INSTRUCTION MANUAL

MODEL SCG-4T
SUBCARRIER GENERATOR

Revised
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I. INTRODUCTION

The Model SCG-4T SCA Subcarrier Generator is a modern, all solid-state instrument intended to develop a direct FM subcarrier for multiplexing FM transmitters with an additional sound channel.

The unit complies with current FCC requirements for SCA service and features small size, all silicon JEDEC-registered semiconductors, extreme stability, excellent sound quality, and simplicity of operation. A front-panel meter indicates peak deviation. The number of controls has been reduced to the minimum needed for broadcast operation. The modulator incorporates standard 75 microsecond pre-emphasis which is field-convertible to any desired curve. Automatic, all electronic muting of the subcarrier in the absence of audio is incorporated. Plug-in circuit cards facilitate maintenance. An extension card is included in order that any printed card may be examined while the unit is in operation. The SCG-4T is completely prewired to enable its use in radio (wireless) remote control applications.

II. SPECIFICATIONS

Type of Modulation	Direct FM (linearized V.C.O.)
Frequency Range	25 to 185 kHz (specify)
Center Frequency	Adjustable; factory preset to within 1 kHz of specified frequency
Frequency Stability	±0.5% of center frequency
Harmonic Content of Subcarrier	Less than 1%
FM Noise	Better than 65 dB down
AM Noise	Better than 55 dB down
Incidental Amplitude Modulation	Less than 5% peak
Deviation Capability	±15% of center frequency
Modulation Response	20 Hz to 15 kHz
Pre-emphasis	75 μsec., other available on request
Modulation Distortion	Less than 1% with wideband demodulator
Metering	Front-panel meter responds to peak audio level and is calibrated in dB
Input Impedance	600Ω, balanced
Input Level	-15 dBm to +10 dBm
Output Impedance	Less than 300Ω
Output Level	Adjustable up to 2.5 volts rms
Subcarrier Control	On, off, or all-electronic muting
Muting Delay	0.5 to 5 seconds
Envelope Rise and Fall Times	70 milliseconds
Operating Temperature Range	0°F to 150°F
Power Requirements	Approximately 10 watts, 120/240 VAC, 50-60 Hz
Semiconductor Complement	19 transistors, 17 diodes, all silicon types
Size	$3\frac{1}{2}$" X 19" standard rack, $8\frac{1}{4}$" deep
Weight	7 pounds
Domestic Shipping Weight	12 pounds

III. CIRCUIT DESCRIPTION

A block diagram of the SCG-4T is shown in drawing 92A 1011. This diagram is laid out in much the same way as the actual schematic diagram shown in drawing 91C 6360. The power supply is shown in drawing 91A 6183, and the three printed circuit boards are shown in drawings 20A 2091, 20A 2092, and 20A 2151.

The audio input is applied to an input transformer and then to the modulation level control. Transistors Q1 through Q3 form an audio amplifier with built-in pre-emphasis. The output of this audio amplifier is applied to three circuits; the peak voltmeter, the frequency-modulated oscillator, and the muting generator.

A selected amount of the audio voltage drives the peak voltmeter with transistors Q4 through Q6 and diodes CR1 through CR5. The output of this metering circuit drives the front-panel meter which is calibrated in dB. Unlike a conventional VU meter, this front-panel meter is peak-sensitive. Further, an acceleration component has been introduced in order that the meter responds quickly. As a result, the actual meter indication is seldom more than 2 dB below actual instantaneous peaks as viewed on an oscilloscope. This meter responds to total modulation after pre-emphasis. If subaudible telemetering tones are applied to the SCG-4T from a transmitter remote control unit, these tones also will appear on the meter. This meter should not be considered as a modulation monitor meter, but rather as a valuable addition to the SCA generator.

The frequency-modulated oscillator develops a stable subcarrier oscillation. The frequency of oscillation is modulated by the incoming audio signal from the audio amplifier.

The oscillator runs at all times. Its output is lightly coupled to the subcarrier gate formed by diodes CR10 and CR11. The output of this gate is amplified with transistors Q18 through Q20. Low-pass filtering of the subcarrier is employed in order that the output waveform is virtually sinusoidal. This filter is a wideband design to reduce high-frequency distortion in the modulating waveform.

A sample of the audio signal is amplified in the muting amplifier Q7 and Q8. This audio signal is then detected with transistors Q9 and Q10 in conjunction with diodes CR6 and CR7. The output of this detector is a DC voltage which then drives the gate control using transistors Q11 and Q12. This circuit delivers output to the subcarrier gate, CR10 and CR11, turning the gate on when there is audio and turning the gate off when there is no audio. There is no middle ground. The rise time of the subcarrier envelope is always about 70 milliseconds when audio starts, and the fall time of the subcarrier envelope is always about 70 milliseconds when audio stops. These envelope rise and fall times have been chosen to eliminate clicks and pops in the multiplex receiver when the subcarrier is muted on and off.

The time lag between the disappearance of audio and the turn off of the subcarrier is adjustable with the front-panel control labeled MUTING DELAY. The subcarrier can be keyed almost at a syllabic rate, or it can be adjusted to hold on between musical selections.

The audio frequency response of the muting amplifier, and so its sensitivity, is shaped so as to respond only to normal program audio. As a result, subaudible switching tones or high-frequency noise will not hold the subcarrier on.

The gate control also drives a pair of transistors Q13 and Q14 which operate the front-panel lamps to indicate whether the subcarrier is on or off. Although the lamps derive their power from an unregulated voltage in the power supply, the lamp driver transistors act as voltage regulators and maintain the lamp voltages at about 10 volts when they are turned on. The lamps are an extended-life type rated for 50,000 hours of operation.

The power supply is conventional except there is no on-off power switch. A full-wave bridge rectifier and Zener regulator provide all power for the system. The power transformer primary can be rewired in the field for operation on 240 VAC.

