297	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
S230	260-1965-00			SWITCH,ROCKER:(4)SPST,125MA,30VDC	81073	76SB04

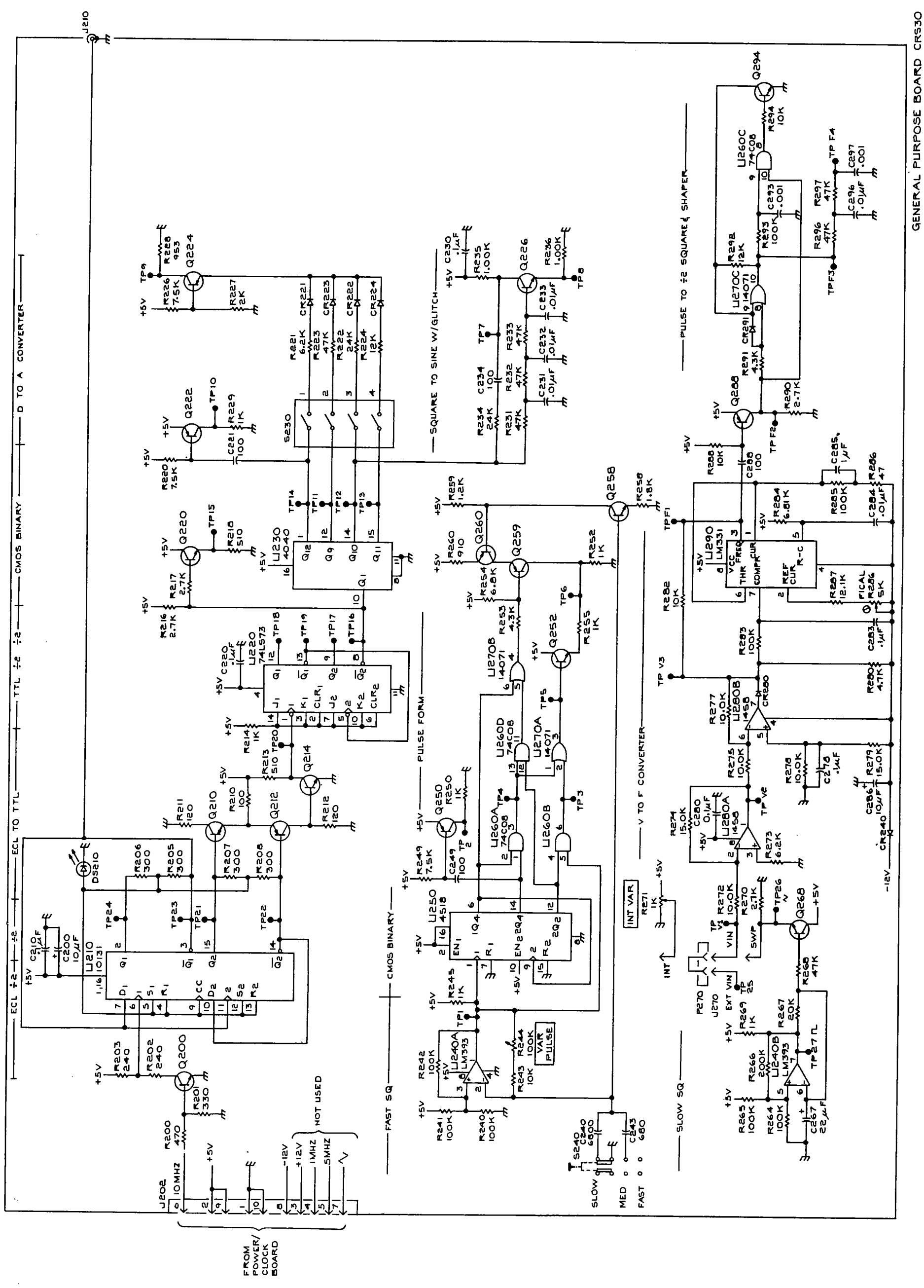
Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
S240	260-0984-00			SWITCH,SLIDE:DPTT,0.5A,125V	79727	G-128-S-0012
U210	156-0230-00			MICROCKT,DGTL:ECL,DUAL D MASTER-SLAVE FF	04713	MC10131(L OR P)
U220	156-0387-02			MICROCKT,DGTL:DUAL J-K FF,SCRN	04713	SN74LS73NDS
U230	156-0545-01			MICROCKT,DGTL:12 BIT BINARY CNTR	02735	CD40408FX
U240	156-1225-00			MICROCKT,LINEAR:DUAL COMPARATOR	01295	LM393P
U250	156-0752-01			MICROCKT,DGTL:DUAL BCD UP COUNTER,SCRN	04713	MC145188CL
U260	156-0577-02			MICROCKT,DGTL:QUAD 2-INP AND GATE,SEL	27014	DM74C08NA+
U270	156-1340-01			MICROCKT,DGTL:QUAD 2-INP OR GATE,SCREENED	02735	CD4071BFX
U290	156-1362-00			MICROCKT,LINEAR:V-TO-FREQUENCY CONVERTER	27014	LM331N
W02	196-2931-00			LEAD,ELECTRICAL:26 AWG,1.25 L,1-N	80009	196-2931-00
W2	196-2931-00			LEAD,ELECTRICAL:26 AWG,1.25 L,1-N	80009	196-2931-00
W03	196-2932-00			LEAD,ELECTRICAL:26 AWG,1.25 L,2-N	80009	196-2932-00
W3	196-2932-00			LEAD,ELECTRICAL:26 AWG,1.25 L,2-N	80009	196-2932-00
W04	196-2933-00			LEAD,ELECTRICAL:26 AWG,1.25 L,3-N	80009	196-2933-00
W4	196-2933-00			LEAD,ELECTRICAL:26 AWG,1.25 L,3-N	80009	196-2933-00
X210	136-0333-00			SOCKET,PIN TERM:U/W 0.03 DIA PINS	00779	1-331677-4
	210-0583-00			NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL (QUANTITY OF 2)	73743	2X-20319-402
	214-0579-00			TERM,TEST POINT:BRS CD PL (QUANTITY OF 34)	80009	214-0579-00



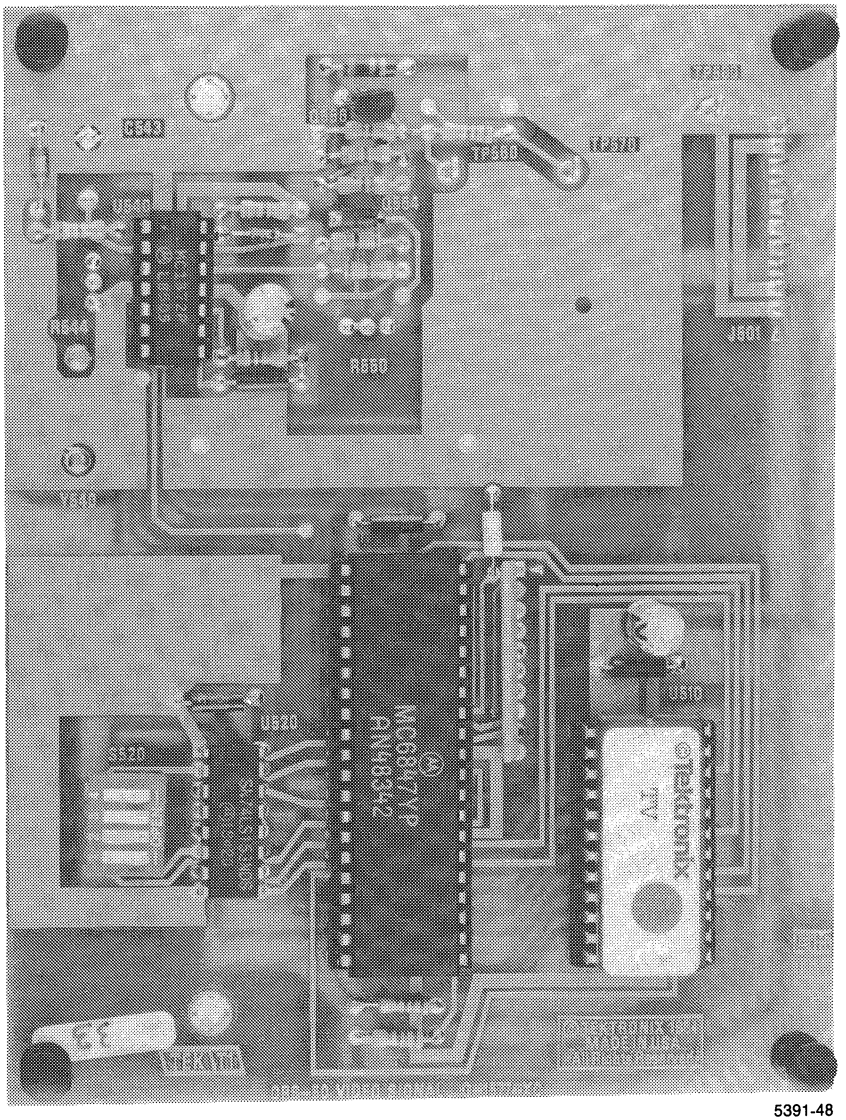
*Component located on back of board.

5391-47

CRS30 General Purpose board.


