

MODEL 2TSG-1
TWO TONE GENERATOR

INSTRUCTION MANUAL



**AUTOMATED INDUSTRIAL
ELECTRONICS CORPORATION
BATESBURG SOUTH CAROLINA**

NOTICE

Warranty registration on this unit is not necessary. The serial number of your instrument has been recorded and placed in our warranty file. The warranty covers all parts and labor performed at our plant. The warranty period is 3 years beginning 10 days after shipment. Misuse or abuse of the equipment will not be covered by warranty.

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1. SPECIFICATIONS

- | A. FREQUENCY | RESOLUTION |
|-------------------------|------------|
| 1000 to 9999 Hz | 1 Hz |
| 100.0 to 999.9 Hz | .1 Hz |
| 10.00 to 99.99 Hz | .01 Hz |
- B. Accuracy — Trimming capacitor in the oscillator circuit allows setting to within + / -1PPM at room temperature.
- C. Stability — Typically + / -10 PPM 0 to 50c
- D. Timing Controls — 100 msec. to 5 seconds variable
- E. Output — Variable up to 2.5 volts RMS across a 600ohm load. Output can be reduced by 60 db typically with the level control.
- F. Distortion — Less than 3% at full output.

2. CIRCUIT DESCRIPTION

Referring to the schematic, Q1, the oscillator transistor operates in the fundamental mode with the frequency of oscillation determined by Y1, a 7.92 mhz crystal. Trimming capacitor C1 allows setting the oscillator to the precise operating frequency.

Q2 and IC1 are used to amplify and isolate the oscillator output. The flip-flop circuit IC2 is used to shape the crystal frequency and divide by four down to 1.98 mHz.

Integrated circuits IC3, IC4, IC5 and IC6 are fractional multipliers such that they will multiply the 1.98 mHz signal by anything from .1000 to .9999, adjustable with the BCD switches to give an output at IC6 of .198 mHz to 1.98 mHz, IC7 is a dual decade circuit which will scale the input by 10 or 100. IC8 is a gating circuit used to select the proper decade from IC7.

The output of IC8 drives the inputs of IC10 and IC11. IC10, IC11, 1 / 6 IC12 and 1/2 IC9 form an up-down counter which divides the frequency by 198. The outputs of the up-down counters are fed into a ladder network to form a triangle which is the frequency selected by the thumbwheel switches and range switch.

IC13 takes the triangle and feeds a diode sine forming network consisting of D35 and D36. Sine wave purity can be adjusted by R61.

IC14 is an analog switching network used to switch between tone A and tone B. This network is controlled by the sequencer network through IC12 , Q3, and Q4.

IC15 is an amplifier used to drive the audio circuit consisting of Q5, Q6, and Q7.

The sequencer circuits IC16, IC17, IC18, and IC19 derive their time information from a 10 ufd capacitor off pins 6 and 7 and the adjustable resistors on the front panel. The outputs of the sequencer circuits drive the LED displays and the gating circuits, IC8 and IC14.

3. OPERATING INSTRUCTIONS:

- A. Turn the on-off switch to on.
- B. Set the thumbwheel switches and range switches to the desired output frequency. The range switch effectively moves the indicated thumbwheel setting down by one or two decades as indicated:

RANGE SETTING	OUTPUT FREQUENCY
X11000 to 9999 Hz
X.1	100.0 to 999.9 Hz
X.01	10.00 to 99.99 Hz

- C. Set the mode switch to Cont. A (left position) and adjust the A Level for the desired output.
- D. Set the mode switch to Cont. B (right position) and adjust the B Level for the desired output.
- E. Set the mode switch to Cycle (center position).
- F. Set the Cycle switch to A or A & B as desired.
- G. Set the A Delay switch on the back panel to on or off as desired. In the off position there is no delay between tones B and A.
- H. Set the B Delay switch on the back panel to on or off as desired. In the off position there is no delay between tones A and B. With both delay switches off the generator simply toggles between the A and B tones.
- I. It is possible to confuse the sequencer circuits with occasional switching transients. When this happens generally all LEDs are off or possibly two may come on at once. To resume normal operation, press the Clear-Cycle button momentarily. After releasing the Clear button the generator begins its sequence on A Duration.
- J. If a single burst or cycle is desired the Clear Switch can be used to achieve this by the following:
 - 1. Set the A DELAY switch on the back panel to the unmarked position. Extreme left as viewed from the back.
 - 2. Press the clear button momentarily. Upon release the sequence will begin on A DURATION and complete one cycle.
 - 3. Repeat step two if desired for another cycle.
- K. For systems requiring A durations between .001 and .05 seconds make sure the A Dur. switch on the rear panel is in the proper position.
- L. Care should be taken that high voltages are not applied to the output terminals.

4. MAINTENANCE

This instrument has been designed to give years of trouble-free operation. In the event a trouble does occur we recommend you return it to the factory for repair. If it is necessary to make field repairs the following guides should be observed.

- A. Remove the two top screws on the back panel and slide the top portion of the case back to remove.
- B. Check for obvious faults; broken wires, integrated circuits not completely in sockets, broken or discolored parts, etc.
- C. The following guides will help you localize a problem. A good high frequency scope and a high impedance voltmeter will be necessary.
- D. After the faulty part has been located remove the screws from the delay switches on the back panel and the printed circuit mounting screws then tilt the P.C. board up to remove and replace the part.

5. TROUBLE SHOOTING PROCEDURE (GENERAL)

- A. The trouble can be localized to one of four general categories, sine wave generator, sequencer, analog switching circuit, or power supply.
 1. If there is no output on either tone but the LED indicator lamps come on when you switch to continuous A or continuous B the trouble is probably in the sine generator section.
 2. If there is output but the sequencer is erratic, misses functions, more than one light on at a time then the trouble is probably in the sequencer section.
 3. If the LEDs light and there is output on one tone but not on the other then probably the trouble is in the analog switching network.
 4. If nothing happens when you turn the power on then probably the fault is in the power supply section.

B. ALIGNMENT

After troubleshooting and parts replacement, alignment may be necessary to produce the purest sine wave output. Switch settings should be as follows:

- MODE SW.- CONT (A)
 - (A) Thumbwheels 1000
 - (A) Range X1
 - (A) Level MAX CW
1. With a scope probe at the junction of R33-R40 adjust R26, R27, R28, R29, R30, R31, R32 in that order, for a triangle waveform with no shingle effect. It may be necessary to repeat these adjustments several times to get the best looking waveform.
 2. With a scope probe at IC13 pin 6 adjust R58 for a triangle with no clipping on either side.
 3. With a scope probe at IC14 pin 8 adjust R61 for best sine wave.
 4. Put a 22 ohm load across the output jacks. With the scope probe on the output adjust R71 for the best sine wave. If some clipping occurs, adjust for symmetry of clip.
 5. Remove the 22 ohm load. With a distortion analyzer across the output terminals adjust R61 for lowest distortion.
 6. For best performance repeat steps 2 through 5 several times.

