



SOLID-STATE

COAXIAL SWITCH

MODEL TC-2



Fig. 1—Model TC-2-5B

JERROLD ELECTRONICS CORPORATION

Philadelphia, Pa. 19105

COAXIAL SWITCH

Model TC-2

INSTRUCTION MANUAL 435-597.2

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DESCRIPTION

Model TC-2 is a high-speed, electronically controlled switching unit designed for the simultaneous display of two waveforms on an oscilloscope. In addition, the circuitry permits manual switching for displaying either of two waveforms individually.

In appropriate test setups, together with such instruments as a sweep generator, variable attenuators, and other accessories, Model TC-2 will permit fast, repetitive laboratory or production line "measurements by comparison." R-F transmission parameters such as gain, loss, frequency response, and reflection coefficient (return loss, VSWR) of a test circuit can be compared against a preset reference.

Model TC-2 consists of two basic units: one housing the solid-state driver circuitry and controls, the other housing the two coaxial switch heads. Each switch head has two

mercury-wetted reed relays mounted to form a single-pole, double-throw coaxial switch. In standard models the two basic units are mounted one on top of the other to form an instrument which is portable and convenient for bench-use. For 19" relay rack mounting, special brackets (Model TC-2-RK) can be ordered for installing the two units side by side, requiring only 3½" vertical rack space.

The instrument is available with either 50 or 75-ohm switch heads. The 50-ohm version (Model TC-2-5B) uses BNC fittings and is matched up to 1200 MHz; the 75-ohm version (Model TC-2-7F) uses F fittings and is matched up to 900 MHz.

The power input circuit of the TC-2 is designed to permit operation from 115 or 230 V, 50 or 60 Hz power sources.

SPECIFICATIONS

	MODEL TC-2-5B	MODEL TC-2-7F
FREQUENCY RANGE	dc to 1200 MHz	dc to 900 MHz
ISOLATION, each switch	30 dB min.	
INSERTION LOSS, each switch	0.1 dB max.	
IMPEDANCE, all terminals	50 Ω	75 Ω
MATCH, all terminals	20 dB min. return loss (VSWR 1.21:1 max.)	
EXTERNAL DRIVE INPUT	Sweep blanking pulse with an amplitude of at least +0.5 V	
SWITCHING TIME (energize and transfer time)	1.0 msec. avg.	
MAX. DC CONTACT RATING	10 W, 0.5 A, 100 V, resistive load	
POWER REQUIREMENTS	105-130 V or 210-260 V, 50/60 Hz, 4.5 W	

OPERATION

GENERAL

This section explains the function of the controls and how to connect the instrument in a typical equipment setup.

After unpacking the instrument, first inspect it for any damage that may have been caused in transit. See that the fuse is in place and that the switch head cables are properly mated to J1 and J2 on the rear apron.

The sweep generator used with the TC-2 must provide symmetrical sweep. The return trace must be unblanked for 1:1 switching with external drive; the return trace may be blanked for operation with internal drive and for 1:2 switching with external drive.

Each switch head can be removed from the housing by first squeezing together its spring-loaded protrusions at the top and bottom and then extracting the head. This feature permits placing the heads close to the device under test in applications where jumper cable lengths may be critical;

e.g., when measurements in the gigacycle range are to be made. The cable lengths provided permit placing the heads as far as three feet from the housing. Where greater distance is required, any length of cable may be added.

In order for the reed relays to operate properly, the switch heads must always be positioned so that the COMMON terminal is uppermost.

CONNECTING THE UNIT

Connections to the two switch heads are made through the three fittings marked 1, 2, and COMMON on the front face of each head. When connecting the TC-2 into a test setup, select one head to serve as the input head, the other to serve as the output head. As the two heads are identical and interchangeable, either head may be selected to serve as the input or output unit.

Fig. 2 shows a typical setup for measuring the response of a resonant circuit. For this setup connect the output of the sweep generator to the COMMON fitting on the input

head; connect the COMMON fitting on the output head to the input terminal on the r-f detector. Connect the output of the detector to the vertical input of the oscilloscope.

The reference device and the circuit under test may now be connected. Connect the input of the reference device to fitting 1 on the input head; connect the output of the reference device to fitting 1 of the output head. Connect the input of the circuit under test to fitting 2 on the input head, the output of the circuit under test to fitting 2 on

the output head. The unit may now be operated.

Measurements with an error of less than 0.1 dB are possible using the switcher provided that the reference attenuation has a high degree of accuracy and that jumpers in the reference leg are carefully matched to the jumpers in the test leg. This matching requires that the jumpers be taken from the same reel of cable and that the total length of the jumpers in the reference leg is equal to the total length in the test leg.