IV. INSTALLATION AND OPERATION

The SCG-4T will normally be mounted in the transmitter exciter compartment. The power cord will be connected to any source of 120 volts. Audio input from the telephone line, line amplifier, or limiter is connected to the barrier strip on the rear of the device. The subcarrier output appears at both the front and rear of the unit. This has been done in order to facilitate incorporation of the SCG-4T into any type of multiplex transmitter in use today.

The unit may also be mounted externally to the transmitter, in which case the output line to the transmitter's exciter must be carefully shielded. The line between the SCG-4T and the transmitter should have less than 3000 pf of capacity.

When the unit is ready for operation, turn the SUBCARRIER control switch to the ON position. This holds the subcarrier on regardless of whether or not there is audio modulation present. Then adjust the OUTPUT LEVEL control for the proper subcarrier injection into the FM exciter. This will require an FCC Type Approved SCA monitor, and the injection will generally be set at 9% to 10% for stereo and 10% to 20% for stations transmitting a monaural program. The FREQUENCY ADJUST control can be used to set the unit exactly on frequency.

Now apply audio modulation. Advance the MODULATION control until the SCG-4T front-panel deviation meter is peaking an indicated 0 dB. This will normally deviate the subcarrier the proper amount for currently available multiplex receivers. Present day SCA receivers are typically designed for 6 kHz maximum deviation. The peak-sensitive panel meter on the SCG-4T indicates the peak instantaneous deviation of the subcarrier, and is calibrated arbitrarily in dB.

Switch the SUBCARRIER control switch to the AUTO MUTE position. Adjust the MUTING DELAY control so that the receivers handle the program as smoothly as possible. The MUTING DELAY control will smoothly adjust the time lag between disappearance of audio and muting of the subcarrier. For normal

background music applications the SUBCARRIER control switch should be left in the AUTO MUTE position. When relaying signals which must not have any pops or thumps introduced by the multiplex receiver muting circuitry, as for example a network newscast, it is recommended that the subcarrier be left on at all times or else the muting time be set at maximum.

When operating the main channel in a monaural mode, the frequency response of the audio going into the SCG-4T need not be restricted, and the allowable deviation will be dependent to some extent on the type of receiver in use. But when stereo is being transmitted, the deviation must be held down to 4 kHz on peaks, and the frequency response of the audio being applied to the SCG-4T must be rolled off rapidly above 5 kHz. This is mandatory in order that higher order, lower sideband energy does not penetrate the stereo information region which extends up to 53 kHz. A 5 kHz low-pass filter with mounting bracket is available for simple installation in the SCG-4T. Specify a 5 kHz Low-pass Filter, Type 2-1283, and mounting bracket for the SCG-4T. This filter is connected between the audio input barrier strip and the input transformer as shown on the SCG-4T schematic.

Two subcarriers may be used when stereo is not being transmitted For example, a background music channel might be broadcast on 67 kHz and a network program might be relayed on 41 kHz. In some instances three subcarriers have been simultaneously applied to an FM transmitter.

V. RADIO REMOTE CONTROL

The SCG-4T has been designed with full radio (wireless) remote control of an FM broadcast transmitter in mind. Examination of the schematic will show that there is an extra input to the audio section and an extra output from the subcarrier section. These extra connections are for use with Moseley Associates, Inc. Types II, II/C, and III Radio Remote Control Systems. Operation of the FM transmitter by radio remote control is simplified because the SCG-4T is prewired to handle both types of telemetry (metering) signals.

When the SCG-4T is used with the Moseley Associates, Inc. Type II and II/C Radio Remote Control Systems, it will be located at the transmitter site as in a normal installation. The

subaudible telemetry (metering) output from the Moseley Associates Transmitter Control Unit is connected to the TEL INPUT on the rear of the Model SCG-4T. In this manner subaudible metering tones will modulate the subcarrier with metering information which will be received at the studio to operate the metering system in the Studio Control Unit. These metering tones, in the 20 Hz to 30 Hz range, are about 18 dB below program level and will be inaudible on subscribers' receivers. The tone level can be monitored on the SCG-4T deviation meter. The OUTPUT LEVEL of the SCG-4T is adjusted as in a normal installation.

When the SCG-4T is used in conjunction with a Moseley Associates, Inc. Type III Radio Remote Control System, it will be located at the studio. The subcarrier output from the SCG-4T is connected to one of the multiplex input connectors on a Moseley Associates Studio-to-Transmitter Link. Connect the OUTPUT of the SCG-4T to the MX1 or MX2 jack on the STL transmitter. Also connect the REF OUTPUT to the Model SPC-1 Subcarrier Phase Comparator. This reference output is needed to phase-detect the metering information which is impressed onto the subcarrier by a phase modulation process at the transmitter site. The SCG-4T OUTPUT LEVEL control is adjusted for approximately 20% injection into the STL transmitter, about 1.5 V P-P.

VI. FIELD MODIFICATIONS

If the SCG-4T is to be turned on and off by remote control, the simplest method is to ground pin 8 of the muting board to turn the subcarrier on. Switch the front-panel subcarrier switch to OFF. Pin 8 of the muting board also appears on the subcarrier control switch which may offer easier access for such a field modification. Grounding this point with a relay operated by the remote control system will turn on the subcarrier. The point may be brought out through an unused type BNC connector on the rear of the unit, or a small connector may be added to the rear of the SCG-4T.

Some multiplex receivers are designed for 150 microsecond de-emphasis. If the Model SCG-4T is to be changed from the standard 75 microsecond to 150 microsecond response, capacitor C3 should be changed from 0.1 microfarad to 0.22 microfarad. Flat response, without pre-emphasis, is available by removing C3.

If the muting system seems to have too much sensitivity for a particular application, the gain of the muting amplifier may be decreased by increasing the value of the gain-controlling resistor R39. Conversely, decreasing the value of R39 will increase the muting amplifier sensitivity.

The subcarrier-envelope rise and fall times are controlled by timing capacitor C20. Lowering this capacitor value will shorten both the rise and fall times. Increasing the capacitor value will lengthen both rise and fall times. Notice that this capacitor does NOT affect the muting delay time. Rather, it only affects the subcarrier envelope shape.