GENERAL PURPOSE BOARD CRS30
ECL ÷2
÷2
ECL TO TTL
TTL ÷2 ÷2
CMOS BINARY
D TO A CONVERTER
SQUARE TO SINE W/GLITCH
PULSE FORM
PULSE TO ÷2 SQUARE & SHAPER
V TO F CONVERTER
FAST SQ
SLOW SQ
NOT USED
FROM POWER/ CLOCK BOARD
INT VAR
VAR PULSE
SLOW
MED
FAST

CRS50 Video Signal Board—Training Labs



5391-48

The CRS50 Video Signal Board.

CRS50 VIDEO SIGNAL BOARD

INTRODUCTION

The TV Board generates an NTSC interlaced video signal. This board was developed to demonstrate the TV Triggering and Clamp features of the TEKTRONIX 2400 Series oscilloscopes and it will make pictures on a video monitor.

VIDEO SIGNALS

The schematic diagram and the circuit board illustration at the back of this section may be helpful in locating the test points, controls, and switches.

Test point TP 560 is the signal output, and TP 570 is the same signal after it has passed through a high frequency filter (low pass). This filters the color subcarrier, 3.58 MHz square wave, leaving a more sinusoidal wave in the Color Burst. The 3.58 Mhz frequency can be noticed throughout the Horizontal Blanking period. TP 580 is the ground point for the Video Signal board.

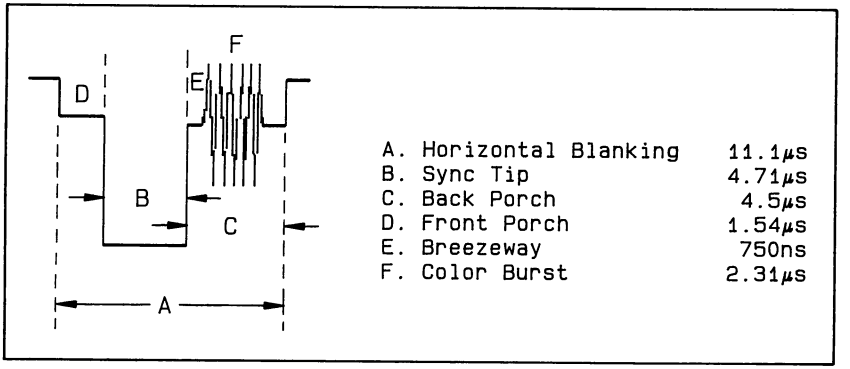
The video display switch S520 selects the type of composite video signal that will be applied to TP 560 and TP 570. This switch has 16 possible combinations, each of which has a composite video signal. Only 4 settings will give a display similar to those found in video test systems. These are color bars, cross hatch, white box/black border and staircase. The other settings have little or no meaning on a video display but will work fine for oscilloscope demonstrations and other training purposes.

The video display switch settings for the four meaningful video signals are given in Table 4-1.

TABLE 4-1
Video Display Switch Settings

Section	Position	Display
A	Closed	Color Bars
B	Open	
C	Closed	
D	Closed	
A	Closed	Cross Hatch
B	Open	
C	Open	
D	Closed	
A	Closed	White Box/Black Border
B	Open	
C	Closed	
D	Open	
A	Closed	Staircase
B	Open	
C	Open	
D	Open	

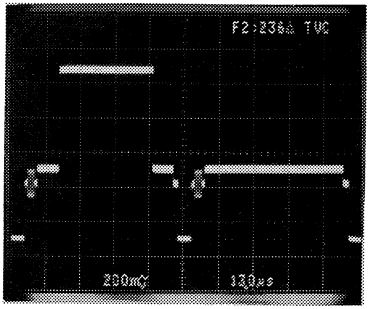
Figure 4-1 shows the timing measurement points on the Horizontal Blanking period. The timing measurement between points are given in approximate values only.



5391-49

Figure 4-1.

The TEKTRONIX 2400 series of oscilloscopes with TV Triggering display not only the trigger mode in use but also the individual picture line when field triggered as shown in Figure 4-2.



5391-50

Figure 4-2.

The TV Clamp on the TEKTRONIX 2400 series oscilloscopes can be demonstrated by first using ac coupling while changing the four-bit switch settings. As the average picture value changes, the signal shifts vertically. When the TV Clamp is activated, the Back Porch of the signal is clamped at the Ground reference.

For further information on TV measurements ask for Tektronix Application Note 38W-5708 "Video Measurements Using 2445 and 2465 Oscilloscopes with Television Triggering" at your nearest Tektronix Sale Office or representative.

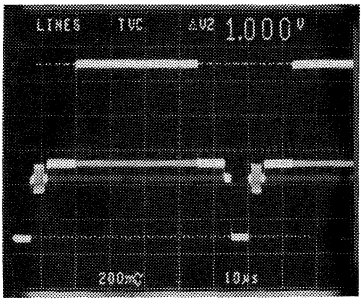
ADJUSTMENTS PROCEDURE

The only test equipment required to adjust and to verify the board performance is an Oscilloscope with a vertical bandwidth of 50 Mhz or greater with a 10X probe.

1. Set the test oscilloscope vertical at 0.2 V with X10 probe, sweep speed to 10 μs, and the trigger to TV Lines and Negative Slope for a stable display.

2. Connect the test oscilloscope X10 probe ground lead to TP 580 and signal lead to TP 570.

3. ADJUST the variable resistor R550 for 5-division display (1V) as shown Figure 4-3.



5391-51

Figure 4-3.

4. Set the test oscilloscope sweep speed to 1 μs and the X10 Mag to on.

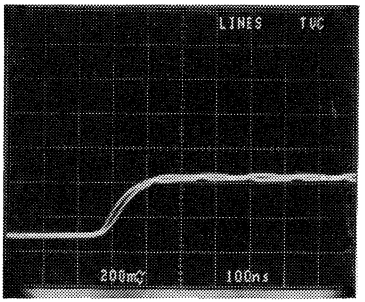
5. Adjust the Horizontal POSITION control to place the rising edge(s) of the sync tip on the screen.

6. ADJUST—The variable resistor R544 until the two rising edges coincide as shown in Figure 4-4 .

7. Use the horizontal POSITION control to place the Color Burst portion of the signal on the screen.

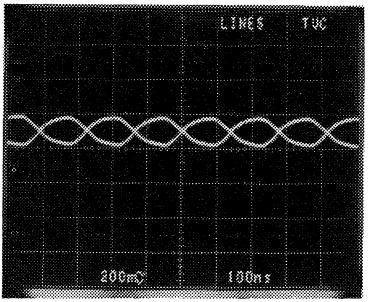
8. ADJUST—Variable capacitor C543 for a symmetrical crossing at the 50% point of the sine waves as seen in Figure 4-5.

9. Disconnect the test oscilloscope from the CRS50 board.



5391-52

Figure 4-4.



5391-53

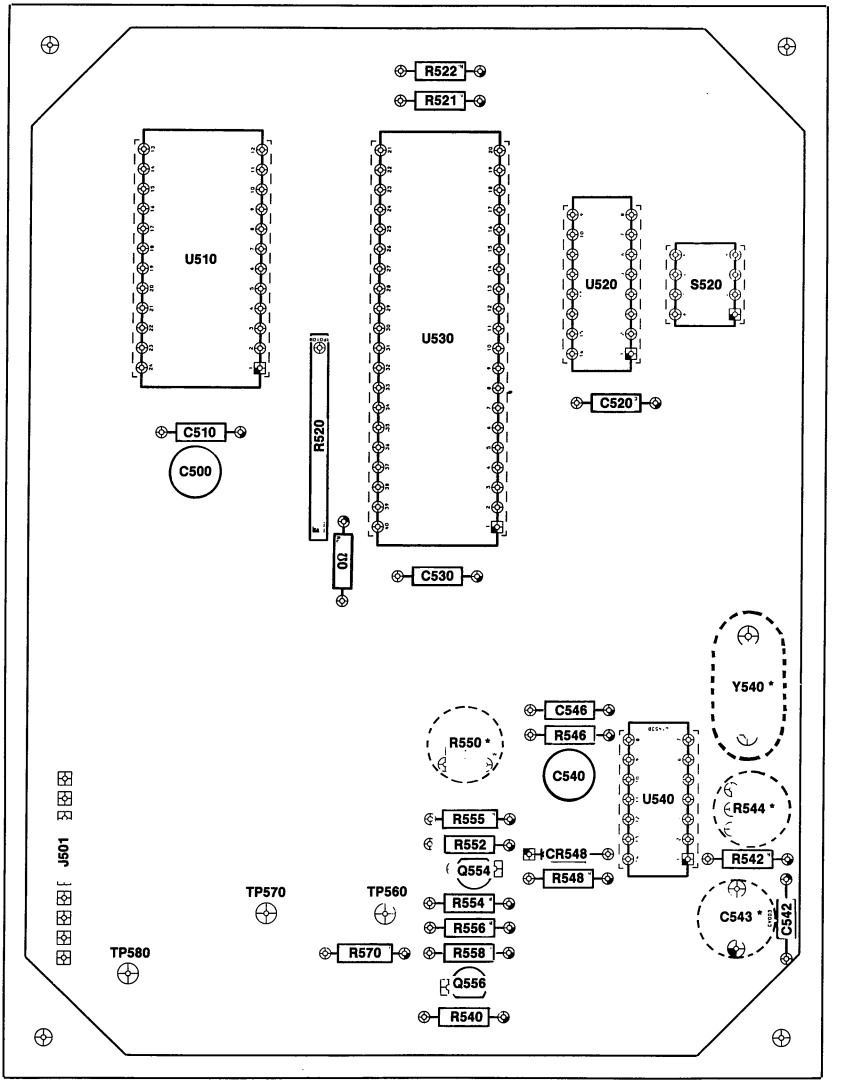
Figure 4-5.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
11236	CTS OF BERNE INC	406 PARR ROAD	BERNE IN 46711
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507
33095	SPECTRUM CONTROL INC	8061 AVONIA RD	FAIRVIEW PA 16415
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
75378	CTS KNIGHTS INC	400 REIMANN AVE	SANDWICH IL 60548
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
81073	GRAYHILL INC	561 HILLGROVE AVE P O BOX 373	LA GRANGE IL 60525