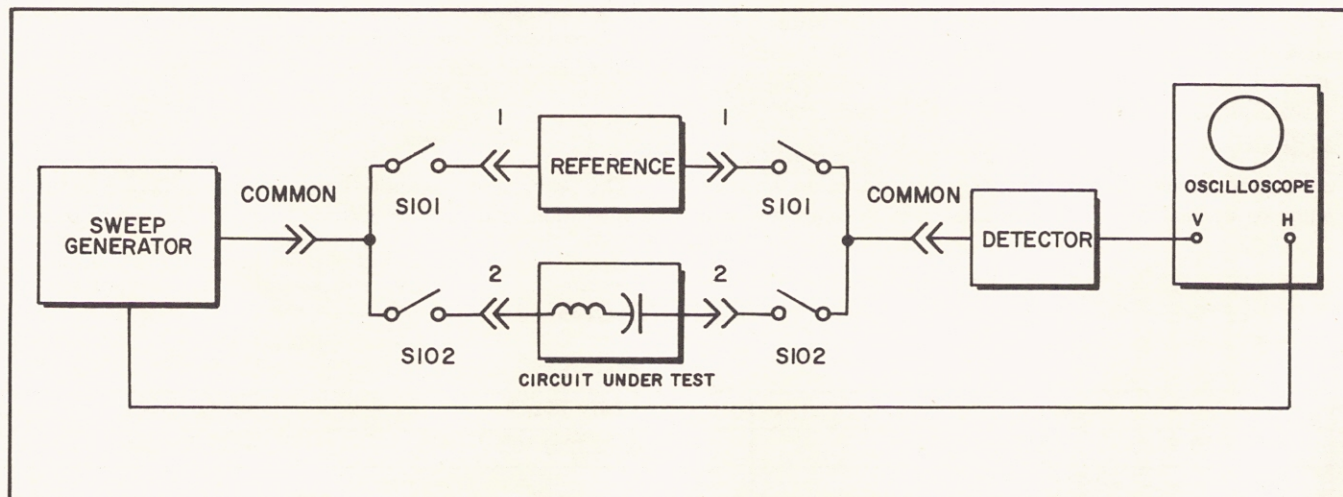


Fig. 2—Typical Test Setup

CHART OF CONTROLS

Name	Type and Schematic Ref.	Position	Function
FRONT PANEL			
PHASE	Potentiometer, R2	cw-ccw	Phasing adjustment of oscilloscope display (effective only when operating with internal sync).
FUNCTION	Wafer switch, S3	INT DRIVE 1	Selects for display the response of device connected between the "1" terminals of switch heads.
		2	Selects for display the response of device connected between the "2" terminals of switch heads.
		1-2	Selects automatic switching with internal drive for the simultaneous display of the response of two devices.
		EXT DRIVE 1-2	
		1:2	Selects automatic switching with external drive. Switching rate is half the driving pulse rate. Sweep may be blanked.
		1:1 FWD*	Selects automatic switching with external drive. Switching rate is the same as the driving pulse rate. Sweep may not be blanked.
		1:1 REV*	Same as above, except that directions of the oscilloscope traces are reversed.
POWER	SPST toggle switch, S1	Up Down	Energizes unit. De-energizes unit.
Pilot Light	Neon lamp, DS1	On Off	Indicates that unit is energized. Indicates that unit is de-energized.
1 COMMON 2	BNC or F-61A fittings, J101 J102 J103	—	Switch head fittings. There is one set of these fittings for each head.

*The designations FWD and REV are for reference only. The switch positions for forward and reverse sweep will have to be determined for each unit.

Name	Type and Schematic Ref.	Position	Function
REAR PANEL			
F1 1 AMP	1 A fuse, F1	—	Fuses power supply (change to 0.5 A fuse for 230 Vac operation).
Power Selector	DPDT slide switch, S2	115	Permits operation from a 115 Vac power line.
		230	Permits operation from a 230 Vac power line.
J2 and J3	7-pin sockets J2 and J3	—	Provide for interconnecting switch heads and control unit.
EXTERNAL TRIGGER J1	BNC fitting, J1	—	Provides for driving the unit with the blanking pulse from the sweep generator.

CIRCUIT DESCRIPTION

GENERAL

Model TC-2 comprises a built-in power supply, pulse generating and amplifying circuits, and four mercury-wetted reed relays. The relays form two single-pole, double-throw switches, one switch in each head. The circuit stages and signal flow are shown in Fig. 3. Dwg. 861-998 is the schematic diagram.

The switching frequency of the TC-2, when it is operated with internal drive, depends upon the power line frequency. Wherever this dependence is relevant, the condition that exists when the TC-2 is powered from a 60 Hz source will be given first, and the condition that exists when the TC-2 is operated from a 50 Hz source will immediately follow in parenthesis; e.g. 60 Hz (50 Hz).

POWER SUPPLY AND PHASE SHIFTER

The -7.5 V power supply is a full-wave rectifier circuit employing line transformer T1, rectifiers CR1, CR2, and filter capacitor C2. The secondary of T1 produces 13.5 Vac; it is tapped at the center and fused by F1 to ground.