If the subcarrier frequency is changed significantly, as for example from 67 kHz to 41 kHz, certain changes must be made to the equipment. One such change is the changing of the oscillator timing capacitors CA and CB. A second change involves changing values in the low-pass filter including LA, LB, and related capacitors. Consult the factory for the proper values of components to be used for the new frequency.

The frequency of the SCG-4T can be most conveniently monitored by connecting a frequency monitor to the REF OUT jack on the rear of the chassis. Subcarrier output will appear at this jack whenever the normal output is avilable, but at a higher level. Although the circuit impedance is very low at this connector, it should not be loaded with a low or reactive load, or incidental amplitude modulation may be generated. If the REF OUT jack already has a connection made to it in a Moseley Associates, Inc., Type III Radio Remote Control System, then a BNC "T" connector will enable the frequency meter to be bridged across the REF OUT jack. When using a digital frequency counter, use a minimum gate time of 0.1 second.

Calibration of the front-panel dB meter is arbitrary. It is suggested that the calibration control, R15, be adjusted so that 0 dB deflection occurs at a subcarrier deviation of ±6 kHz as illustrated in Figure 15A 1009.

APPENDIX I

Frequency Lock of Model SCG-4T with TV Horizontal Sync Pulse

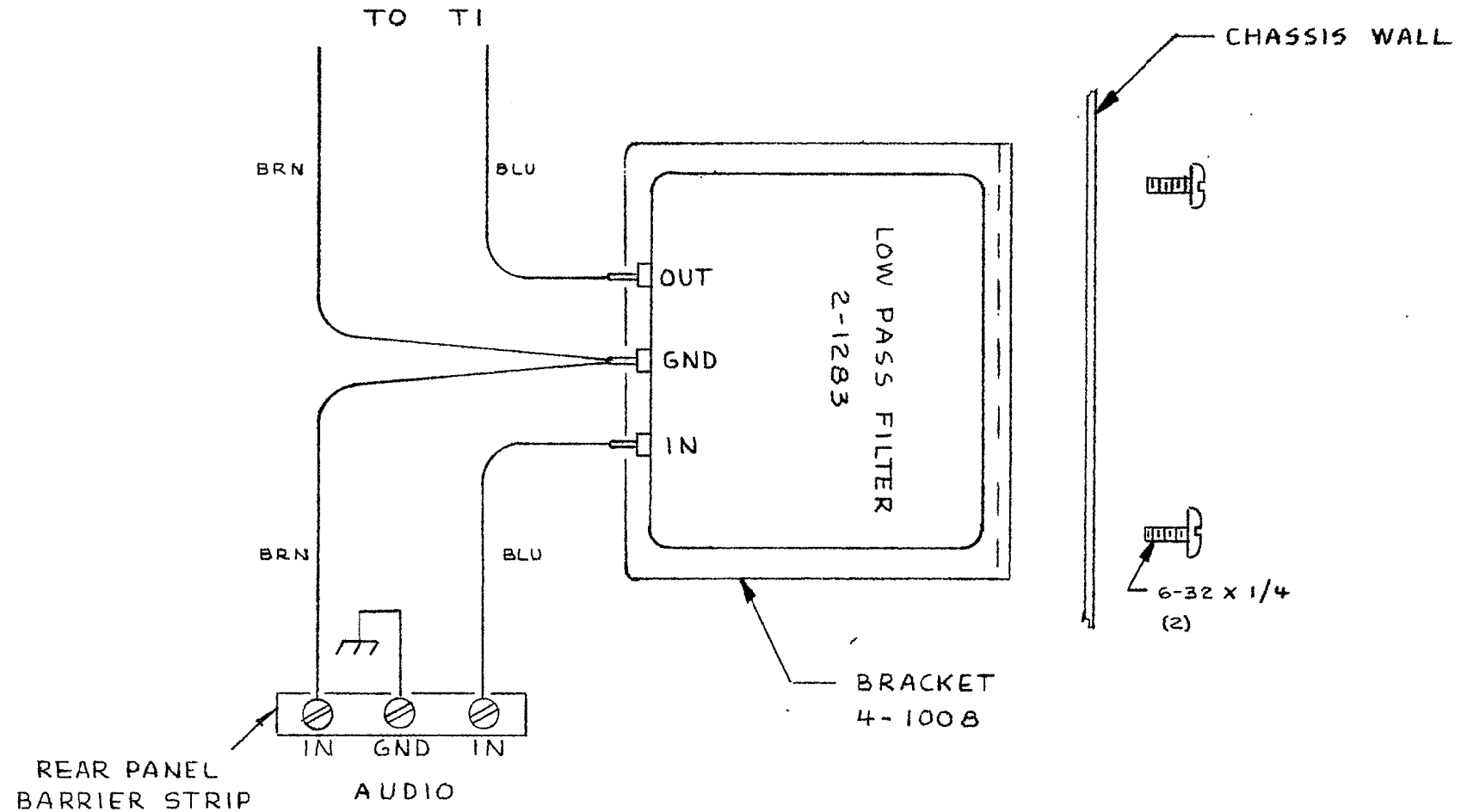
When the SCG-4T is used to multiplex the aural channel of a television signal, operation on 63 kHz (the fourth harmonic of the horizontal sync rate) is highly recommended. This enables synchronization of the SCG-4T oscillator to the horizontal sync pulses available in the television station. Synchronization is necessary if the possibility of a beat note between the 63 kHz subcarrier frequency and the fourth harmonic of the 15,750 Hz sweep rate in the multiplex receiver is to be avoided.

A very simple method of synchronization has been devised to enable the SCG-4T to be locked to the TV station's horizontal 5 microsecond pulse distribution system. Drawing 91A-6210 shows the modification of the SCG-4T. Basically, the 5 microsecond pulse is applied along with the audio and DC frequency-control voltage to the modulated oscillator. The amplitude of this pulse is adjusted so as to just barely synchronize the SCG-4T oscillator. This will cause the distortion in the demodulated SCA subcarrier to increase from about .4% up to approximately 2%, but this is considered permissible. The lock-in range is about 100 Hz under these conditions, which is sufficient to hold the SCG-4T in sync for long periods of time.