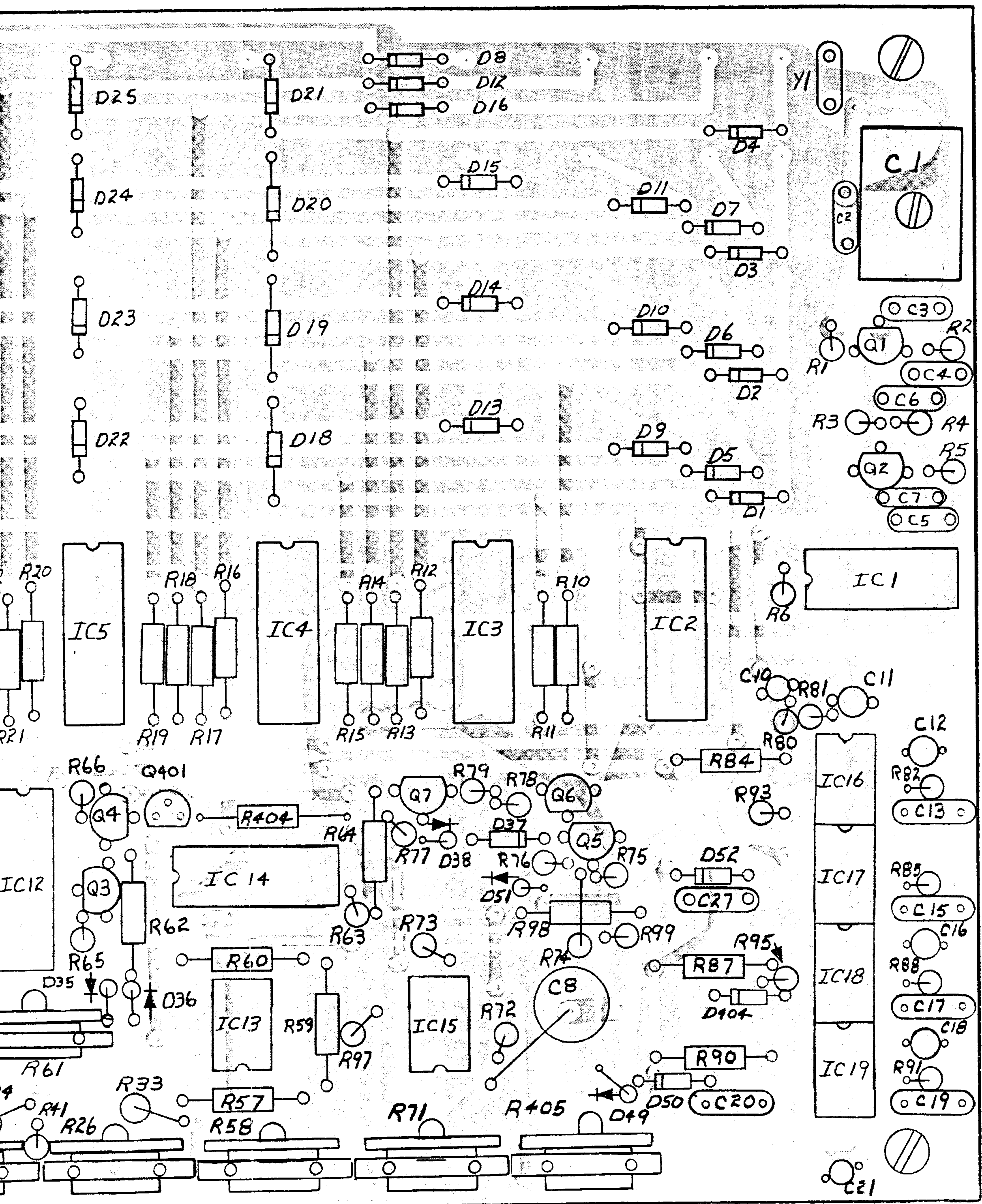
BILL OF MATERIALS 2TSG-1

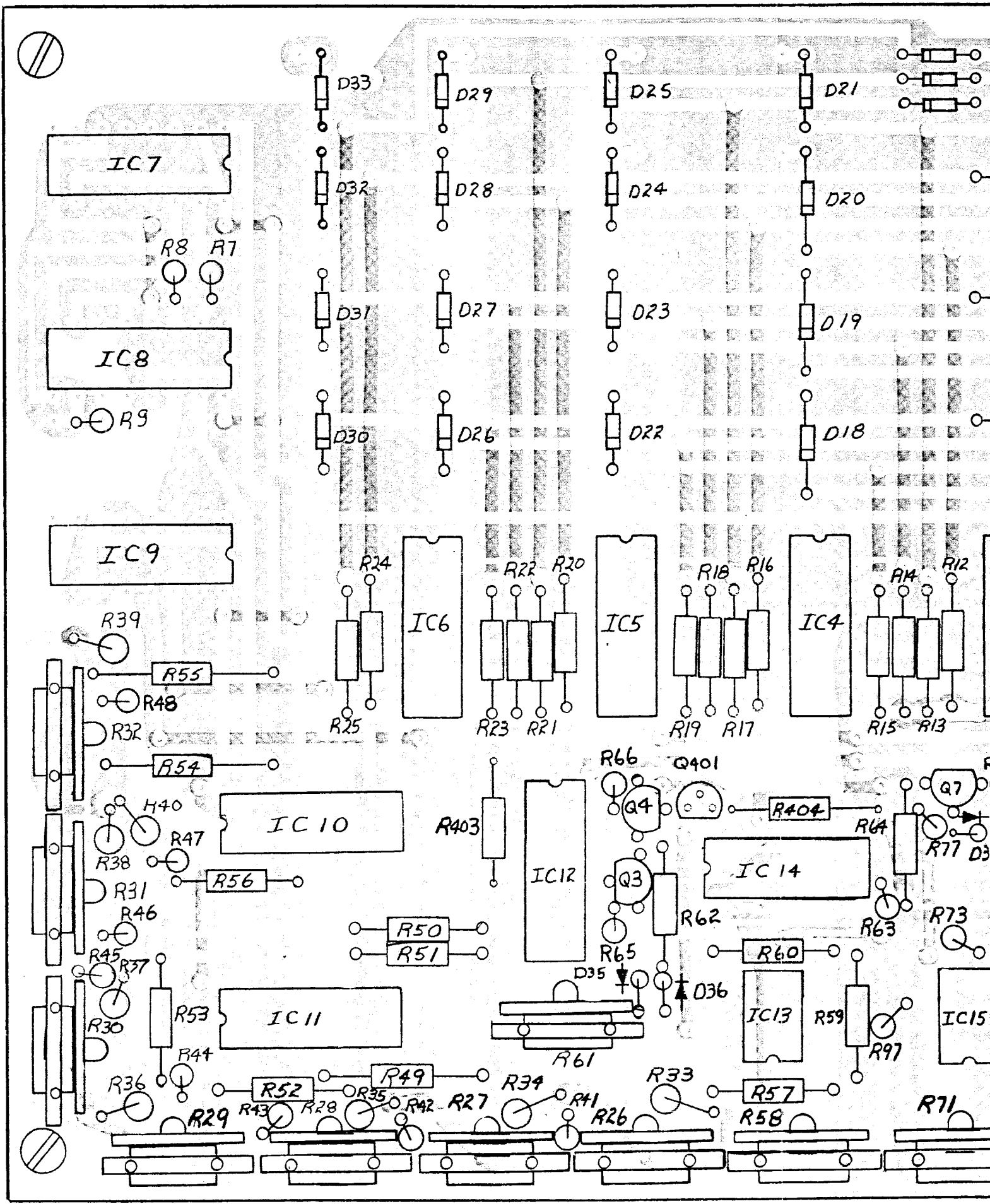
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
C1	Trimmer 7-60pf	IC7	MC14518
C2	Mica 39pf	IC8	MC14506
C3	Mica 330pf	IC9	IC2
C4	Mica 100pf	IC10	MC14510
C5	Ceramic .01mfd	IC11	IC10
C6	Ceramic .001mfd	IC12	MC14049
C7	C6	IC13	LM307
C8	Electrolytic 100mfd	IC14	MC14016
C9	Electrolytic 1000 mfd	IC15	IC13
C10	Tant. 1mfd	IC16	NE555
C11	Tant. 10mfd	IC17	IC16
C12	C11	IC18	IC16
C13	C5	IC19	IC16
C14	C11	IC20	MC7905
C15	C5	IC21	MC7805
C16	C11	IC22	MC7812
C17	C5		
C18	C11	J1	Binding Post, Red
C19	C5	J2	Binding Post, Black
C20	C6		
C21	C10	Q1	Transistor, MPS3563
C22	C6	Q2	Q1
C23	C6	Q3	Transistor, MPS3638
C24	Electrolytic 470mfd	Q4	Q3
C25	C24	Q5	Transistor, 2N3904
C26	C24	Q6	Transistor, MPS6562
C27	C6	Q7	Transistor, MPS6560
C28	C10		
C29	C10	R1	Resistor 100K ¼w 10%
C30	C10	R2	Resistor 3.3K ¼w 10%
C31	.1uf Ceramic	R3	Resistor 33K ¼w 10%
C32	C31	R4	R3
C33	C10	R5	Resistor 3.9K ¼w 10%
		R6	Resistor .39M ¼w 10%
D1-D38	Diode IN914	R7-R25	R3
D39-D44	Diode IN4001	R26-R32	Resistor Variable 1K
D45-D48	LED	R33	Resistor 1.0K 1%
D49-D52	Diode IN914	R34	Resistor 1.96K 1%
		R35	Resistor 4.02K 1%
F1	Fuse ¼ AMP	R36	Resistor 8.06K 1%
		R37	Resistor 16.2K 1%
IC1	MC14012	R38	Resistor 33.0K 1%
IC2	SCL4027	R39	Resistor 61.9K 1%
IC3	MC14527	R40	Resistor 133K 1%
IC4	IC3	R41-R48	Resistor 220ohm ¼w 10%
IC5	IC3	R49-R55	R2
IC6	IC3	R56	R5