When the power selector switch is set to 230 to operate the unit from a 230 V line, the factory-supplied 1 A fuse should be replaced with a 0.5 A fuse. Since the pilot light DS1 is across the primary of T1 and fusing is accomplished in the secondary circuit, the pilot light will go on even if F1 is blown.

The phase shifter circuit comprises C1, L1, and PHASE control R2 connected across the secondary of T1.

SCHMITT TRIGGER AND FLIP-FLOP

Depending on the position of FUNCTION switch S3, either the 60 Hz (50 Hz) signal from the phase shifter or an externally generated signal is applied to the input of Schmitt trigger Q5/Q6. This circuit provides an output of constant peak value for the period that the input waveform exceeds a specific voltage. The clipped output of this circuit is a square wave which has the same frequency as the driving source. The external drive signal must be a square wave pulse whose amplitude is greater than +0.5 volt. The pulse train at the output of the Schmitt trigger

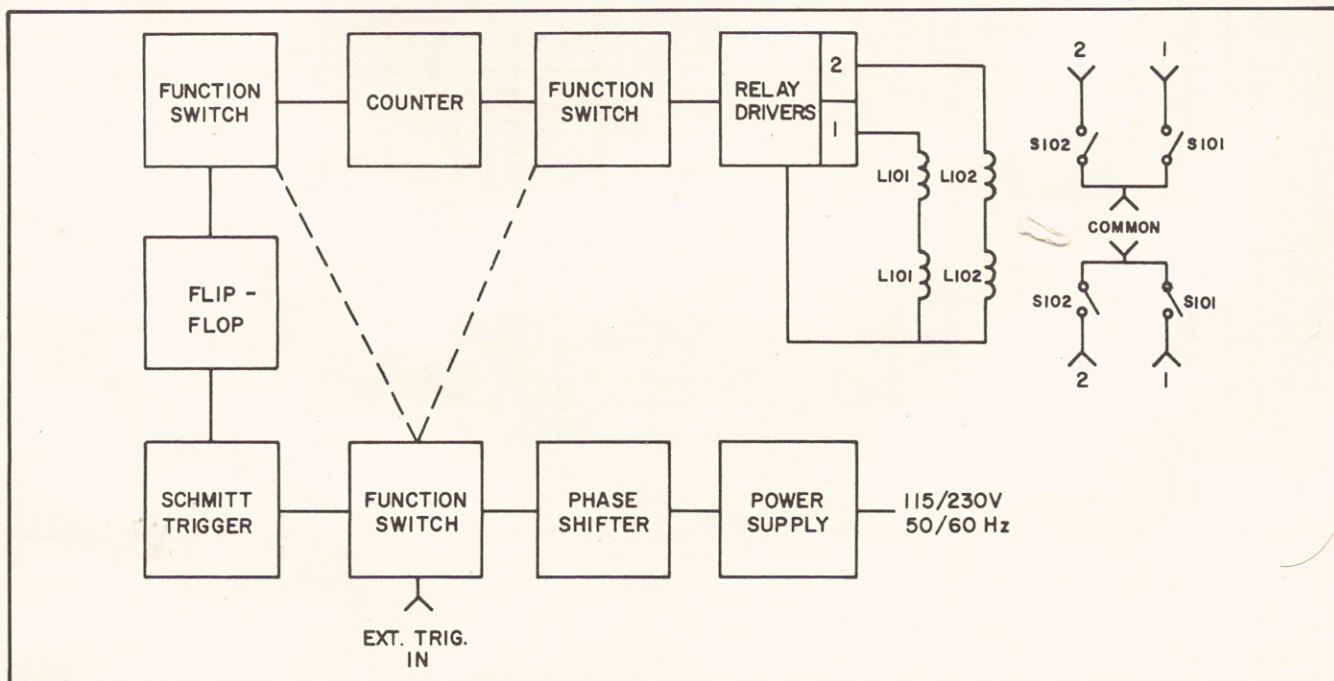
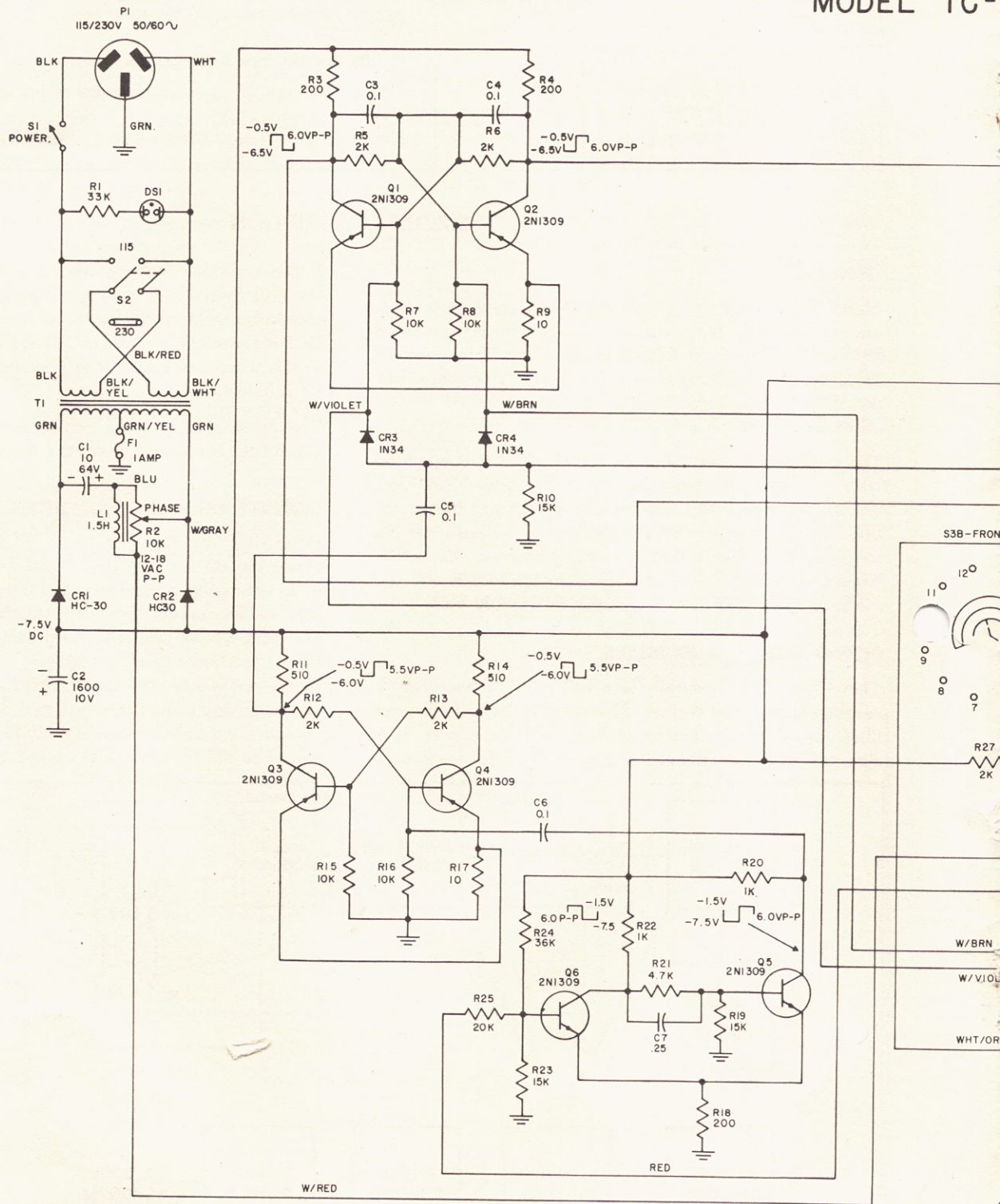