A small amount of the SCG-4T subcarrier will be fed back into the horizontal 5 microsecond line. This will be in the vicinity of 35 db to 45 db below the 2 volt level of the line. Should this be considered excessive, it is recommended that a separate distribution amplifier output be supplied to drive the SCG-4T. This line should be terminated since the sync input to the SCG-4T is of high impedance. The load presented to the sync distribution line will be about 500 pf.

The 5 microsecond sync pulse from the TV sync distribution amplifier is applied to the properly labelled BNC connector on the rear of the SCG-4T. Measure this pulse and be sure it is between 2 and 4 volts peak. With the modulation control on the SCG-4T set at minimum, carefully lock the SCG-4T frequency with the fourth harmonic of the horizontal sync rate. This can be done most easily by adjusting the frequency control on the SCG-4T front panel with the aid of an SCA receiver tuned to 63 kHz. Program material can now be applied. Periodic checking of the SCG-4T frequency should be done to assure that no beat notes will occur.

Should the sync pulse be lost, the SCG-4T will run free and will probably remain within a subaudible beat of the proper frequency for moderate lengths of time.



REF. SCHEMATIC 91C6360.

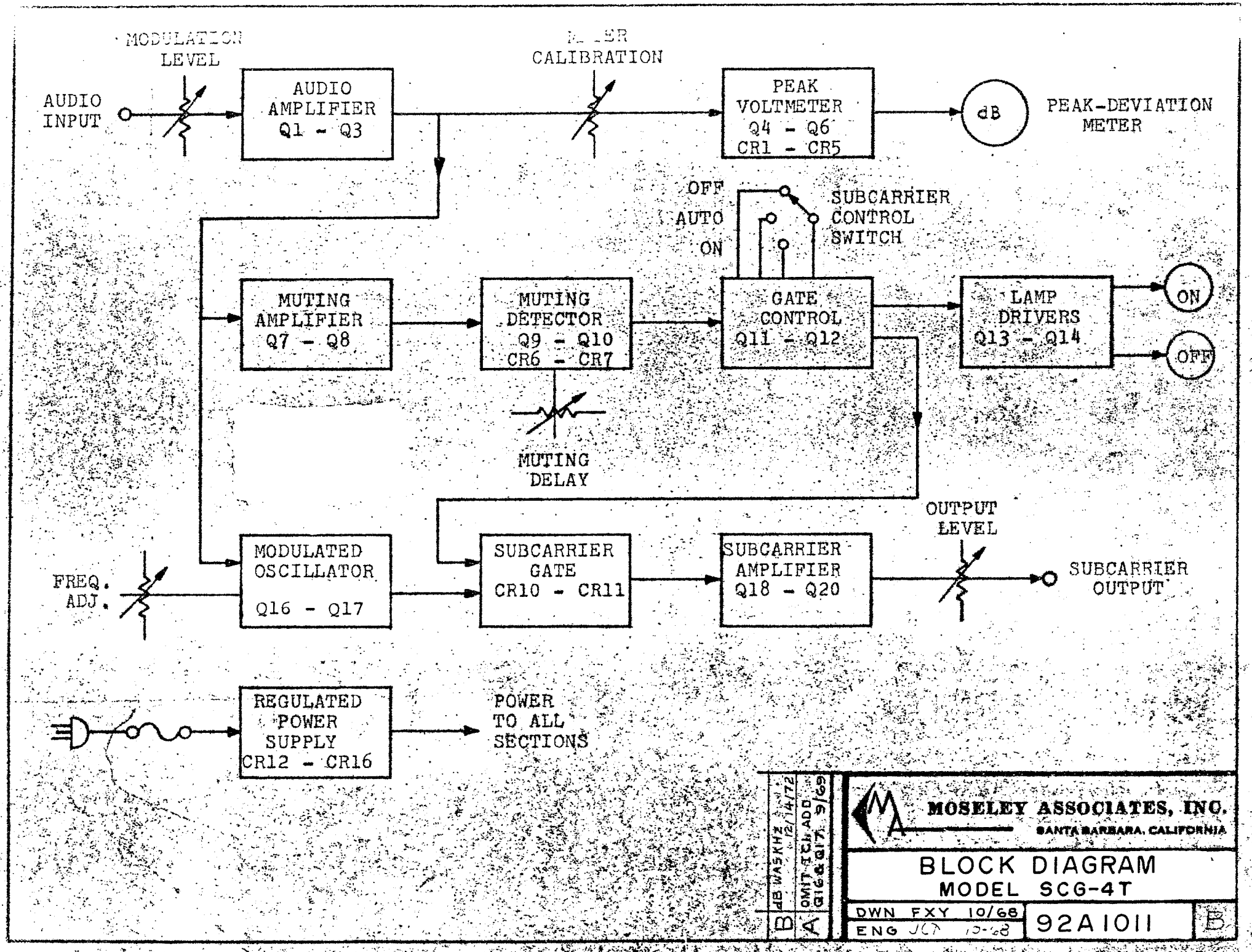
REVISIONS	DATE	MGMT. APPR.