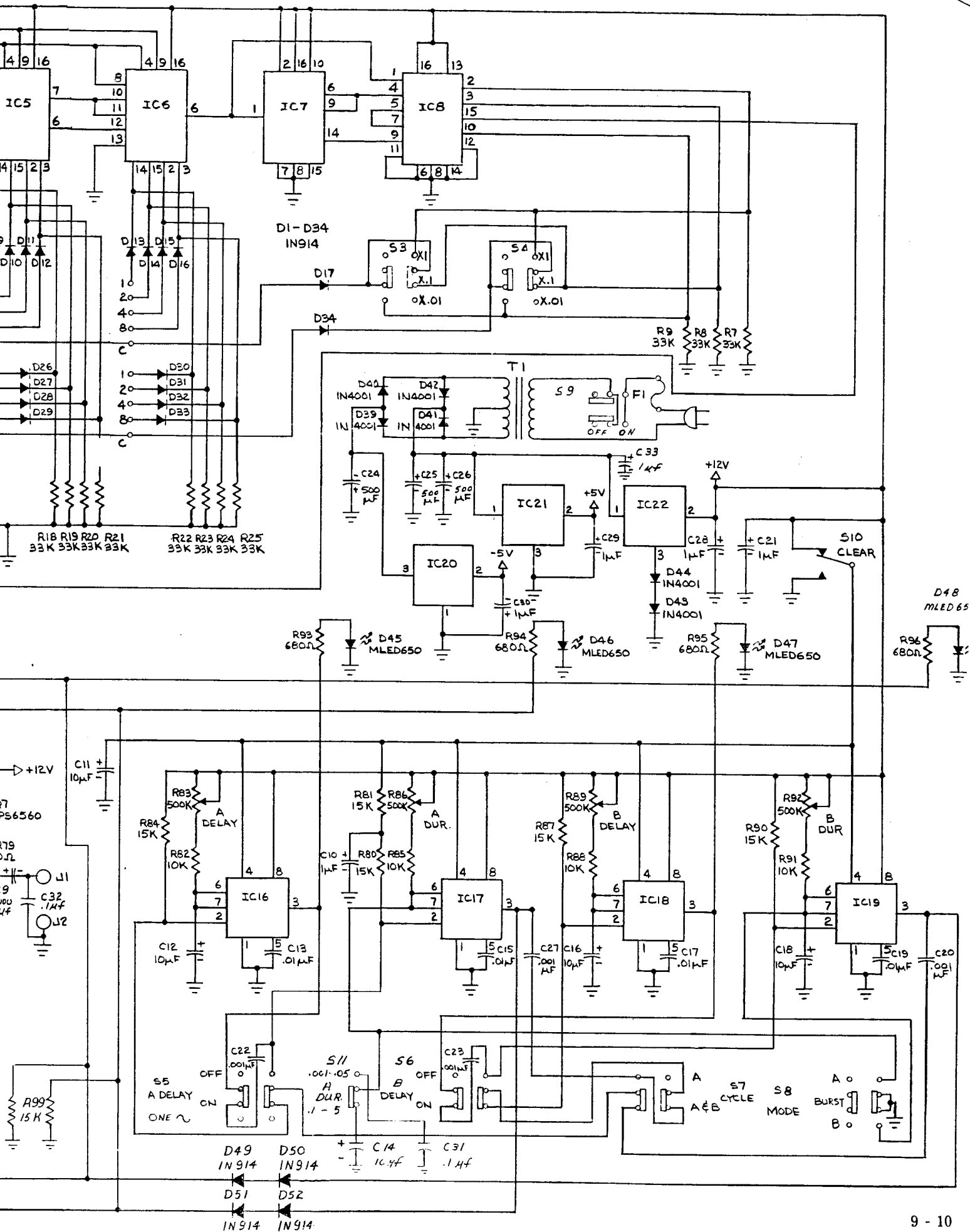
BILL OF MATERIALS 2TSG-1 (Cont.)

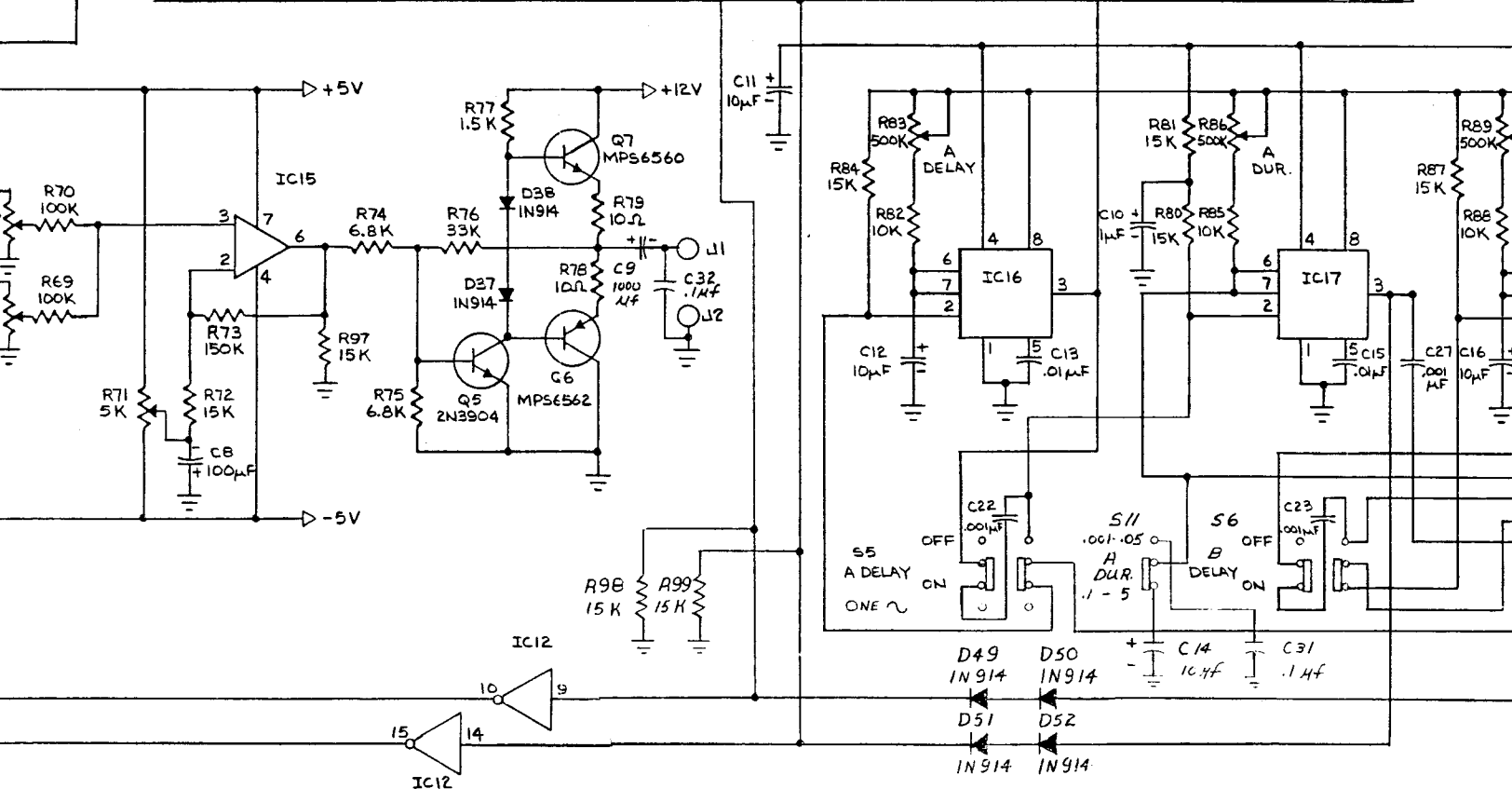
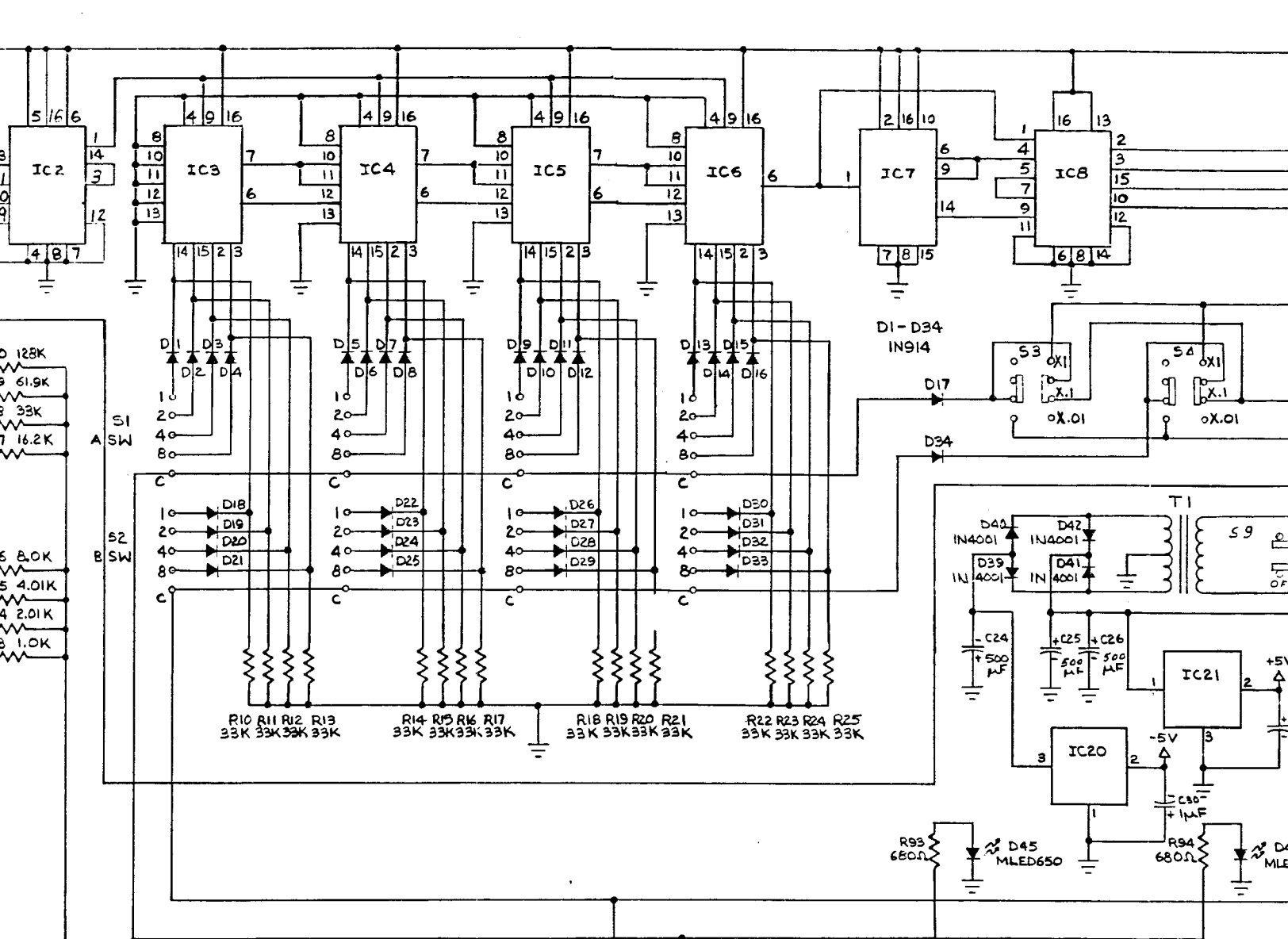
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
R57	Resistor 1.0K ¼w 5%	S1	BCD Switch
R58	Resistor Variable 5K	S2	S1
R59	Resistor 150K ¼w 10%	S3	2pole 3pos slide
R60	R3	S4	S3
R61	R58	S5	S3
R62	Resistor 15K ¼w 10%	S6	S5
R63	Resistor 47K ¼w 10%	S7	S5
R64	R63	S8	S3
R65	Resistor 10K ¼w 10%	S9	S5
R66	R65	S10	Push Switch
R67	Resistor Variable 10K	S11	S5
R68	R67		
R69	R1	T1	Transformer
R70	R1		
R71	R58	Y1	Crystal 7.92 mHz
R72	R62		
R73	R59		
R74	Resistor 6.8K ¼w 10%		
R75	R74		
R76	R3		
R77	Resistor 1.5K ¼w 10%		
R78	Resistor 10 ohms ¼w 10%		
R79	R78		
R80	R62		
R81	R62		
R82	R65		
R83	Resistor Variable 500K		
R84	R62		
R85	R65		
R86	R83		
R87	R62		
R88	R65		
R89	R83		
R90	R62		
R91	R65		
R92	R83		
R93-R96	Resistor 680 ohms ¼w 10%		
R97	R62		
R98	R62		
R99	R62		