Fig. 3—Functional Block Diagram

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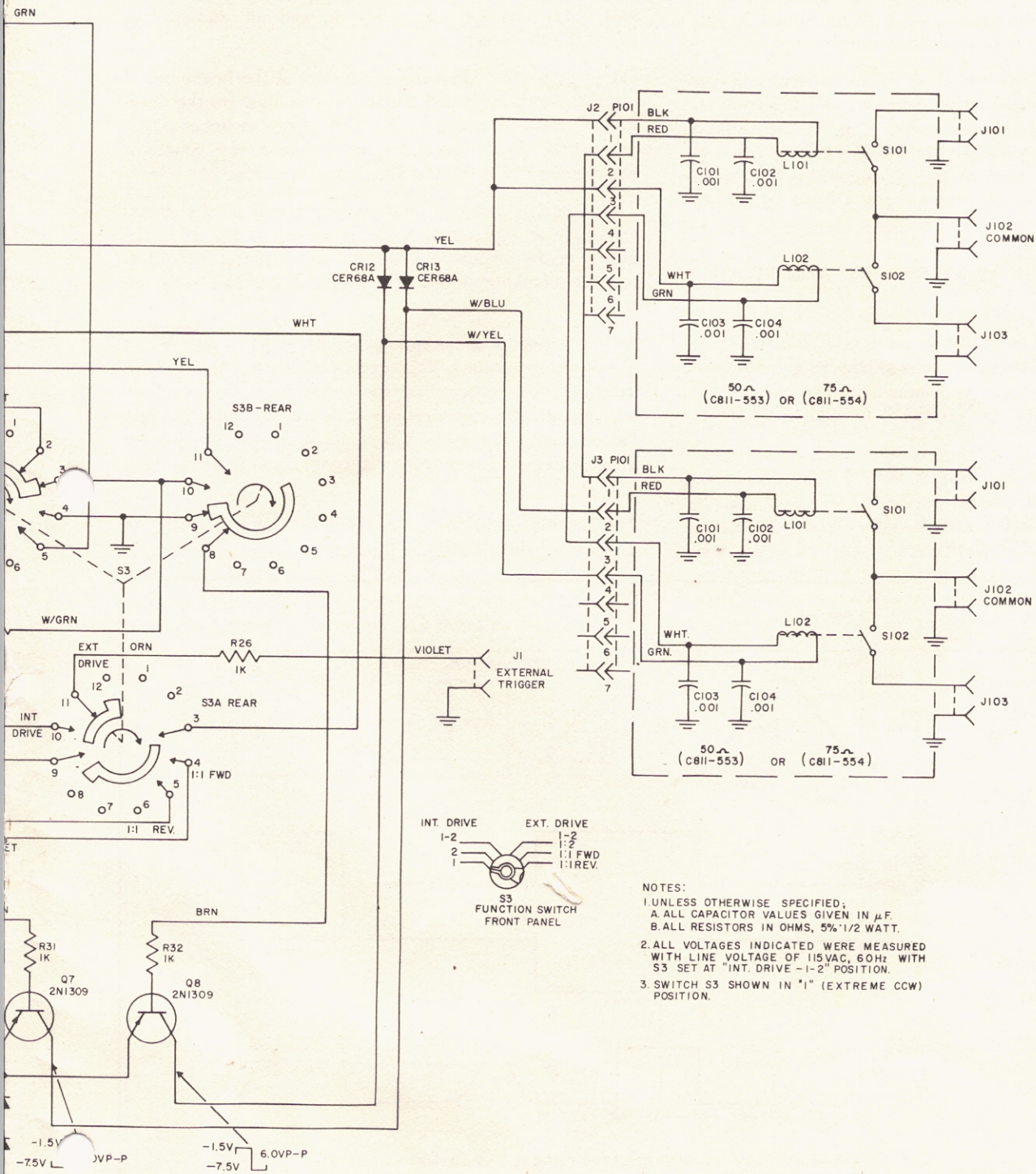


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is differentiated by C6 and R16 to trigger flip-flop Q3/Q4. The signal at the collector of Q3 is differentiated by C5 and R10 and fed to diodes CR3 and CR4 in the counter circuit.

COUNTER CIRCUIT

When the FUNCTION switch is set to INT DRIVE 1-2 or to EXT DRIVE 1:2, the positive-going spikes of the differentiated pulses appearing at CR3 and CR4 trigger the counter Q1/Q2 at half the rate of the flip-flop, producing pulse trains at the collectors of both transistors. In this condition the circuit acts as a 2:1 counter.

When the FUNCTION switch is set to either 1:1 FWD or 1:1 REV, Q1 and Q2 do not function as a 2:1 counter. In this mode, CR3 or CR4, depending on the desired sweep direction, is shorted by the FUNCTION switch and the circuit then operates at the driving pulse frequency. The pulses at the collectors of Q1 and Q2 are applied to the FUNCTION switch.

FUNCTION SWITCH, RELAY DRIVERS, AND RELAYS

Manual Switching

With the FUNCTION switch in position 1 or 2, power is applied through R27 and contacts of the switch to drive Q7 or Q8, respectively, into conduction. The base of the non-operating transistor is grounded through the FUNCTION switch.

When Q7 is conducting, switches S101 in the switch heads close, and the signals applied to the "1" fittings, J101, are passed to the COMMON fittings, J102. When Q8 is conducting, switches S102 close, and the signals applied to

the "2" fittings, J103, are passed to the COMMON fittings.

Automatic Switching with Internal Drive

With the FUNCTION switch set to INT DRIVE 1-2, the Schmitt trigger is driven by a 60 Hz (50 Hz) sinewave derived from the phase control network and applied to the trigger through S3.

Q1 and Q2 function as a 2:1 counter so that their collector pulses occur at a 30 pps (25 pps) rate. These pulses switch Q7 and Q8 alternately on and off through the FUNCTION switch.

Fig. 4 shows that Q8 starts to conduct at the beginning of the first sweep cycle and remains in that state for the duration of the full sweep cycle. This closes switches S102, connecting the device under test to the sweep generator and detector (for the test setup shown in Fig. 2).

The circuit is swept during the trace half of the sweep cycle. Since the return trace (retrace) is blanked, the output of the detector falls to zero and remains there during the blanking period, producing a baseline trace on the display.

At the beginning of the next sweep cycle, Q8 is cut off and Q7 begins to conduct. This opens switches S102 and closes switches S101, connecting the reference device into the test circuit. The reference device is swept during the first half of the sweep cycle and again, with the return trace blanked, a base line trace is displayed during the blanking period.

The resulting display is illustrated in Fig. 5, relating all portions of the display to the timing diagram in Fig. 4.