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93017

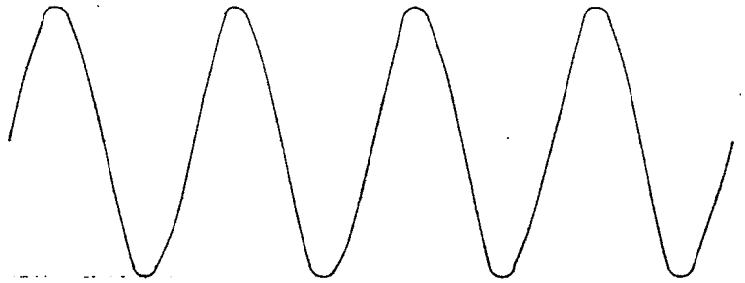
LOW PASS FILTER INSTALLATION
2-1283 TO SCG-4T

TOL: FRACT. ± 1/32, .XX ± .030, .XXX ± .010, ∠ ± 1/2°

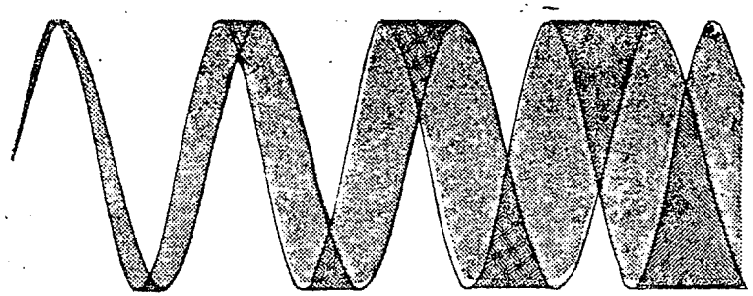
DWN	F XY	11/8/72	SCALE:
CHK			
ENG	JCP	8 NOV 72	93A1050


MODULATION LEVEL
AUDIO INPUT
AUDIO AMPLIFIER Q1 - Q3
METER CALIBRATION
PEAK VOLTMETER Q4 - Q6 CR1 - CR5
dB
PEAK-DEVIATION METER
OFF
AUTO
ON
SUBCARRIER CONTROL SWITCH
MUTING AMPLIFIER Q7 - Q8
MUTING DETECTOR Q9 - Q10 CR6 - CR7
GATE CONTROL Q11 - Q12
LAMP DRIVERS Q13 - Q14
ON
OFF
MUTING DELAY
OUTPUT LEVEL
FREQ. ADJ.
MODULATED OSCILLATOR Q16 - Q17
SUBCARRIER GATE CR10 - CR11
SUBCARRIER AMPLIFIER Q18 - Q20
SUBCARRIER OUTPUT
REGULATED POWER SUPPLY CR12 - CR16
POWER TO ALL SECTIONS
B dB WAS KHz 12/14/72
A OMIT TC1 ADD Q16 & Q17 9/69
MOSELEY ASSOCIATES, INC.
SANTA BARBARA, CALIFORNIA
BLOCK DIAGRAM
MODEL SCG-4T
DWN FXY 10/68
ENG JCT 10-68
92A1011
B

UNMODULATED SUBCARRIER



SUBCARRIER DEVIATED ±9.166% OF CENTER FREQUENCY



SUBCARRIER FREQUENCY	DEVIATION USING STANDARD PATTERN
26 KHz	2.38 KHz
39 KHz	3.575 KHz
41 KHz	3.758 KHz
67 KHz	6.142 KHz
185 KHz	16.96 KHz

REVISIONS	DATE	MGMT. APPR.
A REDRAWN.	17/APR/74 REB	

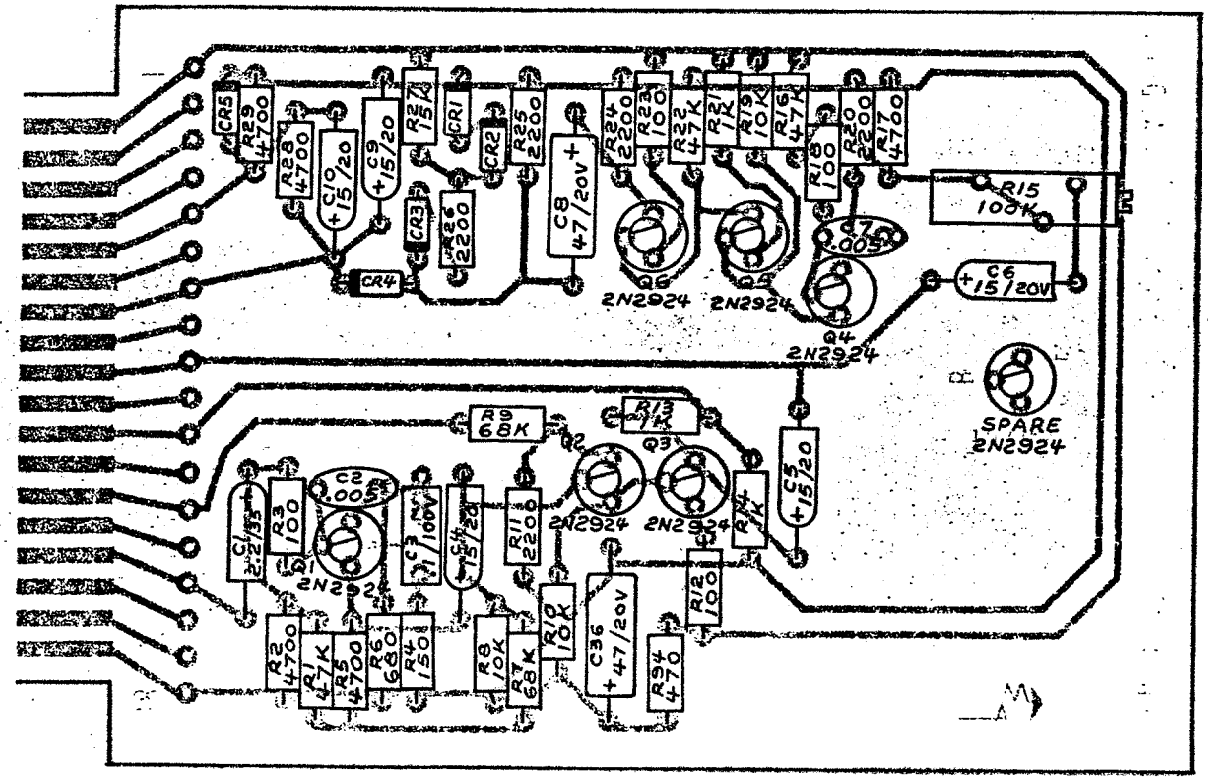
MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93017

METER CALIBRATION
SUBCARRIER GENERATOR

TOL: FRACT. ± 1/32, .XX ± .030, .XXX ± .010, ∠ ± 1/2°

DWN	REB	17/APR/74	SCALE:
CHK			15A 1009 A
ENG	JCP	17APR 74	

B-560 #136



NOTES.