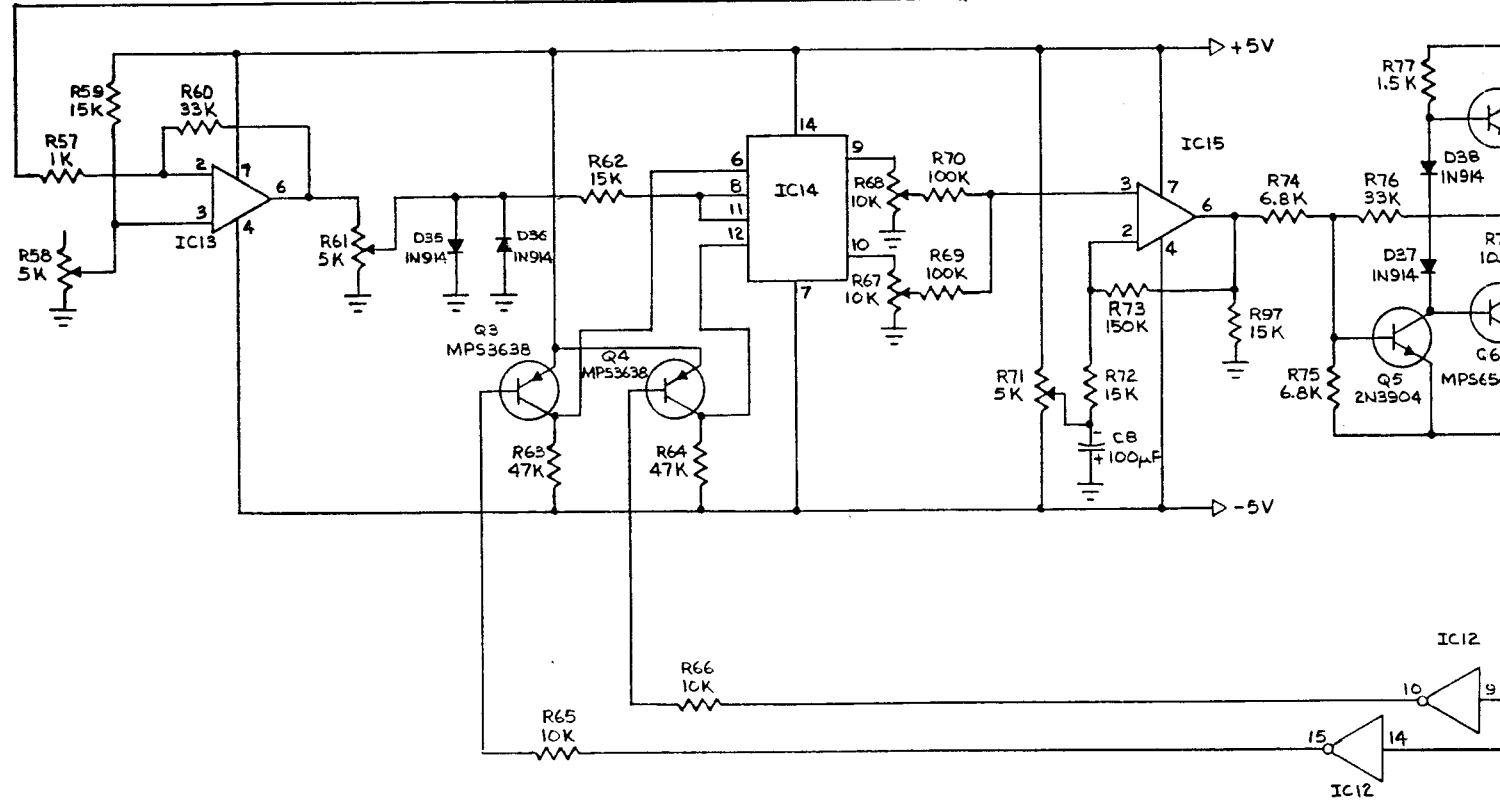
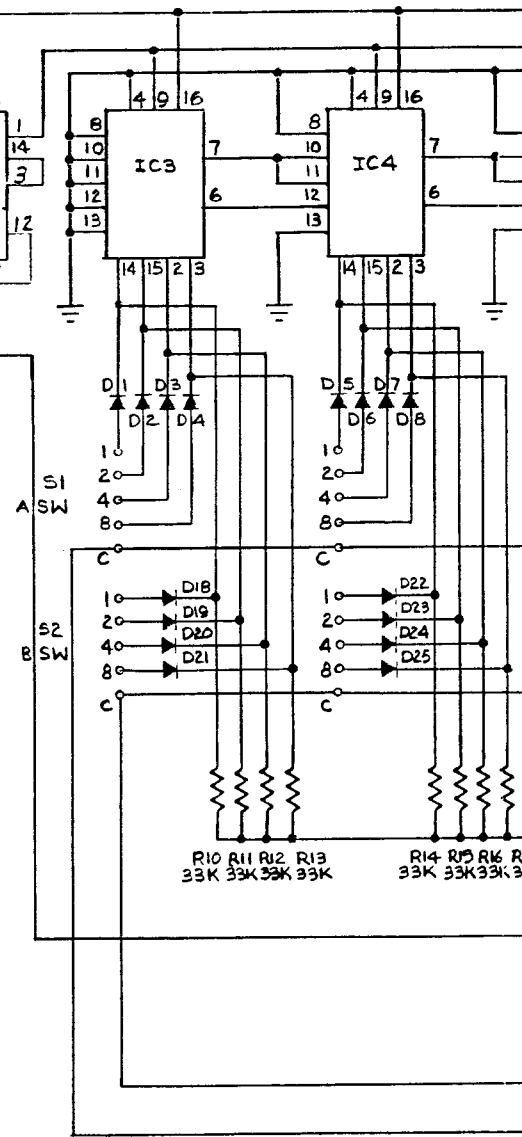
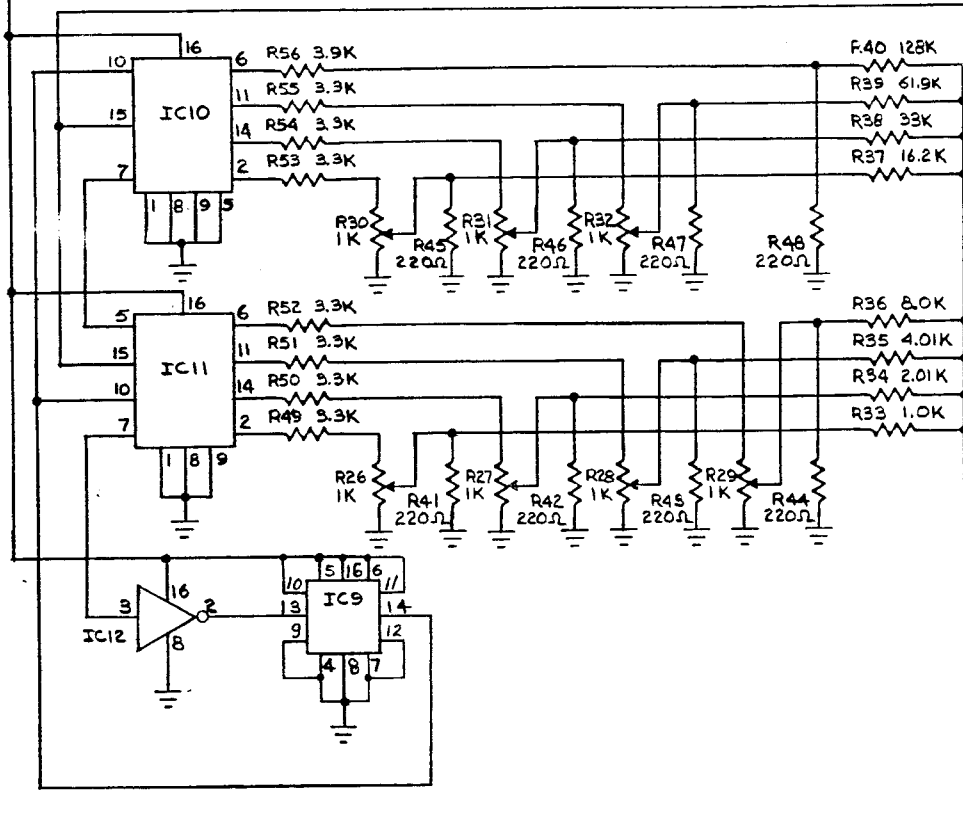
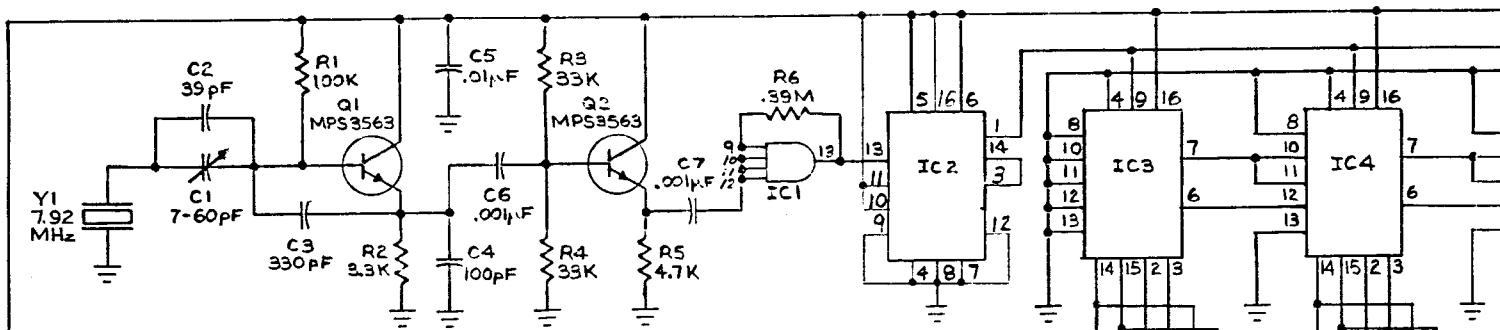
For parts replacement order by model number symbol and description.
 Example 2TSG-1 (R83) resistor, variable 500K.