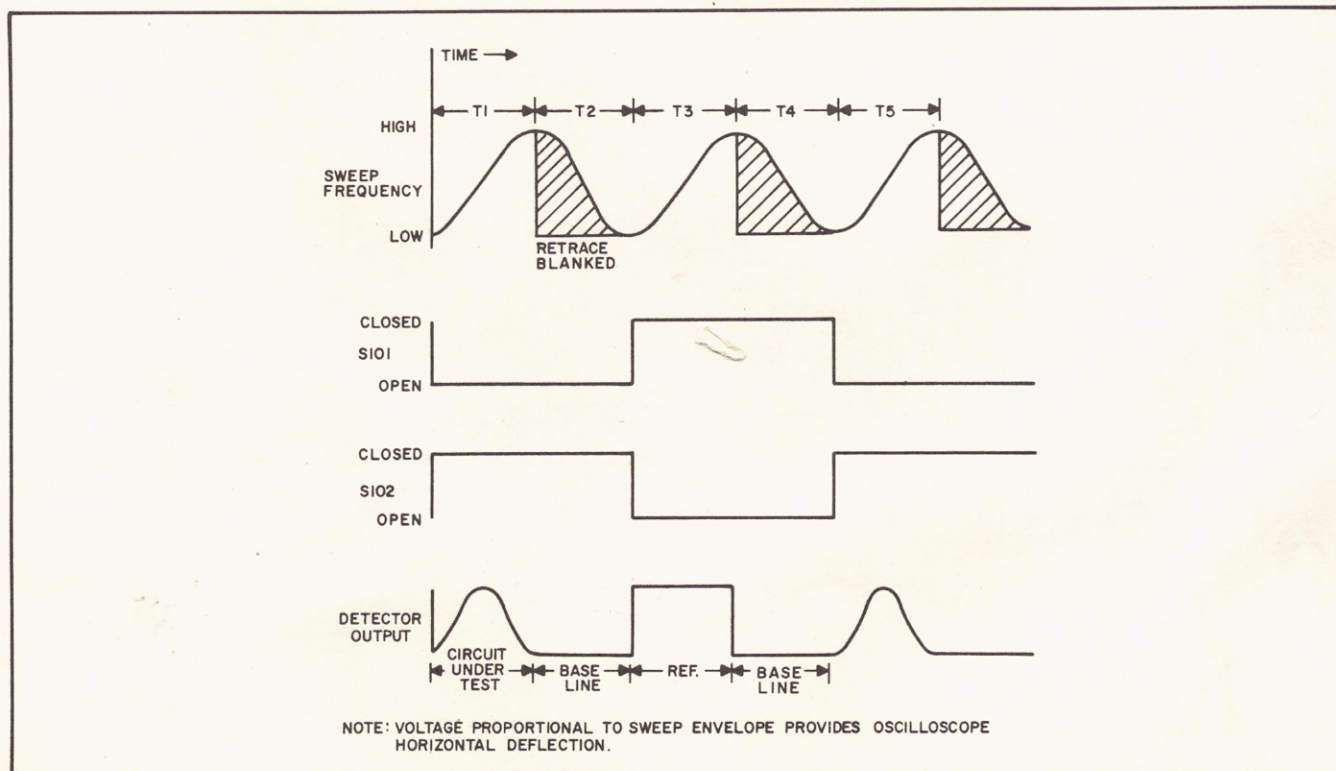


Fig. 4—Timing Diagram for Switching with Internal Drive and for 1:2 Switching with External Drive

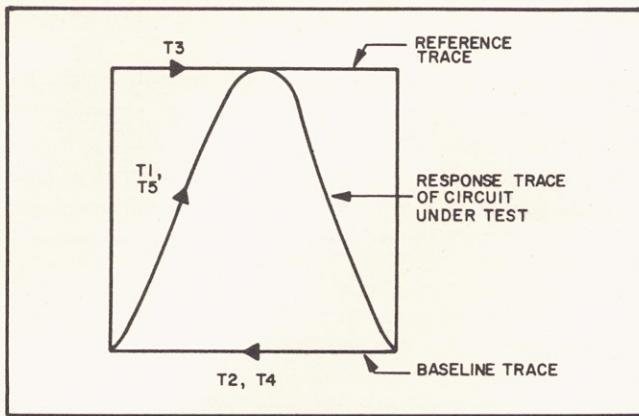


Fig. 5—Timing and Direction of Display Components for Switching with Internal Drive and for 1:2 Switching with External Drive

Automatic Switching with External Drive

With the FUNCTION switch in the EXT DRIVE 1:2 position, the Schmitt trigger is driven by the sweep blanking pulse applied through the EXTERNAL TRIGGER fitting J1 and contacts of the switch. Q1 and Q2 continue to operate as a 2:1 counter so that the switching rate is half that of the driving pulse rate. Operation is as described for switching the internal drive. The PHASE control is not effective when the unit is operated with external drive.