1. TRIM PER 5A1220
2. DRILL PER 51A5166
3. UNLESS OTHERWISE SPECIFIED
   RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%
   CAPACITOR VALUES ARE IN MICROFARADS.
4. ⊣▭⊢ DENOTES IN4154 DIODE
5. THIS DWG. SUPERSEDES 2A1187
6. SCHEMATIC 91C6360

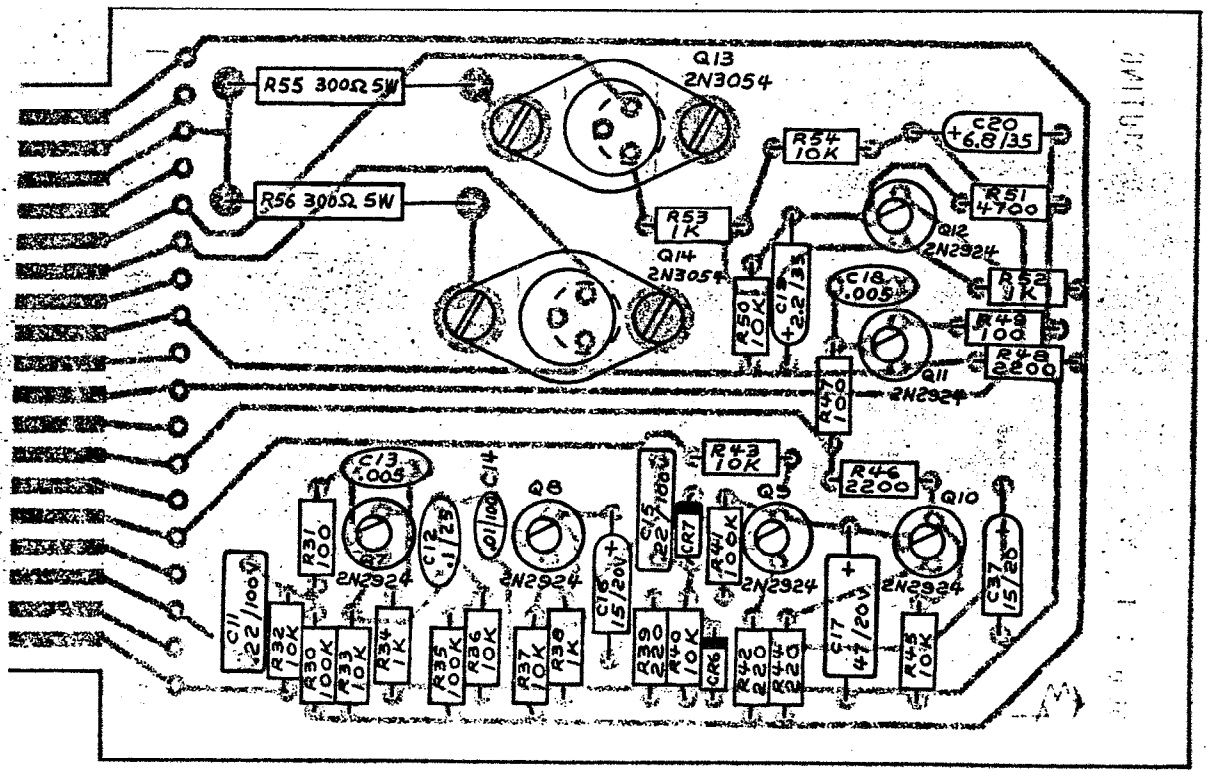
REVISIONS	DATE	SCHEMATIC WAS
A	11/17/72	91C6283

MOSELEY ASSOCIATES, INC.
SANTA BARBARA, CALIFORNIA

COMPONENT LAYOUT.
AUDIO BOARD A — SCG-4T

TOL. FRACT ± 1/32, .XX ± .030, .XXX ± .010

DWN	F X Y	9/68	SCALE: FULL
CHK			20 A 2091 A
ENG			



NOTES:

1. TRIM PER 5A1220
2. DRILL " 51 A 5157
3. UNLESS OTHERWISE SPECIFIED
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   CAPACITOR VALUES ARE IN MICROFARADS.
4. ⊣▭⊢ DENOTES IN4154 DIODE.
5. THIS DWG SUPERSEDES 2A1188
6. SCHEMATIC 91C6360.
7. Q13 & Q14 ARE MOUNTED ON 1/4"DIA. 3/8" THREADED SPACERS WITH TWO 6-32 X 1/4" SCREWS EACH SPACER