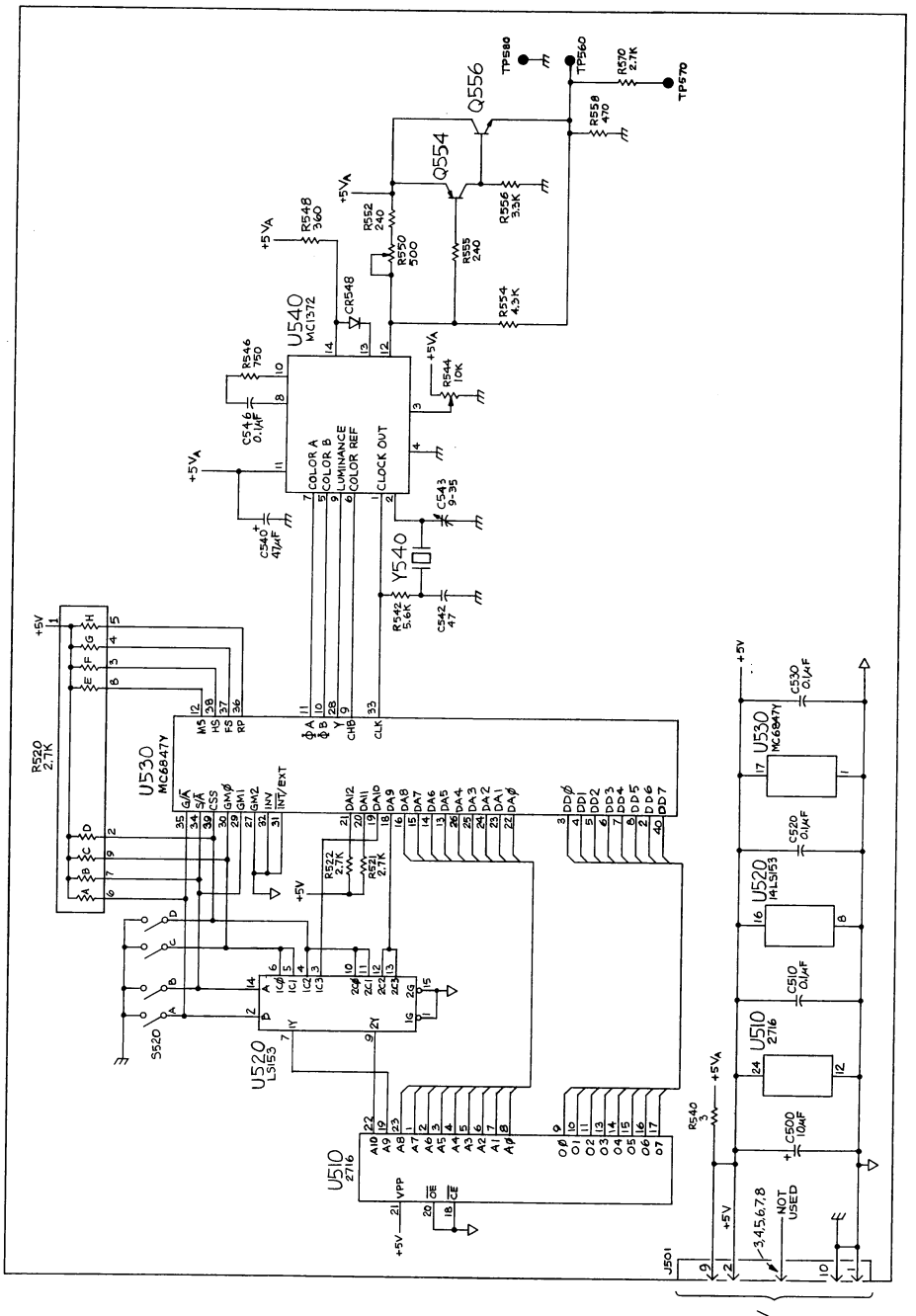
Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C500	290-0804-00			CAP,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
C510	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C520	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C530	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C540	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
C542	281-0763-00			CAP,FXD,CER DI:47PF,10%,100V	04222	MA101A470KAA
C543	281-0092-00			CAP,VAR,CER DI:9-35PF,200V	33095	53-717-001 D9-35
C546	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
CR548	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V	03508	DA2527 (1N4152)
G5	348-0849-00			GROMMET,FSTNR:0.187 ID,NYLON BLACK	80009	348-0849-00
J501	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 10)	22526	48283-036
P5	214-3732-00			PLUNGER,FSTNR:0.187 DIA,NYLON BLACK	80009	214-3732-00
Q554	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q556	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
R520	307-0650-00			RES NTWK,FXD,FI:9,2.7K OHM,5%,0.150W	11236	750-101-R2.7K
R521	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R522	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R540	307-0110-00			RES,FXD,CMPSN:3 OHM,5%,0.25W	80009	307-0110-00
R542	315-0562-00			RES,FXD,FILM:5.6K OHM,5%,0.25W	57668	NTR25J-E05K6
R544	311-1559-00			RES,VAR,NONWW:TRMR,10K OHM,0.5W	32997	3352T-1-103
R546	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R548	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J

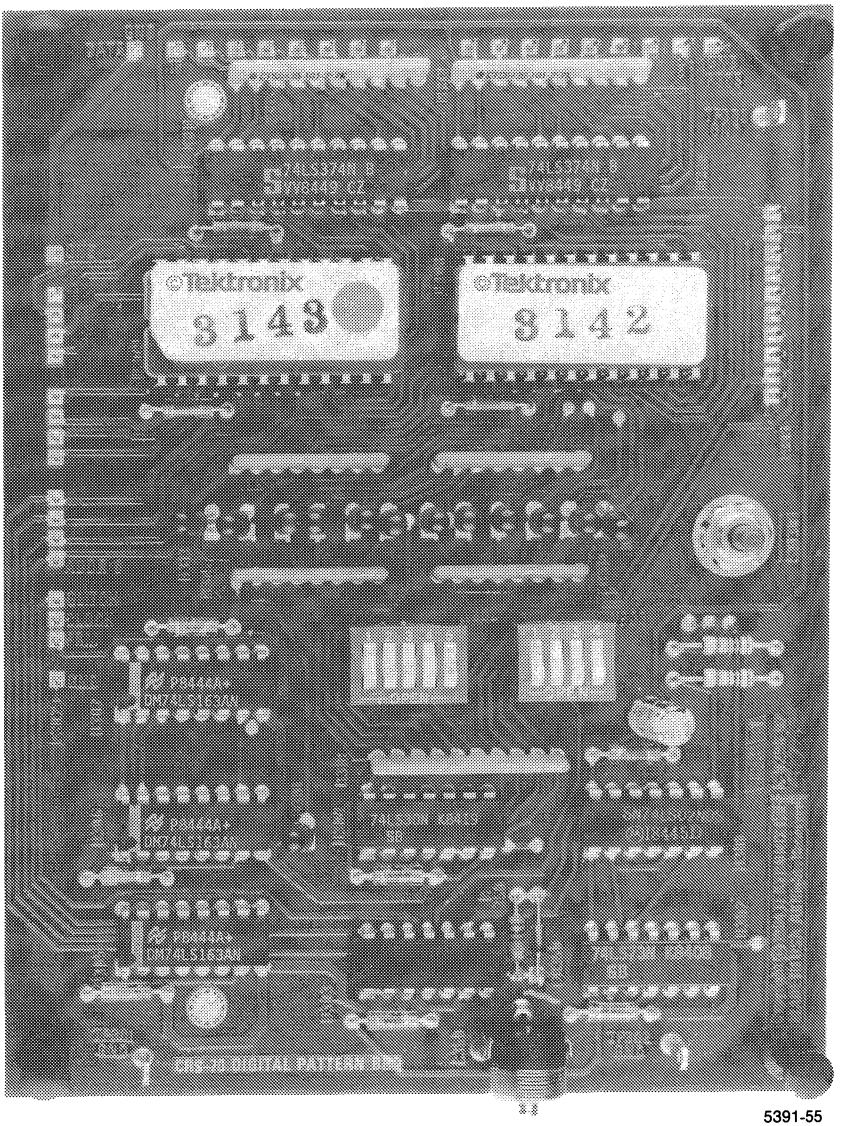
Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R550	311-1564-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3352T-CK5501
R552	315-0241-00			RES,FXD,FILM:240 OHM,5%,0.25W	19701	5043CX240R0J
R554	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R555	315-0241-00			RES,FXD,FILM:240 OHM,5%,0.25W	19701	5043CX240R0J
R556	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R558	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R570	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
S520	260-1965-00			SWITCH,ROCKER:(4)SPST,125MA,30VDC	81073	76SB04
TP560	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP570	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP580	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
U510	160-4427-00			MICROCKT,DGTL:NMOS,2048 X 8 EPROM,PRGM	80009	160-4427-00
U520	156-0798-02			MICROCKT,DGTL:DUAL 14/1-LINE SEL/MUX	01295	SN74LS153NP3
U530	156-2569-00			MICROCKT,DGTL:NMOS,VIDEO DISPLAY CONT	04713	MC6847YP
U540	156-2546-00			MICROCKT,LINEAR:COLOR TV VIDEO MODULAR	04713	MC1372P
W530	131-0566-00			BUS,COND:DUMMY RES,0.094 OD X 0.225L	24546	OMA 07
Y540	158-0069-00			XTAL UNIT,QTZ:3.579545 MHZ,+/-0.0035%	75378	TX-005



*Component located on back of board. 5391-54

CRS50 Video Signal Board.