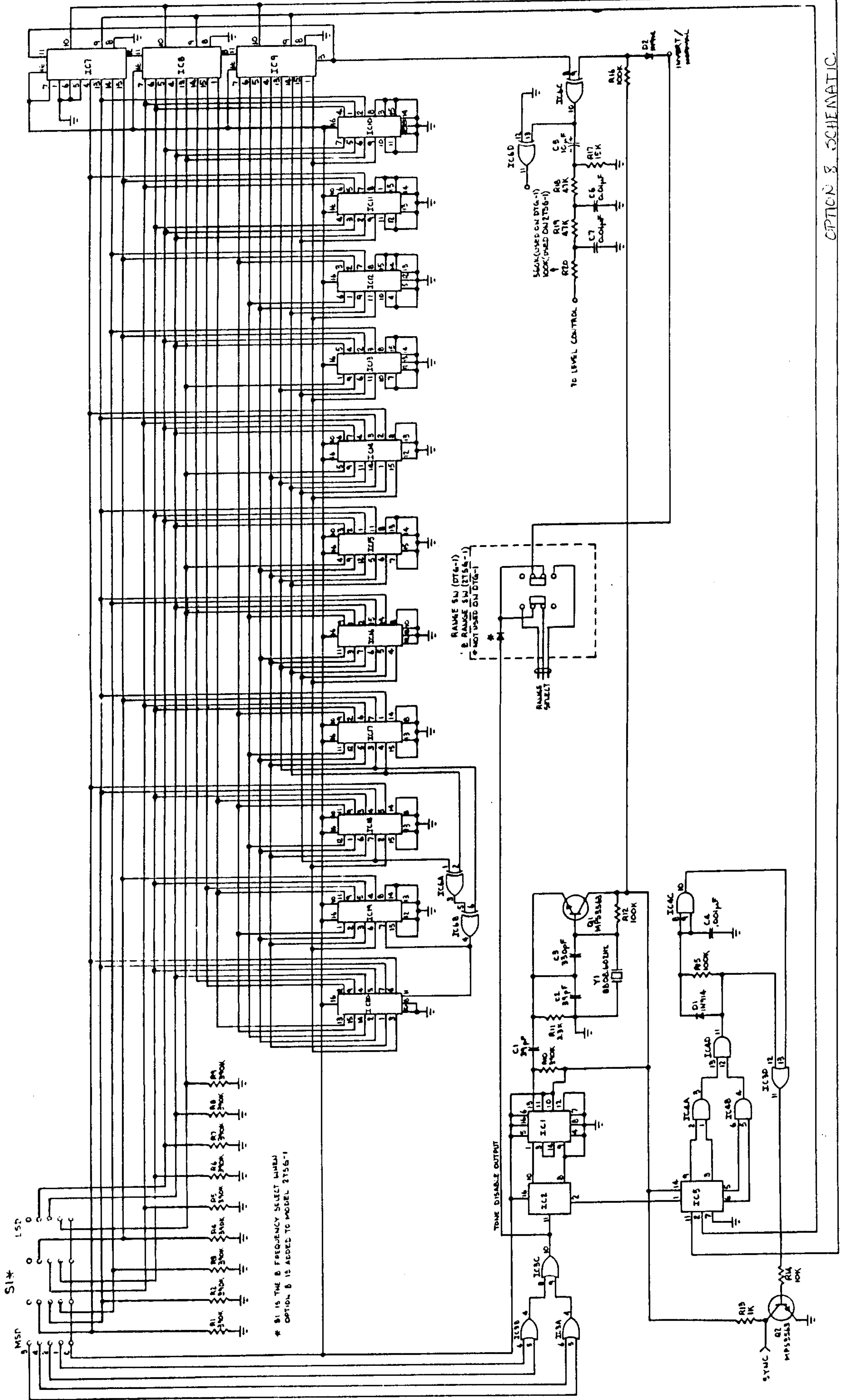












OPTION B SCHEMATIC

* B1 IS THE B FREQUENCY SELECT WHEN
OPTION B IS ADDED TO MODEL 2T56-1

RANGE SW (DTG-1)
B RANGE SW (DTG-1)
NOT USED ON DTG-1

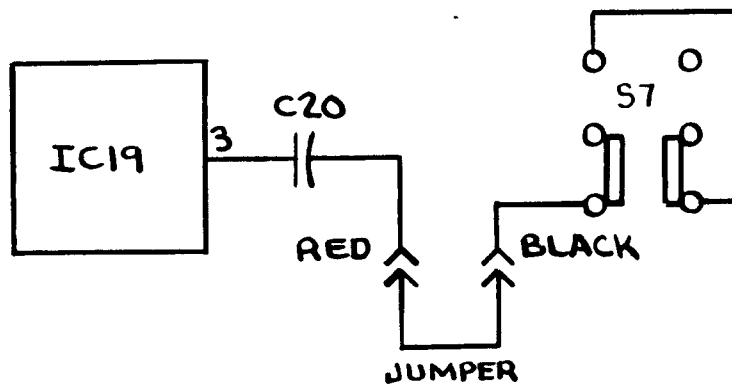
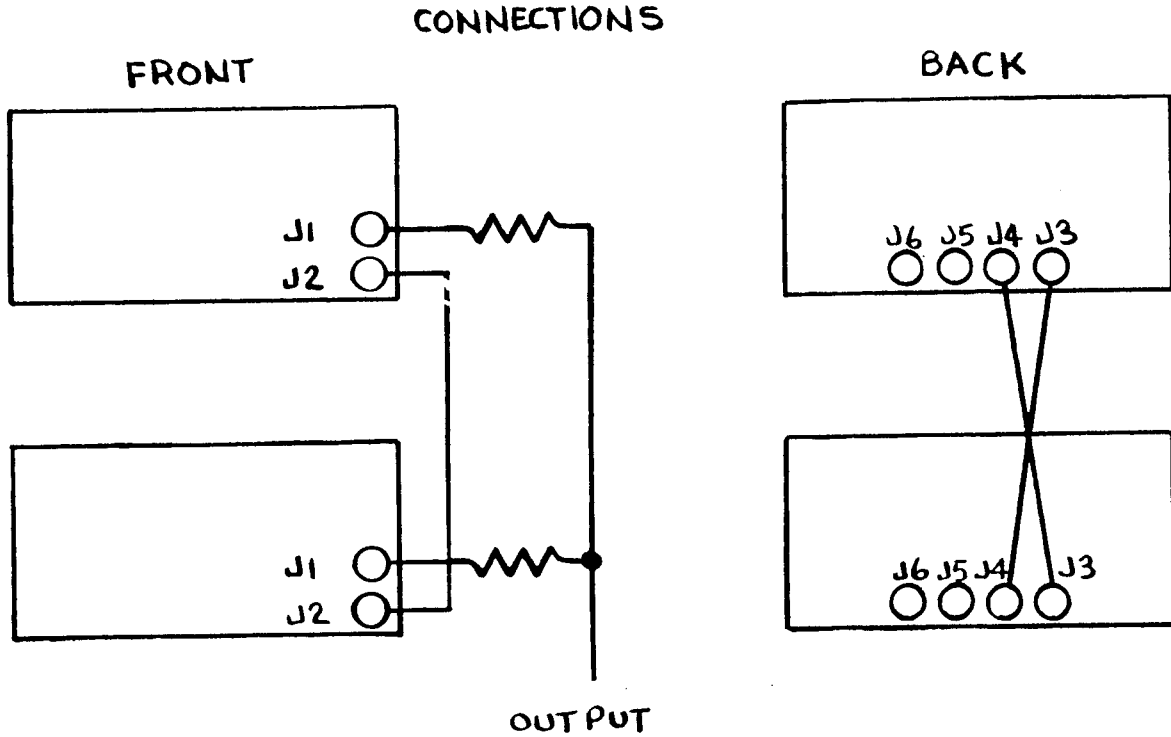
TE LEVEL CONTROL

TONE DISABLE OUTPUT

OPTION 1

Instructions for using two 2TSG-1 Generators in series (4 sequential):

1. Connect the black posts together on the front panel. Connect the red output posts together through 100 ohms to each unit.
2. On the rear panel, remove the jumper between J3 and J4 on each unit. Connect black J3 of one unit to red J4 of the other unit.
3. Set both mode switches to CYCLE A & B. Determine which unit is to be the master unit. Press the CLEAR button on that unit and hold down until both units are cleared. Upon release of the CLEAR button, the sequence will start on A duration of the master unit.



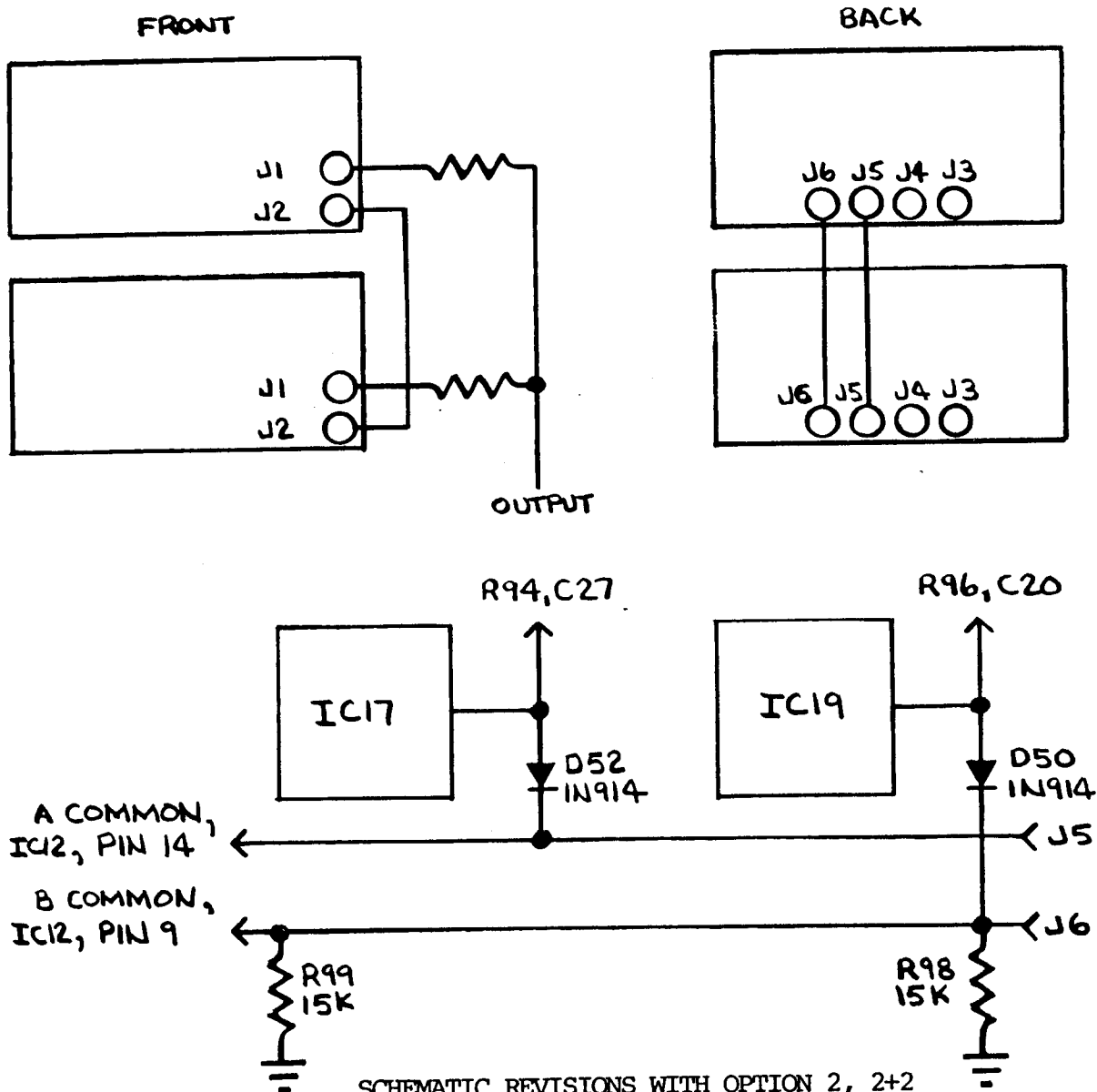
SCHEMATIC REVISIONS WITH OPTION 1, 4 SEQUENTIAL

OPTION 2

Instructions for using two 2TSG-1 Generators in parallel (2+2):

1. Connect the black ground posts together. Connect the output posts together through 100 ohms to each unit.
2. On the rear panel, connect J5 of one unit to J5 of the other unit. Connect J6 of one unit to J6 of the other unit.