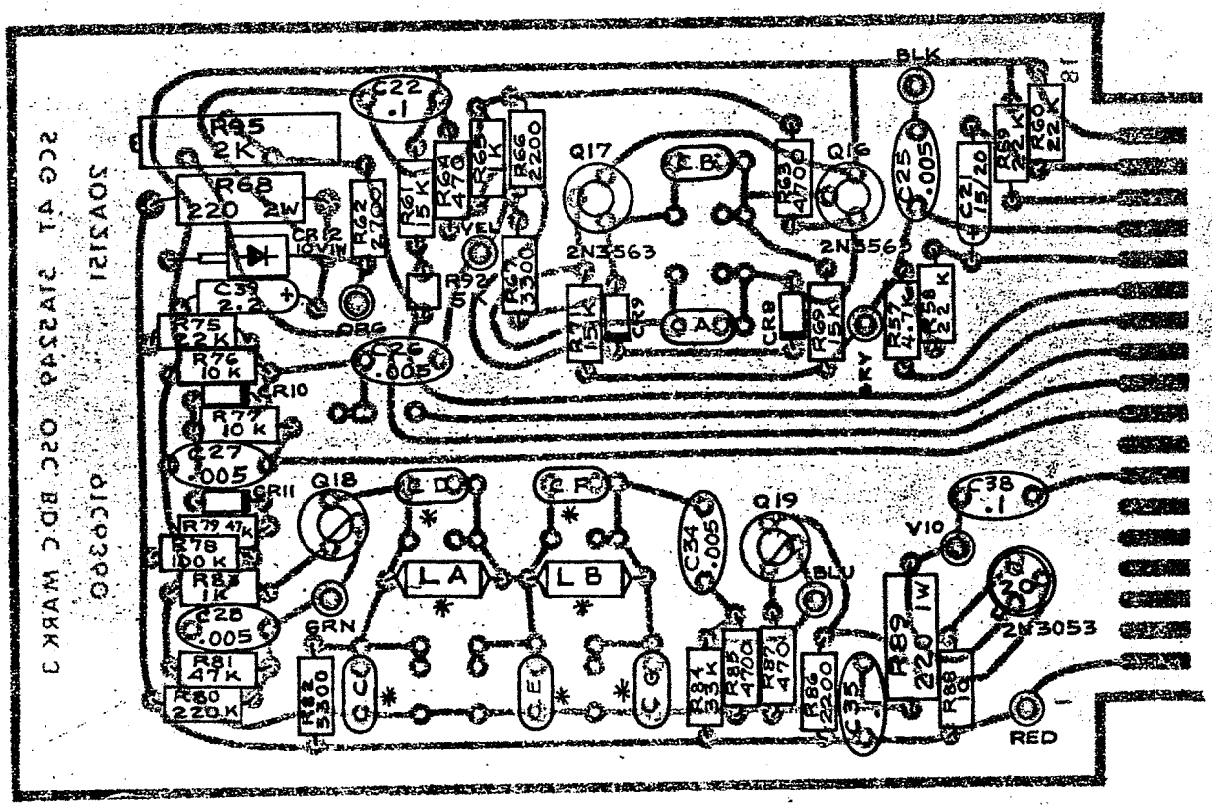
REVISIONS	DATE	
A	11/17/72	SCHEMATIC WAS 91C6283. C12 & Q14 TO DISC.

MOSELEY ASSOCIATES, INC.
SANTA BARBARA, CALIFORNIA

COMPONENT LAYOUT
MUTING BD. B — SCG-4T

TOL. FRACT ± 1/32. .XX ± .030. .XXX ± .010

DWN	F X Y	9/68	SCALE: FULL
CHK			20 A 2092 — A
ENG			



NOTES:

1. UNLESS OTHERWISE SPECIFIED
   RESISTOR VALUES ARE IN OHMS 1/2 W, 10%
   CAPACITOR " " " MICROFARADS
   DIODES ARE IN4154
   TRANSISTORS ARE 2N2924
2. * VALUES OF CA-CG, LA & LB SHOWN ON DWG. 94A4501
3. TRIM & DRILL 51A5249
4. SCHEMATIC 91C6360

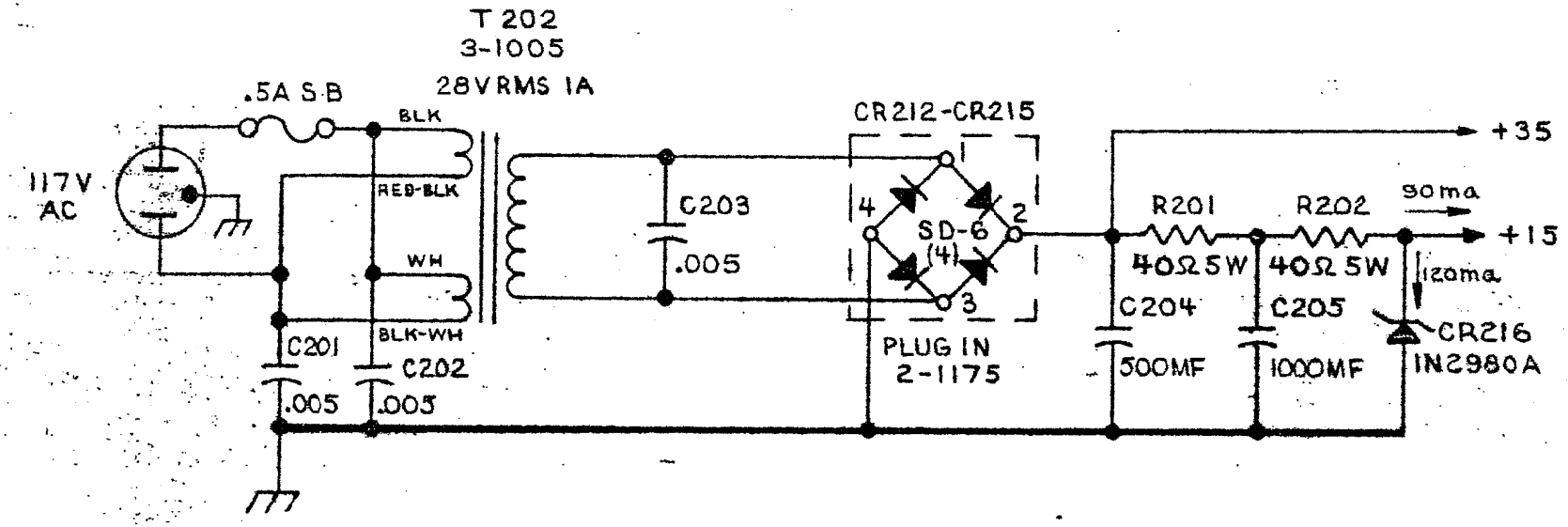
REVISIONS	DATE	
D	R95 WAS 2500Ω. ECO 466	8/26/71
C	R58 WAS 4.7 K. ECO 346.	5-70
B	Q16 & Q17 WERE 2N3644. REVISE NOTE 2. ECO 359	11/70
A	C23 & C24 WERE * ECO 319.	2-70

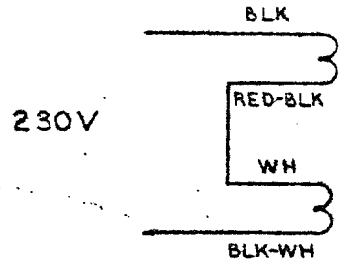
MOSELEY ASSOCIATES, INC.
SANTA BARBARA, CALIFORNIA