VIDEO SIGNAL BOARD CRS50
U530 MC6847Y
U540 MC1372
U520 LS153
U510 2716
Q554
Q556
Y540
S520
U501
FROM POWER/ CLOCK BOARD
3,4,5,6,7,8 NOT USED
COLOR A
COLOR B
LUMINANCE
COLOR REF
CLOCK OUT
+5V
+5VA



5391-55

The CRS70 Digital Pattern Board.

CRS70 DIGITAL PATTERN BOARD

INTRODUCTION

The Digital Pattern Board generates digital signals to teach the use of the Word Recognizer, Delay By Events, and Boolean Trigger functions of the CTT/Word Recognizer, option 09, for the TEKTRONIX 2400 family of Oscilloscopes.

The circuitry on this board generates a repeating series of 16-bit-wide, digital-pattern, words. These patterns can be single-stepped or driven by the 1 MHz clock. The series length can be set in multiples of 256 words, to a maximum of 4096 words. both the starting and ending addresses can be set, in 256-word increments, from their respective ends of the series.

BASIC CIRCUIT DESCRIPTION

A 1 MHz clock input from the Power Unit Board drives three cascaded, four-bit, synchronous, binary counters U305, U306 and U307. The 12 output lines of the counters, located on the pins along the left edge, are used as address inputs to the two, 4096-by-8 bit EPROMs U308 and U309. The 16 data output lines of the EPROMs are latched by two eight-bit latches U310 and U311. The output of the latches are terminated into 2.7 KΩ pull-up resistors and are used as the data output test points. These test points are along the top edge of the board.

An additional circuit provides a variable glitch at a 1 kHz rate. Labeled Glitch, the pin on the left edge has been used to demonstrate the "Glitch Capture" feature of the TEKTRONIX 2430 Oscilloscope. The capacitor C350 varies the width of the glitch between approximately 4 ns to 23 ns.

The patterns generated on this board are contained in EPROMs, and are as follows:

1. A 1k 8-bit-wide, Gray Code (output of optical encoder with 256 position resolution).

2. A 1k, random, digital-logic-circuit output.

CONTROLS

The schematic diagram and the circuit board illustration at the back of this section may be helpful in locating the test points, controls, and switches.

The controls on the Digital Pattern Board are the five-bit (S302) and the four-bit (S303) Dip (dual in-line package) switches, and a momentary switch S301.

The first through fourth bit of SW302 controls the starting address of the 12-bit counter. The four-bit switch, SW303, controls the ending address of the counter. To avoid erratic behavior, do not set the ending address to occur before the starting address.

When Bit 5 of SW302 is open, the 1 MHz clock is disabled and the single step function becomes operable. This function is stepped by pressing the momentary switch, S301. The LEDs (DS302 through DS313) show the state of the counter and can be read directly while in the single-step mode. When Bit 5 is closed the clock overrides the single-step mode and causes the LEDs to change too quickly to be read.

ADDRESSES

In Hexadecimal and with the appropriate switch settings for the four 1k blocks, the start and stop addresses are given in Table 5-1.

Table 5-1
S302 and S303 Settings

Switch Positions[a]								Address	Description
S302				**S303**					
1	2	3	4	1	2	3	4		
0	0	0	0	0	0	1	1	000-3FF	Gray Code
0	1	0	0	0	1	1	1	400-7FF	Available
1	0	0	0	1	0	1	1	800-BFF	Random Logic
1	1	0	0	1	1	1	1	C00-FFF	Available

[a] 0 = Open, 1 = Closed

To determine the switch setting for a specific starting or ending point, the most significant digit of the HEX address needs to be converted to binary. The resultant four-bit string is the switch setting for the address in question. This can be easily seen in the addresses and settings for the first two blocks above.

Parallel to the left edge of the board is a row of pins P302. These are numbered (front to back) 1 through 17. It should be noted that counter addresses 0-11 start at Pin 5 and go to Pin 16. Along the top edge of the board is pin group P303. These are numbered 1 through 18, beginning on the right and counting to the left. The EPROM (Erasable Programmable Read Only Memories) outputs begin at Pin 2 for address 0 and end at Pin 17 for address 15. Pins 2 through 9 are the low bits of the two EPROMs and Pins 10 through 17 are the high bits.

EVENTS EXERCISE

Trigger on the Framing Pulse. Use the Clock as the event which delays the B trigger. It is now possible either to walk through the EPROM output one clock cycle at a time utilizing Delay By Events or to go to a specific clock cycle on the counter. The Gray code has an interesting output on the "LO" EPROM, the one on the right side of the board.

ADJUSTMENT PROCEDURE

There is no adjustment procedure for the CRS70 board.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

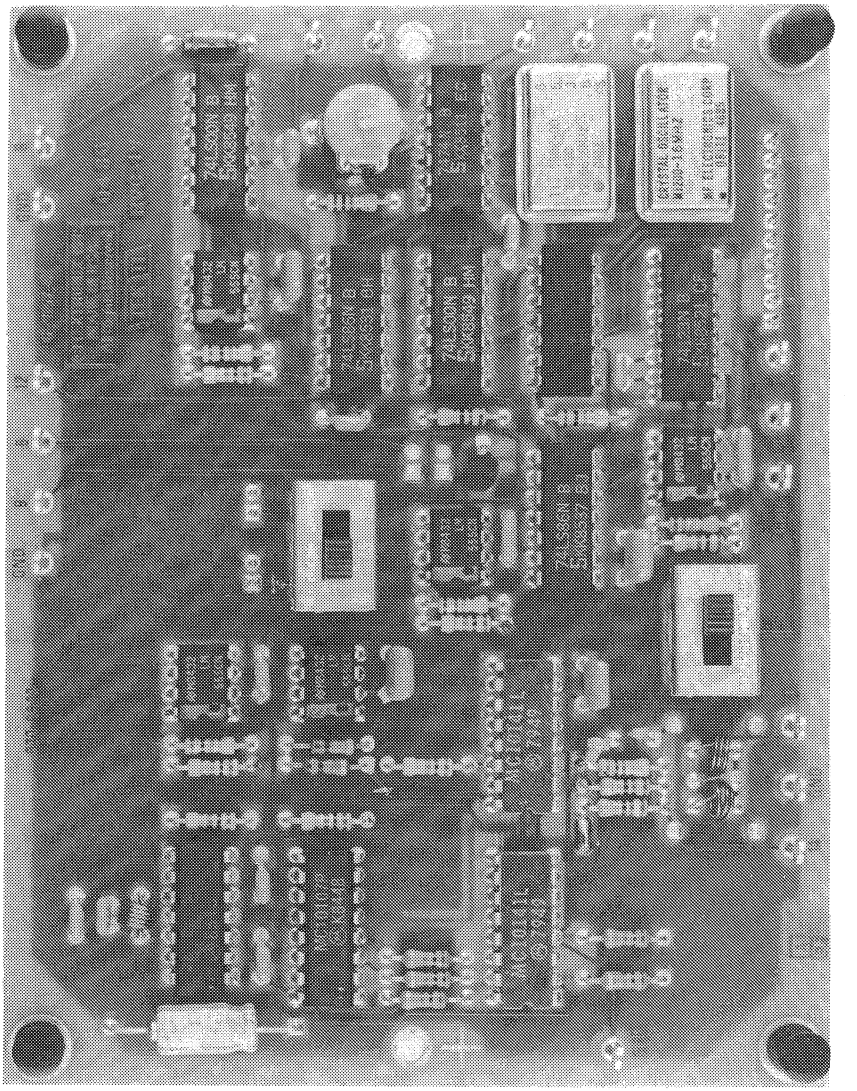
Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
01121	ALLEN-BRADLEY CO	1201 SOUTH 2ND ST	MILWAUKEE WI 53204
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
09353	C AND K COMPONENTS INC	15 RIVERDALE AVE	NEWTON MA 02158
11236	CTS OF BERNE INC	406 PARR ROAD	BERNE IN 46711
18324	SIGNETICS CORP	811 E ARQUES	SUNNYVALE CA 94086
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
52769	SPRAGUE-GOODMAN ELECTRONICS INC	134 FULTON AVE	GARDEN CITY PARK NY 11040
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
81073	GRAYHILL INC	561 HILLGROVE AVE P O BOX 373	LA GRANGE IL 60525