When the FUNCTION switch is set to either 1:1 FWD or 1:1 REV, CR3 or CR4, respectively, is shorted out and the counter operates at a 1:1 ratio; i.e., the circuit operates at the same frequency as the drive signal, so that switching occurs at the same rate as the driving pulse. The Schmitt trigger continues to be driven by the sweep blanking pulse, but the sweep is unblanked.

Fig. 6 shows the timing relationships for 1:1 forward and reverse operation. For forward sweep Q8 conducts during the trace half of the sweep cycle and Q7 is cut off. Switches S102 are closed during this period, connecting the circuit

under test between the sweep generator and detector. At the beginning for the retrace half of the sweep cycle, Q8 is cut off, Q7 conducts, and switches S101 close while switches S102 open. This connects the reference device into the test circuit. This sequence is repeated at the start of the next and all succeeding sweep cycles.

For the reverse sweep mode, the sequence of events is the reverse of that described above. Fig. 7 illustrates the oscilloscope displays for both forward and reverse sweep, relating all portions of the displays to the timing diagrams in Fig. 6.

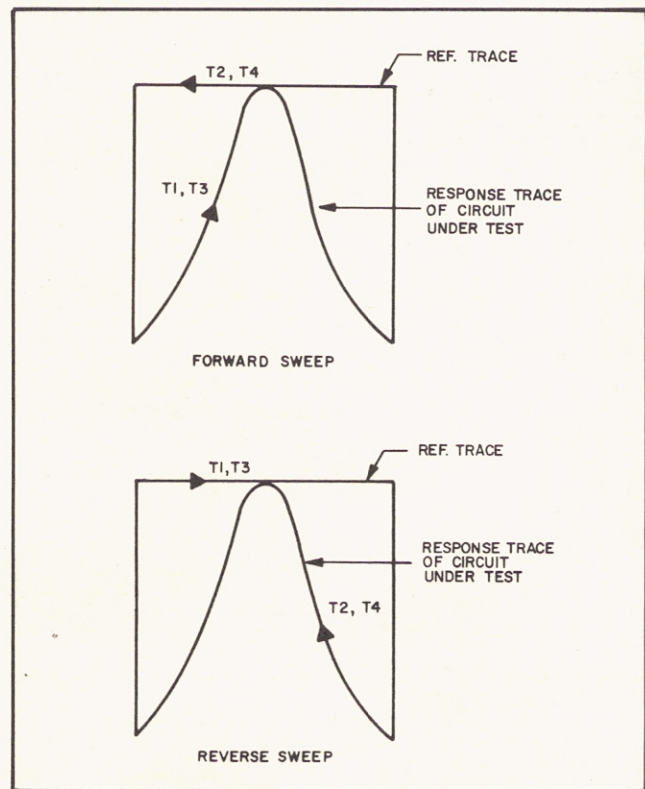


Fig. 7—Timing and Direction of Display Components for 1:1 Switching

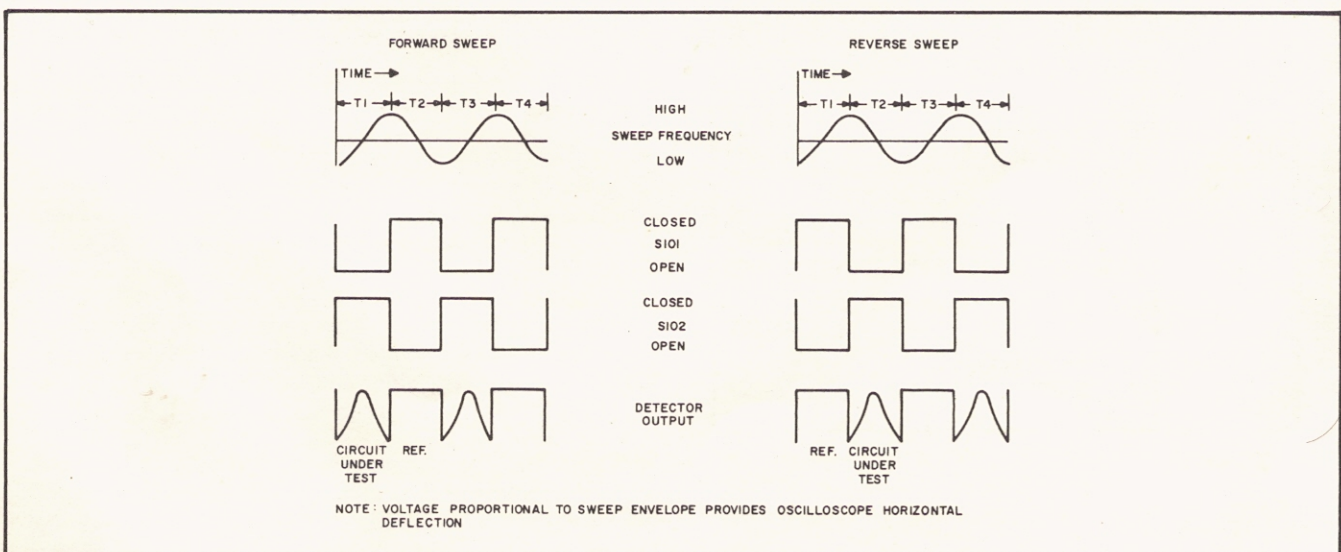


Fig. 6—Timing Diagrams for 1:1 Switching

MAINTENANCE

Model TC-2 is designed to give long, trouble-free service. Repairs should be made only by personnel familiar with solid-state circuitry. The schematic circuit diagram and replacement parts list will be an aid in servicing.