COMPONENT LAYOUT
OSCILLATOR BOARD C SCG-4T

TOL. FRACT ± 1/32, .XX ± .030, .XXX ± .010

DWN	JAG	9-69	SCALE: FULL
CHK	FXY	9/69	
ENG	JCP	9-69	20A2151 D

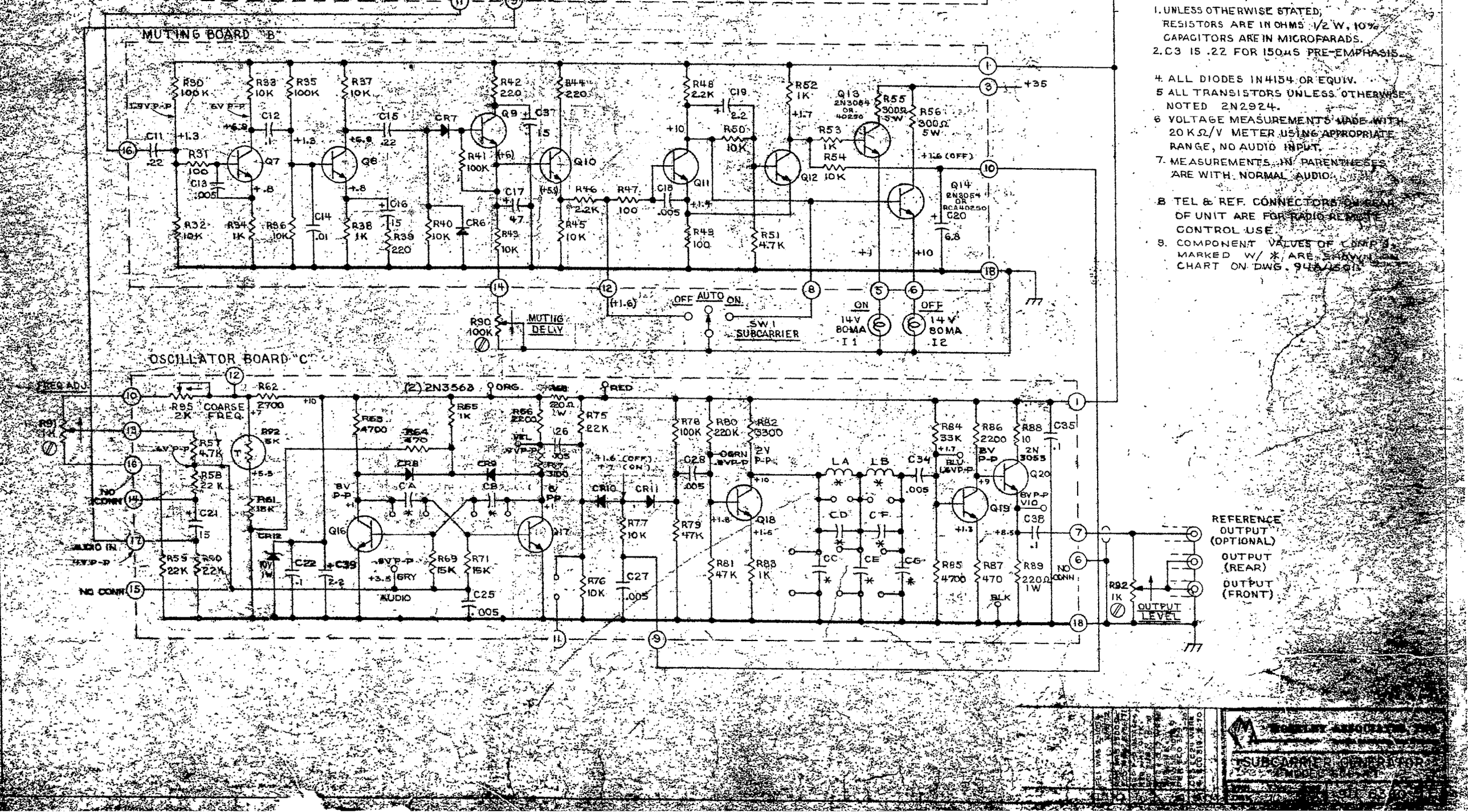




MOSELEY ASSOCIATES, INC.
SANTA BARBARA, CALIFORNIA

POWER SUPPLY
MODEL SCG-4T

DWN	FXY	7/66	91A 6183
CHK	MT	7/66	


MUTING BOARD "B"
OSCILLATOR BOARD "C"
NOTES:
1. UNLESS OTHERWISE STATED, RESISTORS ARE IN OHMS 1/2 W, 10%. CAPACITORS ARE IN MICROFARADS.
2. C3 IS .22 FOR 150μS PRE-EMPHASIS.
4. ALL DIODES IN4154 OR EQUIV.
5. ALL TRANSISTORS UNLESS OTHERWISE NOTED 2N2924.
6. VOLTAGE MEASUREMENTS MADE WITH 20 KΩ/V METER USING APPROPRIATE RANGE, NO AUDIO INPUT.
7. MEASUREMENTS IN PARENTHESES ARE WITH NORMAL AUDIO.
8. TEL & REF. CONNECTORS ON REAR OF UNIT ARE FOR RADIO REMOTE CONTROL USE.
9. COMPONENT VALUES OF COMP'S MARKED W/ * ARE SHOWN ON CHART ON DWG. 948/1501
MUTING DELY
SW1 SUBCARRIER
OFF AUTO ON
I1 14V 80MA
I2 14V 80MA
FREQ ADJ
COARSE FREQ.
(2) 2N3563
ORG
RED
AUDIO IN
NO CONN
AUDIO
OUTPUT LEVEL
REFERENCE OUTPUT (OPTIONAL)
OUTPUT (REAR)
OUTPUT (FRONT)
SUBCARRIER GENERATOR