Replaceable Parts - CRS70

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C301	290-0804-00			CAP,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
C302	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C303	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C304	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C305	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C306	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C307	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C308	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C309	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C310	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C311	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C312	281-0775-01			CAP,FXD,PLASTIC:0.1UF,20%,50V	04222	MA205E104MAA
C350	281-0256-00			CAP,VAR,PLASTIC:10-180PF,100V	52769	GZD18100
CR350	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V	03508	DA2527 (1N4152)
DS301	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS302	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS303	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS304	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS305	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS306	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS307	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS308	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS309	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
DS310	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS311	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS312	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
DS313	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	01295	TIL 209A
G0	348-0849-00			GROMMET,FSTNR:0.187 ID,NYLON BLACK	80009	348-0849-00
P0	214-3732-00			PLUNGER,FSTNR:0.187 DIA,NYLON BLACK	80009	214-3732-00
P301	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 10)	22526	48283-036
P302	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 17)	22526	48283-036
P303	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 18)	22526	48283-036
R301	321-0222-00			RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0	19701	5033ED2K00F
R302	321-0222-00			RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0	19701	5033ED2K00F
R312	307-0650-00			RES NTWK,FXD,FI:9,2.7K OHM,5%,0.150W	11236	750-101-R2.7K
R313	307-0650-00			RES NTWK,FXD,FI:9,2.7K OHM,5%,0.150W	11236	750-101-R2.7K
R314	307-0541-00			RES NTWK,FXD,FI:(7)1K OHM,10%,1W	01121	108A102
R315	307-0541-00			RES NTWK,FXD,FI:(7)1K OHM,10%,1W	01121	108A102
R316	307-1096-00			RES NTWK,FXD,FI:7,2K OHM,2 %,1 W,TC-2	11236	750-81-R2K
R317	307-1096-00			RES NTWK,FXD,FI:7,2K OHM,2 %,1 W,TC-2	11236	750-81-R2K
R318	307-0650-00			RES NTWK,FXD,FI:9,2.7K OHM,5%,0.150W	11236	750-101-R2.7K
R350	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
S301	260-1285-00			SWITCH,PUSH:SPDT,1A,115AC,MOM	09353	P8121

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
S302	260-1827-00			SWITCH,ROCKER:5,SPST	81073	76SB05S
S303	260-1965-00			SWITCH,ROCKER:(4)SPST,125MA,30VDC	81073	76SB04
TP301	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
TP302	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
TP303	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
U301	156-0383-02			MICROCKT,DGTL:QUAD 2-INP NOR GATE	18324	N74LS02NB
U302	156-0387-02			MICROCKT,DGTL:DUAL J-K FF,SCRN	04713	SN74LS73NDS
U303	156-1707-00			MICROCKT,DGTL:QUAD 2-INPUT NAND GATE	04713	MC7400(NDORJD)
U304	156-0465-02			MICROCKT,DGTL:8-INP NAND GATE	01295	SN74LS30NP3
U305	156-0784-02			MICROCKT,DGTL:SYNCHRONOUS 4-BIT BINARY CNTR	01295	SN74LS163AN P3
U306	156-0784-02			MICROCKT,DGTL:SYNCHRONOUS 4-BIT BINARY CNTR	01295	SN74LS163AN P3
U307	156-0784-02			MICROCKT,DGTL:SYNCHRONOUS 4-BIT BINARY CNTR	01295	SN74LS163AN P3
U308	160-3142-00			MICROCKT,DGTL:4K X 8 PROM,PRGM	80009	160-3142-00
U309	160-3143-00			MICROCKT,DGTL:4K X 8 PROM,PRGM	80009	160-3143-00
U310	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF	01295	SN74LS374N3
U311	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF	01295	SN74LS374N3
W0	196-2931-00			LEAD,ELECTRICAL:26 AWG,1.25 L,1-N	80009	196-2931-00
W0	196-2932-00			LEAD,ELECTRICAL:26 AWG,1.25 L,2-N	80009	196-2932-00
W1	196-2933-00			LEAD,ELECTRICAL:26 AWG,1.25 L,3-N	80009	196-2933-00



5391-57

The CRS72 Digital Fault Board.

CRS72 DIGITAL FAULT BOARD

INTRODUCTION

The CRS72 Digital Fault Board provides signals with timing errors. The timing errors are best viewed with an oscilloscope with microchannel-plate (mcp) Cathode-Ray Tube (crt) such as the TEKTRONIX 2467 Oscilloscope. These errors replicate timing errors that can be found in real-life situations, but in a more repeatable form. The types of errors include noise-margin and timing-margin violations, clock corruption, and faulty state transitions.

The six separate circuits on this board are both ECL and TTL. To reduce power consumption, the +5 V supply is switched between either the ECL eye pattern or the TTL circuits. The exception to this is the clock circuit of U19, which is on whenever the board is plugged in and the power supply is turned on.

CONTROLS

There are only three adjustable controls on the board. These consist of two slide switches S1 and S2 and a variable capacitor (VC1).

The variable capacitor VC1, at the top of the board, adjusts the amount of jitter (metastability) in the signal found at TP 5. Capacitor VC1 has enough range, so that most oscilloscopes will be able to observe the metastability in the signal. Oscilloscopes with mcp crt will easily display metastable events that occur too infrequently for other oscilloscopes to show.

Switch S2, on the right edge of the board, supplies power to the ECL eye pattern when in the down position. The TTL circuits are turned on when S1 is in the up position.

Switch S1, in the middle of the board, selects either an automatic switch generated by U19 when in the down position or when in the up position a manually operated switch caused by a closure on J4. Switch S2 is used in conjunction with a cable connected between J3 and the mini-plug connector on the back panel of the TEKTRONIX 2467 Oscilloscope, labeled "STEP/AUTO EXT SWITCH", to drive the front panel recall feature of the TEKTRONIX 2467 Oscilloscope. When attaching this cable to J3 make sure that the arrow on the connector and the arrow on the circuit board coincide.

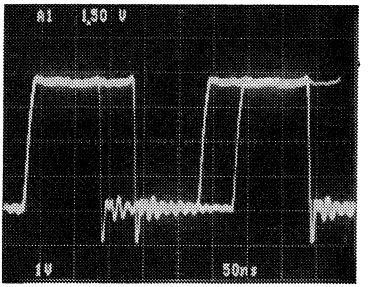
OUTPUT SIGNAL DESCRIPTIONS

The waveforms accompanying the text are from a TEKTRONIX 2465DVS Oscilloscope. Waveform of the faults as displayed by TEKTRONIX 2467 Oscilloscope, are included with the test points having errors.

The schematic diagram and the circuit board illustration at the back of this section may be helpful in locating the test points.

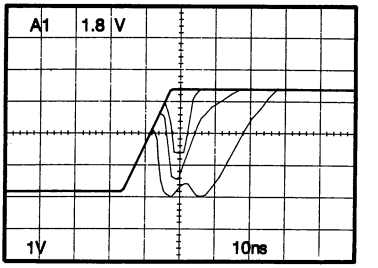
TP 1

The output of Flip-flop U1 provides a metastable signal to TP 1. Inputs to U1 come from two crystals. At 16.0 MHz, Y1 is the data input; at 19.66 MHz, Y2 is the clock input. These nonsynchronous signals create setup and hold time violations causing a faulty output on TP 1. Figure 6-1 shows the waveform that will be seen by most oscilloscopes. Figure 6-2 displays the fault conditions that can be seen under the corners of the signal using the TEKTRONIX 2467 Oscilloscope. This type of fault might be found where asynchronous signals interact, in synchronizing systems, or in VSLI chips responding to an external event. The rate of transients can be increased by changing X1 to a 25 MHz-to-30 MHz crystal.



5391-58

Figure 6-1.

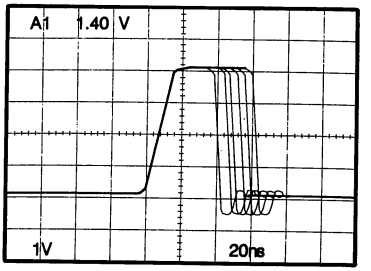


5391-59

Figure 6-2.

TP 2

The output of this circuit provides an erratic, low-rep-rate TTL pulse signal. The clock feeding the data latch has been corrupted by the pulse on TP 4, causing an occasional fault. The low repetition rate of this fault, a 50 ns-to-94 ns wide 3.86 V pulse, prevents it from being displayed by a conventional oscilloscope. A high-writing-rate oscilloscope with a microchannel-plate crt not only allows you to see the fault (see Figure 6-3), but displays it well enough to easily make measurements on it.

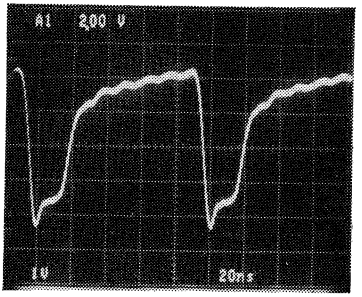


5391-60

Figure 6-3.

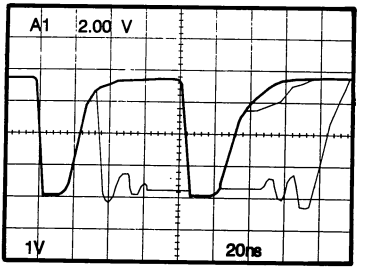
TP 3

This 9.8 MHz TTL clock pulse is degraded by the pulse on TP 4. Figure 6-4 shows the waveform that will be seen by most oscilloscopes. Figure 6-5 displays the fault conditions that can be seen using the TEKTRONIX 2467 Oscilloscope. This signal is used to clock U2B, giving it the faulty output at TP 2.



5391-61

Figure 6-4.

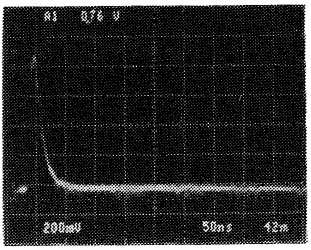


5391-62

Figure 6-5.