3. Determine which unit is desired to be the slave unit. On that unit, switch the A delay to the unmarked position, extreme left position as viewed from the back.
4. Turn both units on and let them cycle out. Timing will now be controlled by the master unit. If one cycle operation is wanted, switch the A delay switch of the master unit to the unmarked position. Press the CLEAR button momentarily. Upon release, the sequence will begin on A duration and complete one cycle. Note that the indicator lights on the slave unit do not turn on.
5. When setting levels for deviation, the following procedure may be helpful:
 - A. Set the master unit to CONT. A, turn the A LEVEL of the slave unit fully CCW.
 - B. Adjust the master A LEVEL to half the desired output.
 - C. Bring the slave A LEVEL up until the full desired output is reached.
 - D. Repeat the above for B.

CONNECTIONS

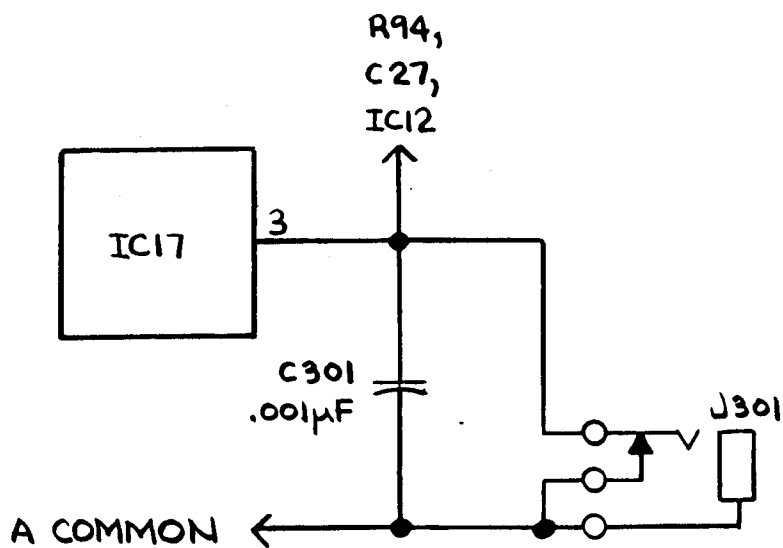
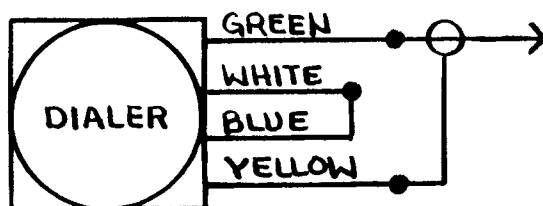


SCHEMATIC REVISIONS WITH OPTION 2, 2+2

OPTION 3

Operating procedure for using Option 3, Telephone Dialing:

1. Adjust the A decades and range switch to the desired frequency, 2805, 1500, etc.
2. Set the Mode switch to A CONT.
3. Plug the dialing mechanism into the jack on the left panel of the generator. Using the plug provided, see below for wiring to the dialer.