If for some reason the unit cannot be repaired in the field, the instrument may be returned to the Jerrold Electronics, Philadelphia, Penna. 19105. After notifying Jerrold of your

intention to return the unit for repair, carefully pack the unit and ship it (with freight and insurance prepaid) together with a note stating the serial number of the unit and listing the difficulties encountered. The instrument will be repaired free of charge under conditions of the warranty. Otherwise, it will be repaired and returned at nominal charges.

REPLACEMENT PARTS LIST

ASSEMBLY: CONTROL UNIT FOR MODELS TC-2-5B AND 7F				REF. DWG. NO.: 861-998
ITEM	SCHEMATIC DESIGNATION	QTY.	DESCRIPTION	JERROLD PART NO.
			CAPACITORS	
1	C1	1	10 μ F, 64 V	127-064
2	C2	1	1600 μ F, 10 V	127-073
3	C3, 4, 5, 6	4	0.1 μ F, 200 V, 20%	125-002
4	C7	1	0.25 μ F, 200 V, 20%	125-008
			CHOKE	
5	L1	1	r-f	B143-126
			CONNECTORS	
6	J1	1	75 Ω BNC, bulkhead receptacle	183-216
7	J2, 3	2	Tube socket, 7 pin	181-169
			DIODES	
8	CR1, 2	2	HC30, silicon rectifier	137-709
9	CR3, 4	2	1N34	139-100
10	CR12, 13	2	CER-68A, silicon rectifier	137-718
11	CR14, 15	2	CER-70, silicon rectifier	137-712
			FUSE	
12	F1	1	1A, 250 V, 3 AG	101-238
			LAMP	
13	DS1	1	NE2H	102-003
			RESISTORS	
14	R1	1	33 k Ω , 1/2 W, 5%	112-548
15	R2	1	10 k Ω , 2 W, 10% potentiometer	A118-132
16	R3, 4, 18	3	200 Ω , 1/2 W, 5%	112-272
17	R5, 6, 12, 13, 27	5	2 k Ω , 1/2 W, 5%	112-398
18	R7, 8, 15, 16	4	10 k Ω , 1/2 W, 5%	112-485
19	R9, 17	2	10 Ω , 1/2 W, 5%	112-107
20	R10, 19, 23	3	15 k Ω , 1/2 W, 5%	112-506
21	R11, 14	2	510 Ω , 1/2 W, 5%	112-326
22	R20, 22, 26, 31, 32	5	1 k Ω , 1/2 W, 5%	112-359
23	R21	1	4.7 k Ω , 1/2 W, 5%	112-443
24	R24	1	36 k Ω , 1/2 W, 5%	112-557
25	R25	1	20 k Ω , 1/2 W, 5%	112-524
			SWITCHES	
26	S1	1	SPST, toggle	162-001
27	S2	1	DPST, slide	162-047
28	S3	1	Wafer	C161-159
			TRANSFORMER	
29	T1	1	Power	C141-209
			TRANSISTORS	
30	Q1, 2, 3, 4, 5, 6, 7, 8	8	2N1309	130-127

ASSEMBLY: SWITCH HEAD FOR MODEL TC-2-5B				REF. DWG. NO.: 861-998
ITEM	SCHEMATIC DESIGNATION	QTY.	DESCRIPTION	JERROLD PART NO.
1	C101, 102, 103, 104	4	CAPACITORS 1000 pF, 500 V, stand-off	129-112
2	J101, 102, 103	3	CONNECTORS 50 Ω BNC bulkhead receptacle, UG-1094/U	S183-216
3	P101	1	Plug, 7 pin	184-045
4	L101, 102	2	SOLENOIDS Coil assembly	B156-976
5	S101, 102	2	SWITCHES Mercury wetted reed	160-107

ASSEMBLY: SWITCH HEAD FOR MODEL TC-2-7F				REF. DWG. NO.: 861-998
ITEM	SCHEMATIC DESIGNATION	QTY.	DESCRIPTION	JERROLD PART NO.
1	C101, 102, 103, 104	4	CAPACITORS 1000 pF, 500 V, stand-off	129-112
2	J101, 102, 103	3	CONNECTORS F-81M, 75 Ω , threaded	818-274
3	P101	1	Plug, 7 pin	184-045
4	L101, 102	2	SOLENOIDS Coil assembly	B156-976
5	S101, 102	2	SWITCHES Mercury wetted reed	160-107


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