TP 4

This low-rep-rate, negative-going 4.5 V, 275 ns pulse is used to degrade the clock signal as it passes through the exclusive-OR gate of U9D. The low rep rate makes this signal extremely difficult to display on the medium writing rate oscilloscope. It was necessary to do multiple exposures to obtain a usable image on film of the waveform using a medium writing-rate oscilloscope (See Figure 6-6).

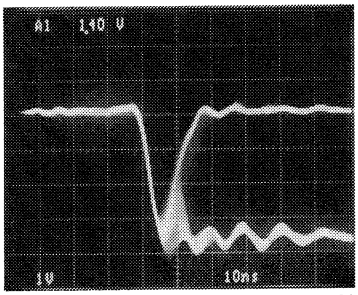


5391-63

Figure 6-6.

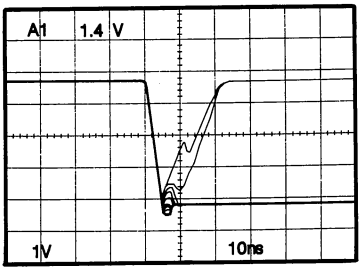
TP 5

By adjusting the variable capacitor VC1, it is possible to create a setup time violation. As the setup time is shortened, the output of the flip-flop may make partial or double transitions. In the extreme metastable condition, conventional oscilloscopes can display the error as seen in Figure 6-7. When VC1 capacitor is adjusted for no metastable display on the conventional oscilloscope, the TEKTRONIX 2467 Oscilloscope will still show a great deal of metastability as shown in Figure 6-8.



5391-64

Figure 6-7.

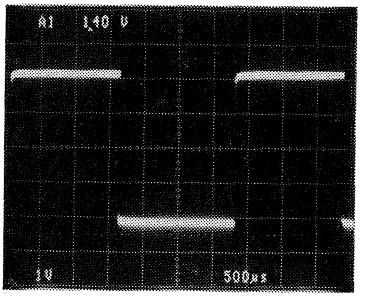


5391-65

Figure 6-8.

TP 7

The square wave signal at this test point has no faults, as shown in Figure 6-9. The energy for the square wave is dissipated through inductor L1 along with the signal at TP 8.

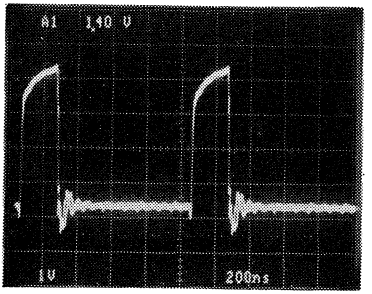


5391-66

Figure 6-9.

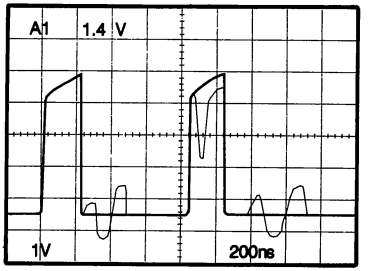
TP 8

The 4 V, 200 ns pulse is generated from the 1 MHz signal on the CRS10 Power Unit board. There is cross talk on this signal due to sharing a common ground inductor with TP 7 signal source. Figure 6-10 shows the waveform that will be seen by most oscilloscopes. Figure 6-11 displays the distortion that can be seen on the waveform using the TEKTRONIX 2467 Oscilloscope.



5391-67

Figure 6-10.

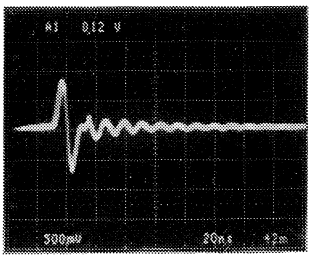


5391-68

Figure 6-11.

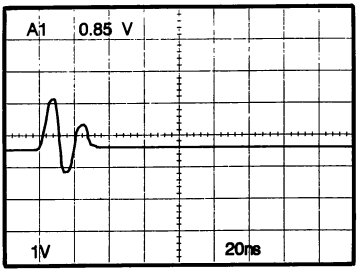
TP 9

This test point has a double pulse signal on it. Unless the oscilloscope is properly triggered, only one of these pulses may be displayed. One pulse is generated when the input rises, and the other is generated when the input falls. The low repetition rate of this signal makes it good for writing-rate demonstrations. It is also good for the pulse display feature of the AUTO SETUP button. Figure 6-12 shows the waveform that will be seen by most oscilloscopes. Figure 6-13 displays the the double pulse signal using the TEKTRONIX 2467 Oscilloscope.



5391-69

Figure 6-12.

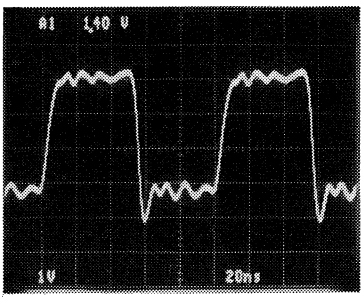


5391-70

Figure 6-13.

TP 10

The signal at this test point is a 9.8 MHz square wave clock signal before it is degraded by the pulse at TP 4 (see Figure 6-14). There are no faults on this signal.

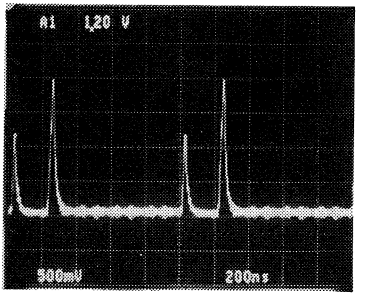


5391-71

Figure 6-14.

TP 11

The double spike signal found at this test point as shown in Figure 6-15 is used as the clock for the metastable output on TP 5. It is directly affected in amplitude and pulse width by adjustment of variable capacitor VC1. The spikes are coincident with the state changes of the signal found on TP 12.

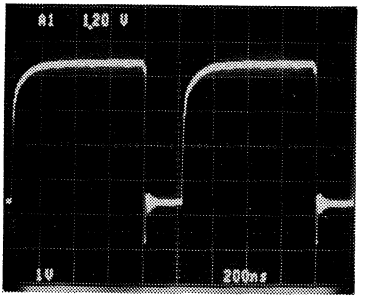


5391-72

Figure 6-15.

TP 12

The 1 MHz square wave signal at this test point is generated on the CRS10 Power Unit Board (see Figure 6-16).

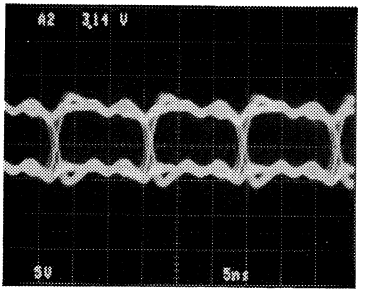


5391-73

Figure 6-16.

TP 15

The one-bit, two-level signal pattern as shown in Figure 6-17 is representative of a computer bus eye pattern. A 50-ohm probe is recommended to minimize loading effect on the circuit. The test point TP CLK should be used as the trigger source while displaying the eye pattern.

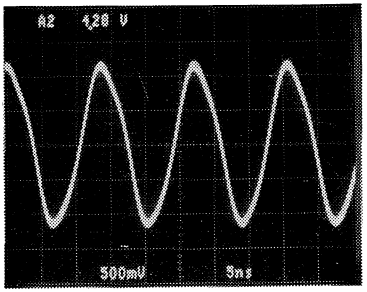


5391-74

Figure 6-17.

TP CLK

The high speed ECL sine wave at this test point (see Figure 6-18) is used as the triggering event for the eye pattern found at TP 15. There are no faults on this signal.



5391-75

Figure 6-18.

ADJUSTMENT PROCEDURE

There is no adjustment procedure for the CRS70 board.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
05397	UNION CARBIDE CORP MATERIALS SYSTEMS DIV	11901 MADISON AVE	CLEVELAND OH 44101
07263	FAIRCHILD CAMERA AND INSTRUMENT CORP SEMICONDUCTOR DIV	464 ELLIS ST	MOUNTAIN VIEW CA 94042
18324	SIGNETICS CORP	811 E ARQUES	SUNNYVALE CA 94086
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
27014	NATIONAL SEMICONDUCTOR CORP	2900 SEMICONDUCTOR DR	SANTA CLARA CA 95051
31433	UNION CARBIDE CORP ELECTRONICS DIV	PO BOX 5928	GREENVILLE SC 29606
52769	SPRAGUE-GOODMAN ELECTRONICS INC	134 FULTON AVE	GARDEN CITY PARK NY 11040
54473	MATSUSHITA ELECTRIC CORP OF AMERICA	ONE PANASONIC WAY	SECAUCUS NJ 07094
54583	TDK ELECTRONICS CORP	755 EASTGATE BLVD	GARDEN CITY NY 11530
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
59660	TUSONIX INC	2155 N FORBES BLVD	TUCSON, ARIZONA 85705
75378	CTS KNIGHTS INC	400 REIMANN AVE	SANDWICH IL 60548

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
82389	SWITCHCRAFT INC SUB OF RAYTHEON CO	5555 N ELSTRON AVE	CHICAGO IL 60630
TK2042	ZMAN & ASSOCIATES	7633 SO. 180TH	KENT, WA 98032