SCHEMATIC REVISION WITH OPTION 3, TELEPHONE DIALING

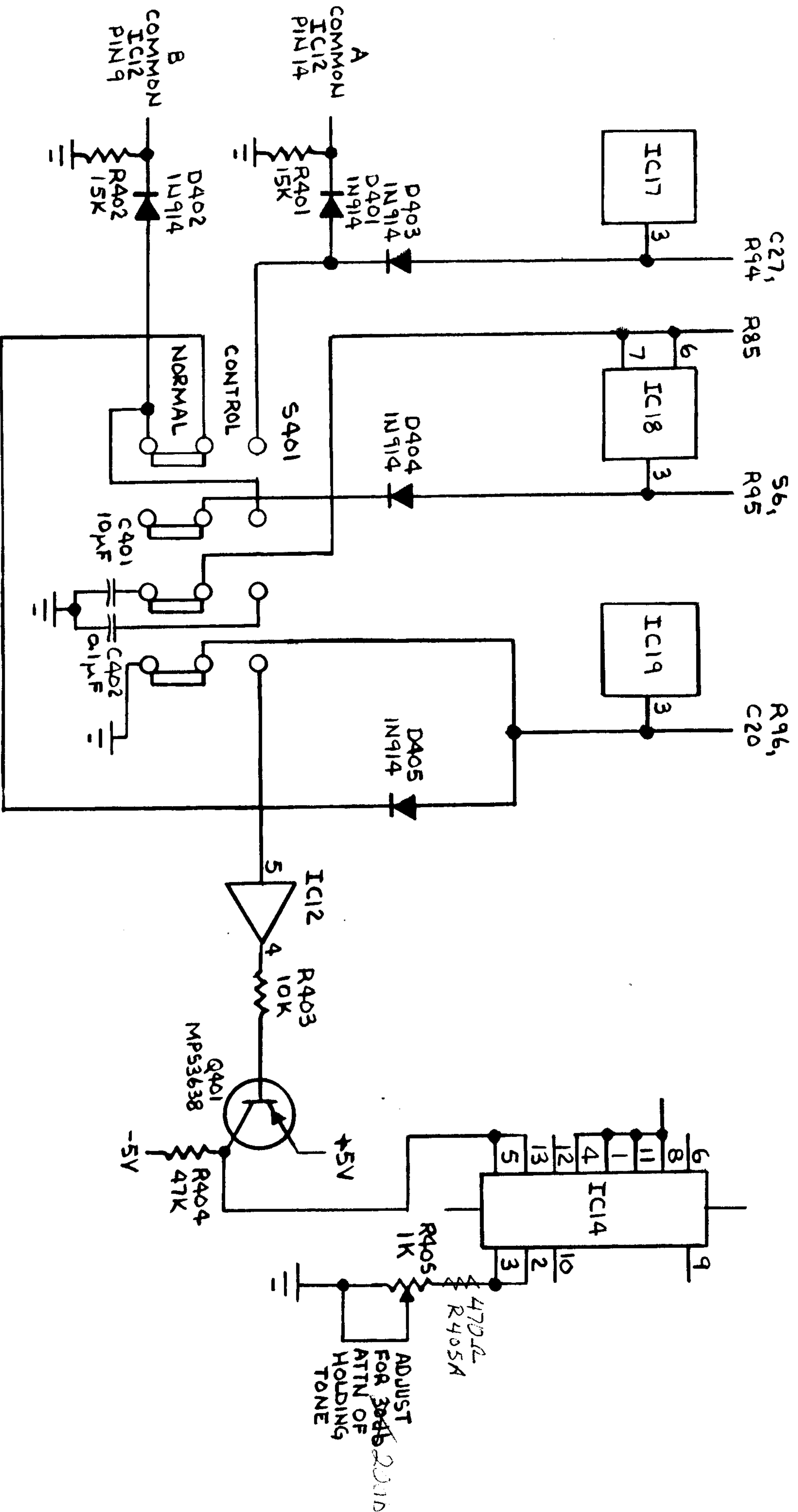
OPTION 4

Operating procedure for using Option 4, TX Control:

1. Set the Mode switch to B CONT.
 2. Set the Cycle switch to A & B.
 3. Set the B Delay switch to ON.
 4. Adjust A decades and range switch to the desired first tone.
 5. Adjust B decades and range switch to the desired second tone.
 6. Adjust A duration for 115ms, fully CCW should be within the system timing tolerance.
 7. Adjust B delay for 40ms. In the control mode, the B delay dial is calibrated .001 to .05 seconds. For 40ms, set to 4. B delay in this case is the duration of the second tone.
 8. Set the NORMAL-CONTROL switch to CONTROL. Press the CLEAR button momentarily. Upon release, the sequence will begin. Note that although the sequence finishes with the B duration LED on, in this mode of operation, the generator has actually returned to the first tone (A) frequency at a level reduction of ~~30 db.~~
20db
(See page 16)
- * See Special Note Below.

CAUTION: If you are bridging telephone lines which may have ringing voltages present, a suitable blocking capacitor should be used.

- * When Option 4 and Option 6 are combined on the same unit, during the function tone (2nd tone), both B delay and B duration LEDS blink on for the duration of the function tone. When the B delay and B duration LEDS go off, the A duration LED comes on and stays on until the CLEAR button is pressed again.

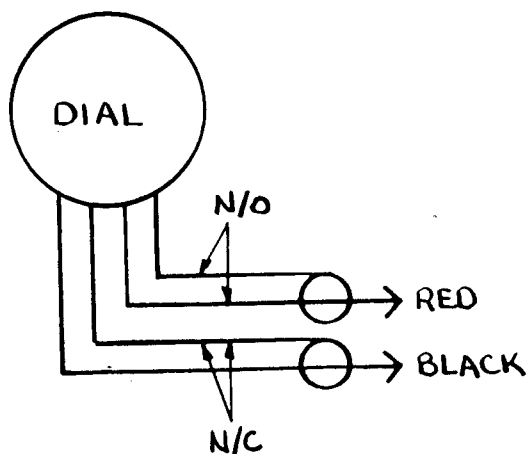


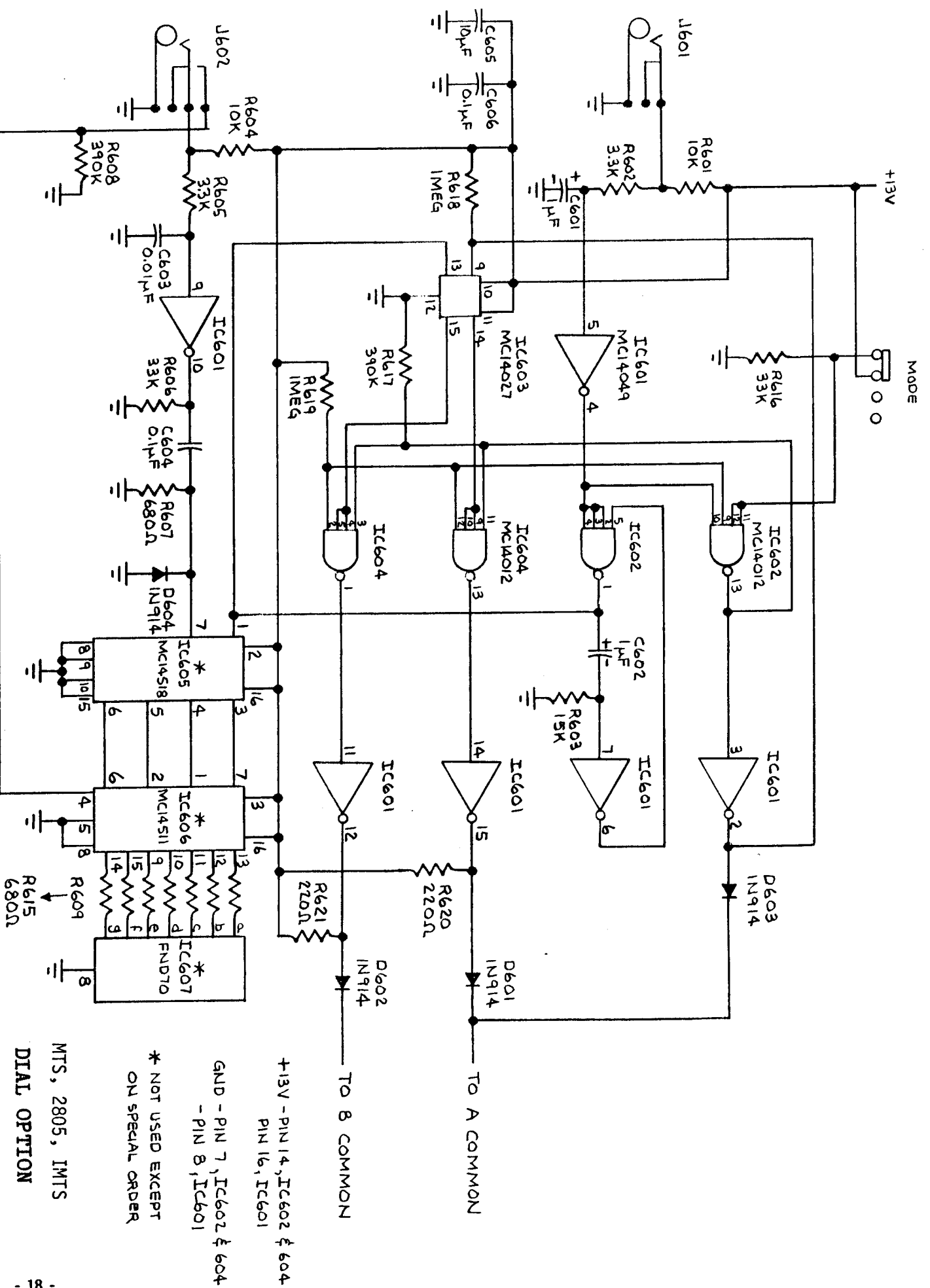
SCHEMATIC REVISIONS WITH OPTION 4, TX CONTROL