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C1	283-0331-00			CAP,FXD,CER DI:43PF,2%,100V	59660	0805536C0G0430G
C2	283-0339-00			CAP,FXD,CER DI:0.22UF,10%,50V	05397	C330C224K5R5CA
C3	283-0024-00			CAP,FXD,CER DI:0.1UF,+80-20%,50V	04222	SR215C104MAA
C4	283-0024-00			CAP,FXD,CER DI:0.1UF,+80-20%,50V	04222	SR215C104MAA
C5	283-0331-00			CAP,FXD,CER DI:43PF,2%,100V	59660	0805536C0G0430G
C6	283-0059-00			CAP,FXD,CER DI:1UF,+80-20%,50V	31433	C330C105M5R5CA
C7	283-0203-00			CAP,FXD,CER DI:0.47UF,20%,50V	04222	SR305SC474MAA
C8	283-0339-00			CAP,FXD,CER DI:0.22UF,10%,50V	05397	C330C224K5R5CA
C9	283-0024-00			CAP,FXD,CER DI:0.1UF,+80-20%,50V	04222	SR215C104MAA
C10	283-0059-00			CAP,FXD,CER DI:1UF,+80-20%,50V	31433	C330C105M5R5CA
C11	283-0024-00			CAP,FXD,CER DI:0.1UF,+80-20%,50V	04222	SR215C104MAA
C12	283-0024-00			CAP,FXD,CER DI:0.1UF,+80-20%,50V	04222	SR215C104MAA
C13	290-0748-00			CAP,FXD,ELCTLT:10UF,+50-10%,25V	54473	ECE-B1EV100S
C14	283-0024-00			CAP,FXD,CER DI:0.1UF,+80-20%,50V	04222	SR215C104MAA
C15	283-0331-00			CAP,FXD,CER DI:43PF,2%,100V	59660	0805536C0G0430G
C16	283-0059-00			CAP,FXD,CER DI:1UF,+80-20%,50V	31433	C330C105M5R5CA
C17	283-0159-00			CAP,FXD,CER DI:18PF,5%,50V	04222	SR155A180JAA
C18	283-0159-00			CAP,FXD,CER DI:18PF,5%,50V	04222	SR155A180JAA
G1	348-0849-00			GROMMET,FSTNR:0.187 ID,NYLON BLACK	80009	348-0849-00
GD1	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
GD2	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
GD3	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0
GD4	131-1261-00			CONTACT,ELEC:CONN,F-SHAPE,BRASS TIN PL	00779	1-380953-0

Replaceable Parts - CRS72

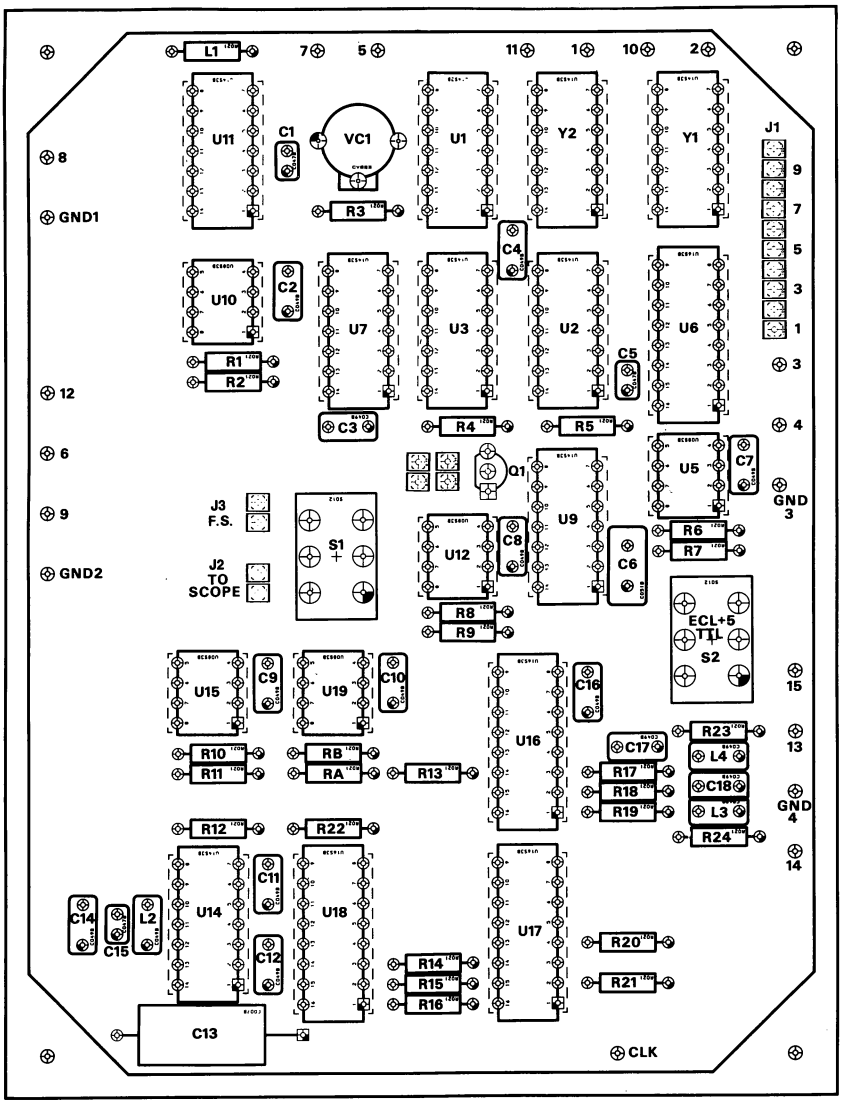
Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
J1	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 10)	22526	48283-036
J2	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 2)	22526	48283-036
J3	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 2)	22526	48283-036
L1	108-1251-00			COIL,RF:FXD,2.7UH,10%	54583	SPT 0406-2R7K-6
L2	108-0620-00			COIL,RF:FIXED,90NH	TK2042	ORDER BY DESCR
L3	108-0421-00			COIL,RF:FIXED,60NH	TK2042	ORDER BY DESCR
L4	108-0421-00			COIL,RF:FIXED,60NH	TK2042	ORDER BY DESCR
P1	214-3732-00			PLUNGER,FSTNR:0.187 DIA,NYLON BLACK	80009	214-3732-00
Q1	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
R1	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R2	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R3	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R4	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R5	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R6	315-0164-00			RES,FXD,FILM:160K OHM,5%,0.25W	57668	NTR25J-E160K
R7	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R8	315-0513-00			RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R9	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R10	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R11	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R12	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R13	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R14	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R15	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R16	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R17	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R18	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R19	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R20	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R21	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R22	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
RA0	315-0105-00			RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
RB0	315-0105-00			RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
S1	260-1811-00			SWITCH,SLIDE:DPDT,0.5A,125VAC-DC	82389	11P-1137
S2	260-1811-00			SWITCH,SLIDE:DPDT,0.5A,125VAC-DC	82389	11P-1137
TP1	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP2	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP3	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP4	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP5	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP6	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP7	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP8	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00

Replaceable Parts - CRS72

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
TP9	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP10	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP11	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP12	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP13	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP14	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP15	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP16	214-0579-00			TERM,TEST POINT:BRS CD PL (TPCLK)	80009	214-0579-00
U1	156-0041-05			MICROCKT,DGTL:DUAL D FLIP FLOP SCRN	01295	SN7474NP3
U2	156-0388-03			MICROCKT,DGTL:DUAL D FLIP-FLOP	01295	SN74LS74ANP3
U3	156-0382-02			MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
U5	156-0402-00			MICROCKT,LINEAR:TIMER	27014	LM555CN
U6	156-0172-02			MICROCKT,DGTL:DUAL RETRIG MONOSTABLE MV	07263	74123PCQR
U7	156-0381-02			MICROCKT,DGTL:QUAD 2-INP EXCL OR GATE	07263	74LS86PCQR
U9	156-0381-02			MICROCKT,DGTL:QUAD 2-INP EXCL OR GATE	07263	74LS86PCQR
U10	156-0402-00			MICROCKT,LINEAR:TIMER	27014	LM555CN
U11	156-0382-02			MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
U12	156-0402-00			MICROCKT,LINEAR:TIMER	27014	LM555CN
U14	156-0266-01			MICROCKT,DGTL:EMITTER COUPLED OSCILLATOR	04713	MC1648PD/LD
U15	156-0402-00			MICROCKT,LINEAR:TIMER	27014	LM555CN
U16	156-0638-01			MICROCKT,DGTL:FOUR-BIT UNIV SHIFT RGTR	04713	MC10141(PDORLD)
U17	156-0638-01			MICROCKT,DGTL:FOUR-BIT UNIV SHIFT RGTR	04713	MC10141(PDORLD)

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
U18	156-0295-00			MICROCKT,DGTL:TRIPLE 2-INP EXCL OR EXCL NOR	04713	MC10107
U19	156-0402-00			MICROCKT,LINEAR:TIMER	27014	LM555CN
VC1	281-0253-00			CAP,VAR,PLASTIC:10-180PF,100V	52769	GZC 18100
W5	174-0360-00			CABLE ASSY,RF:50 OHM COAX,48.0 L	80009	174-0360-00
Y1	119-1408-00			OSC,XTAL CLOCK:16MHZ,0.01%	08111	M1200-16MHZ
Y2	119-1502-00			OSCILLATOR,RF:19.6608MHZ,14 DIP PKG	75378	MX050



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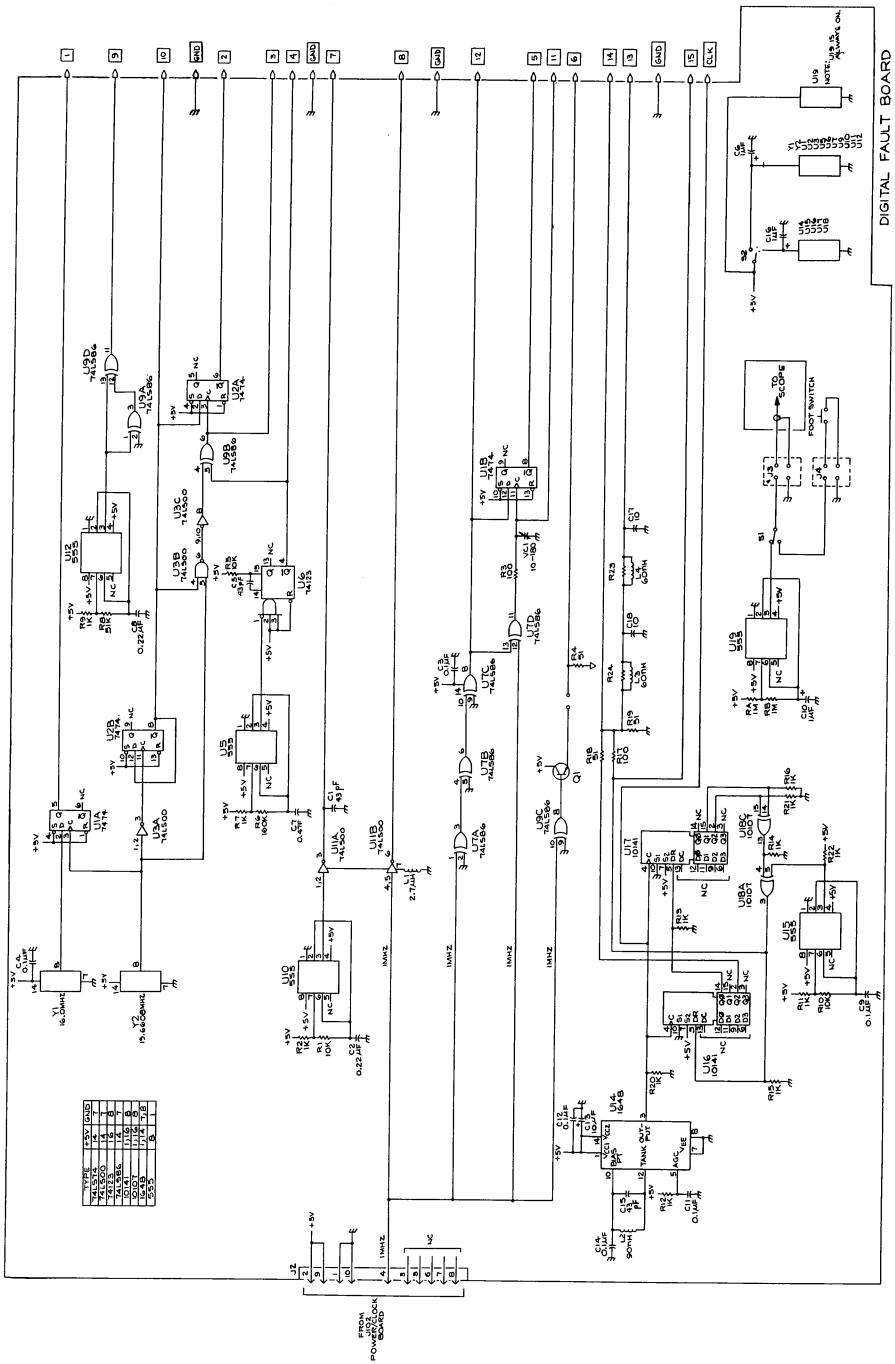
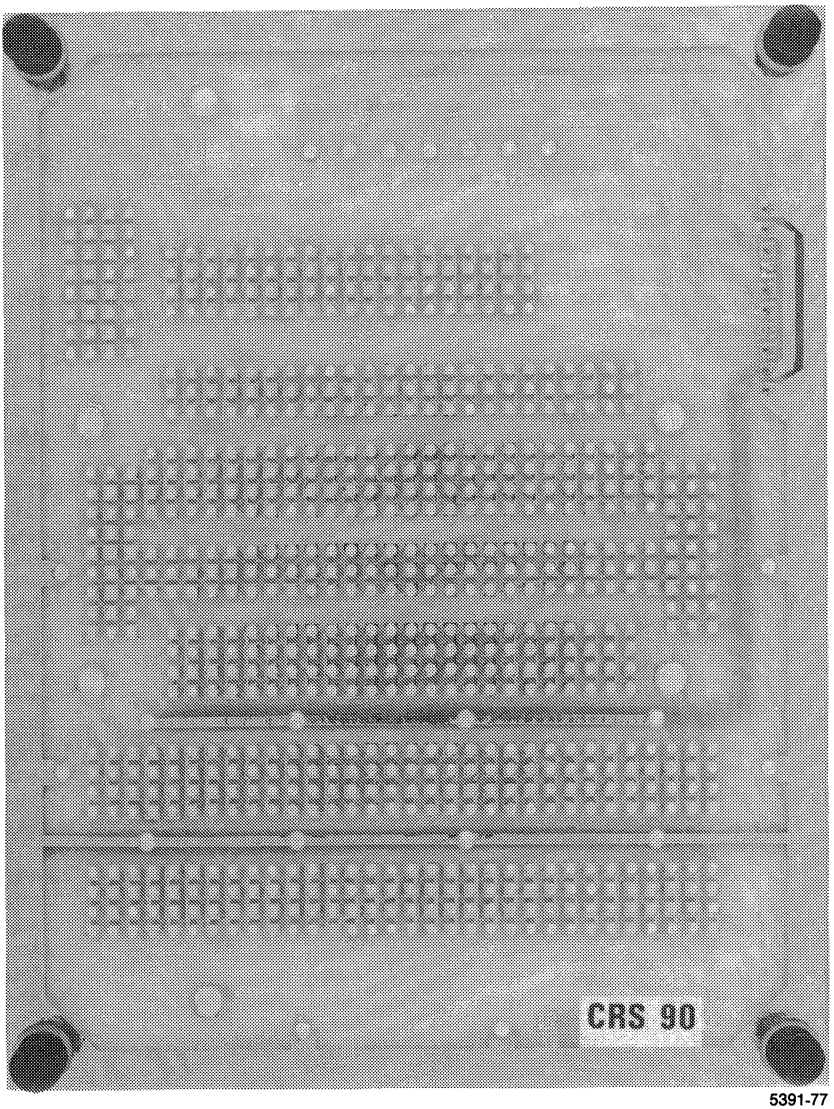
CRS72 Digital Fault board.


DIGITAL FAULT BOARD
FOOT SWITCH
FROM POWER/CLOCK BOARD

CRS90 Builders Board—Training Labs



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The CRS90 Builders Board.

CRS90 BUILDERS BOARD

GENERAL INFORMATION

The Builders Board is for the user to custom design and build his own circuits.

Along the upper edge of the board are seven solder pads that can be used for input signals. These signals, plus ground, from the CRS10 Power Unit Board are found on pins of J102 as follows:

Table 7-1
Signals on J102

J102 Pins No.	Signals
1	Ground
2	+5 V
3	+12 V
4	1 MHz
5	5 MHz
6	10 MHz
7	Triangle
8	−12 V
9	+5 V
10	Ground

The +5 V supply is also available on a bus near the lower third of the board. The ground plane runs around the perimeter of the board and forms a bus across the lower third of the board. For more information on the signals and current that are available for the CRS90 Builders board see "CRS10 Power Unit Board" section in this manual.

INSTALLING COMPONENTS

The holes on the board are through hole plated and spaced for DIP packages. Columns of four in the hole patterns are bussed together. One of the columns of three is bussed together, the other is not.

Near the top and bottom edges of the board are larger holes suitable for mounting potentiometers. Along the left and right edges are four of the larger holes that can be used for either potentiometers or for mounting a vector board onto the Builders Board.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
G3	348-0849-00			GROMMET,FSTNR:0.187 ID,NYLON BLACK	80009	348-0849-00
P3	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
P4	214-3732-00			PLUNGER,FSTNR:0.187 DIA,NYLON BLACK	80009	214-3732-00

Section 8 - Accessories

Standard Accessories

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
	070-5391-00			1	MANUAL,TECH:POWER UNIT	80009	070-5391-00
	119-1912-00			1	XFMR,PWR,STPDN:120V IN,24V OUT,WALL PLUG-IN	80009	119-1912-00
	202-0206-00			1	CASE,CRYG,P:12.25 X 8.0 X 3.875,PLSTC,BL	53718	RQ3-7/8
					CARRYING CASE INCLUDES:		
	129-0498-00			2	.SPACER,POST:2.5 L,4-40,AL 0.188 HEX	80009	129-0498-00
	211-0177-00			2	.SCREW,MACHINE:4-40 X 0.312,PNH,STL	TK0435	ORDER BY DESCR
	214-3737-00			1	.POUCH,PLASTIC:6.0 X 9.0 TRAINING LAB	80009	214-3737-00
	334-6037-00			1	.MARKER,IDENT:MKD TRAINING LAB	80009	334-6037-00
	377-0410-00			1	.INSERT,CRYG CS:ABS,BLACK,TRAINING LAB	80009	377-0410-00

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
53718	GRACE W R AND CO AIRMOLD DIV	BECKER FARMS INDUSTRIAL PK P O BOX 610	ROANOKE RAPIDS NC 27870
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
TK0435	LEWIS SCREW CO	4114 S PEORIA	CHICAGO IL 60609

Optional Accessories

There are currently no optional accessories available at the time of publication of this manual.