OPTION 6

Instructions for using the 2TSG-1 for generating the MTS, IMTS or 2805 Dial Code:

1. Wire the dial mechanism as shown below.
2. On the rear panel, insert the red plug in the jack color coded red. Insert the black plug in the other jack.
3. Move the switch marked A delay to the unmarked position, extreme left position as viewed from the back.
4. Place the Mode switch in the center position.
5. Set the A Thumbwheel switches for 1500 and the A Range switch in the X1 position. Set the B Thumbwheel switches to 6000 with the B Range switch in the X.1 position.
6. The unit is now set up to give MTS dial coded output. When cocked, one of the tones will be present on the output. Upon release of the dial, the output will begin to toggle between 600 and 1500Hz.
7. If 2805 pulsed output is desired, move the Mode switch to A, turn B level fully CCW and set the A Thumbwheel switches for 2805. Upon release of the dial mechanism, the output will stay at 2805 except for approximately 40ms for each number as the dial returns.
8. For IMTS leave Mode switch in Cont. A and adjust the B level control to be equal to the A level control, A and B Thumbwheel switches should be set to proper IMTS frequencies.





+13V - PIN 14, IC602 & 604
 PIN 16, IC601

GND - PIN 7, IC602 & 604
 - PIN 8, IC601

* NOT USED EXCEPT
 ON SPECIAL ORDER

MTS, 2805, IMTS
 DIAL OPTION

OPTION 8

Instructions for using the Digital Tone Squelch Option:

- Step 1: Place the first thumbwheel switch in position Zero. Normally, this switch is prevented from going to Zero to assure that maximum resolution will be achieved when the unit is used as a tone generator.

When this option is added to the 2TSG-1, the B Channel is used as the digital tone squelch generator. In this case, it is necessary to put the mode switch on B continuous.

- Step 2: Place the range switch in X1 or X.01 position.

- Step 3: Feed the output of the tone generator to the external modulation jacks on your signal generator.

Adjust the level control of the tone generator to approximately mid position. Using the modulation level control on the signal generator, adjust for approximately .5 kHz average deviation.

- Step 4: Using the 2nd, 3rd and 4th thumbwheel switches, set for the squelch code of the radio under test. For example: If the squelch code is 070, the thumbwheel switches would read 0070.

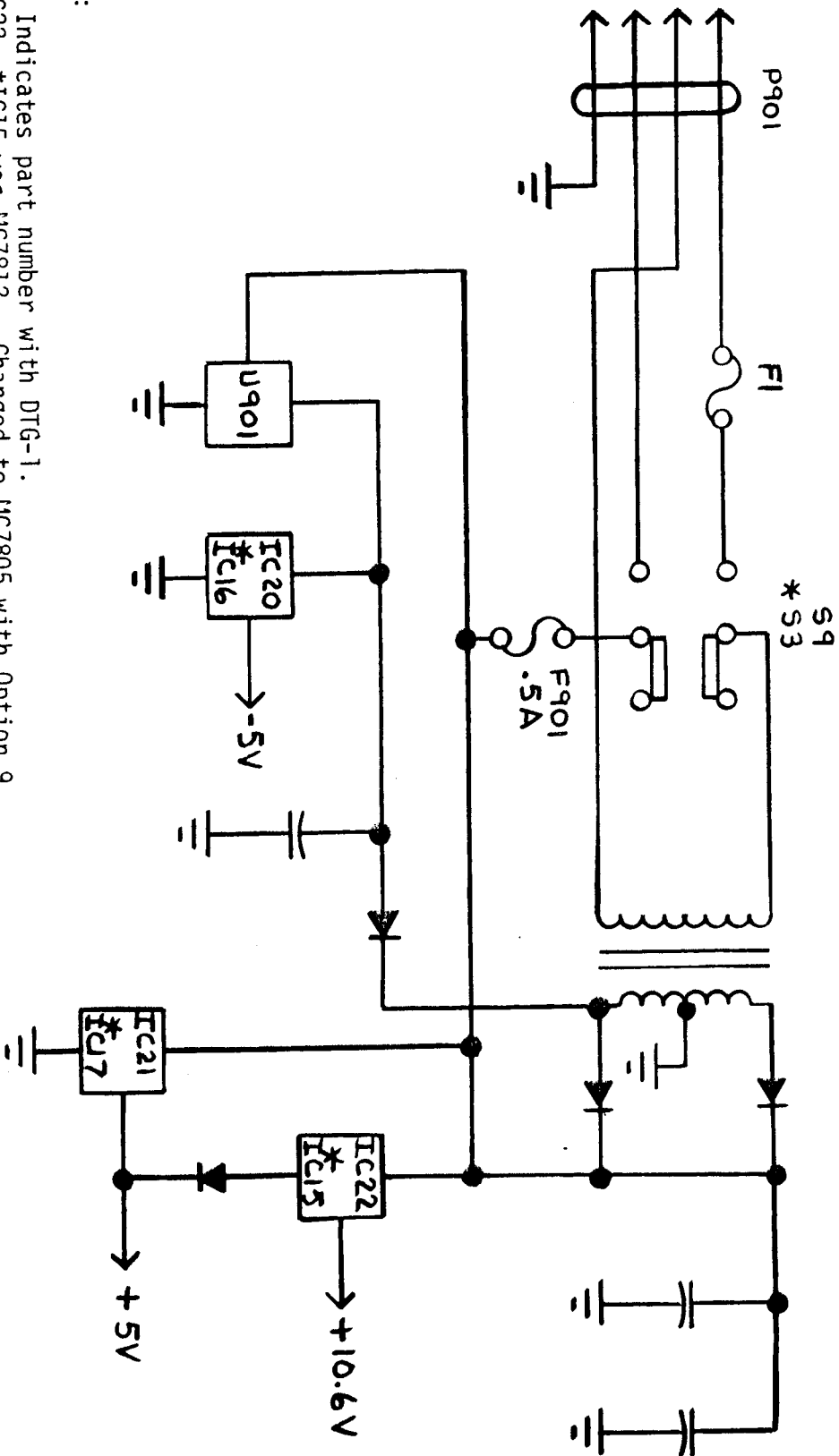
- Step 5: Some signal generators have an odd number of modulation gain stages and therefore invert the modulation pattern. If your receiver does not open using the above procedures, place the range switch in the X.1 position.

- Step 6: When signal tracing in the receiver circuit, it is helpful to use the sync output of the tone generator to trigger your oscilloscope. The sync output is a pulse of approximately 50 usec duration occurring at the beginning of each 23 bit word.

NOTE: If you are injecting the 23 bit word into a high impedance audio stage, it may be necessary to use a small coupling capacitor between the output of the tone generator and the input of the circuit under test.

- Step 7: When returning to normal tone generator operation, it is necessary only to move the 1st thumbwheel switch away from Zero. This automatically programs the range switch to act as a scaler.

Schematic Revisions for Model 2TSG-1 and Model DTG-1
 with Option 9 (AC/DC Operation)



NOTES:

1. * Indicates part number with DTG-1.
2. IC22, *IC15 was MC7812. Changed to MC7805 with Option 9.
3. IC10, *IC9 was MC14510CP. Changed to 4510PC with Option 9.
4. Components not affected by this change but shown above are not labeled.