McMartin industries, inc.

SMR-1

COORDINATION CHANNEL
MODULATOR

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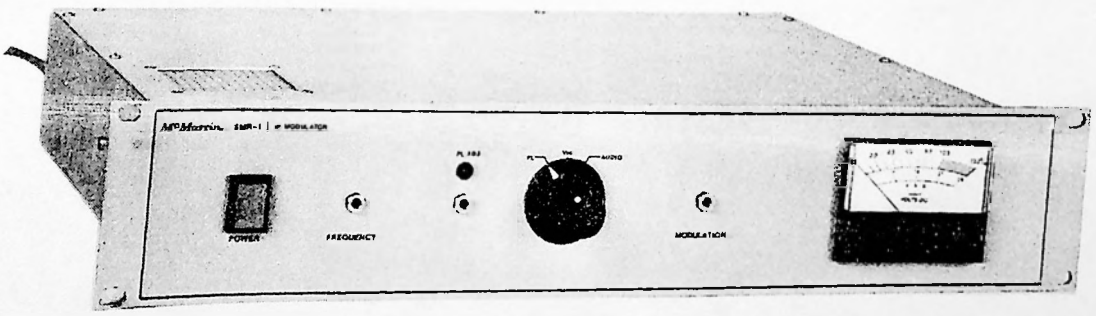
INSTRUCTION MANUAL

SMR-1

COORDINATION CHANNEL MODULATOR



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1.0 Description and Technical Data

1.1 Scope and Purpose of Manual

This instruction manual addresses the SMR-1 Coordination Channel Modulator. Its purpose is to provide instructions for the proper installation, operation, and maintenance of the Coordination Channel Modulator.

1.2 Purpose of Equipment

The SMR-1 Coordination Channel Modulator is intended for use in satellite networks for broadcast distribution. Its main purpose is to facilitate programming and operational coordination of the network by means of voice or data communications between satellite ground terminals originating and those receiving programs. Audio fidelity is adequate for occasional use for second-language program narration, in addition to its normal use for coordination purposes.

1.3 Illustration and Description of Equipment

Figure 1 is a photograph of the SMR-1 Coordination Channel Modulator showing front panel controls and adjustments. Table 1 presents the Technical Specifications for this equipment.

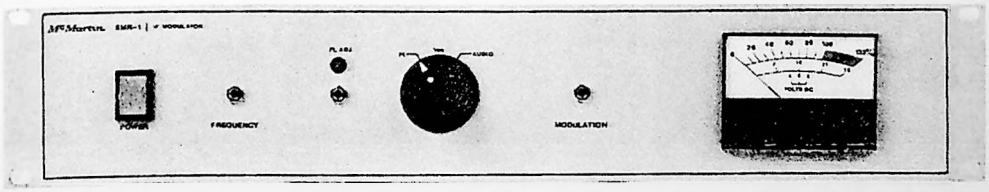


FIGURE 1

TABLE 1

GENERAL SPECIFICATIONS--SMR-I

Audio Input	
Impedance	600 ohm, balanced
Level	+18 dBm
Pre-Emphasis	~~75 us~~ none
Deviation	±10 kHz, peak
Deviation Sensitivity	continuosly adjustable over approximately 20 dB range
Output	
Frequency	70-85 MHz
Level	-10 dBm ± 1dB
Impedance	50-75 ohm
Occupied Bandwidth	25 kHz
Spurious	70 dB Below carrier
Harmonics	30 dB Below carrier
Frequency Response *	±1.5 dB (100 Hz - 5 kHz)
Distortion *	
ThD	<2%, <1% (100Hz - 5 kHz)
IM	<1%, <3% (100Hz - 5 kHz)
Signal to Noise *	Better than 60 dB
Primary Power	120 VAC ± 10% 50/60 Hz, 25 W
Size Overall	H = 3 1/2" (8.9 cm) W = 19" (48.3 cm) D = 13" (33.0 cm)
Finish	Front panel (painted -beige enamel) Chassis (etched aluminum)
Environmental	Will operate within above limits from 0° to 50° C.

* Operated back to back with companion demodulator.

GENERAL DESCRIPTION

The SMR-1 is a low power modulated RF source designed to operate in the 70-85 MHz frequency band.

The modulator uses a crystal referenced phase lock technique to generate a direct FM modulated signal.

Figure 2 is a block diagram showing the general circuit arrangement of the SMR-1.

A balanced 600 ohm audio input is provided by the input transformer. Following this is a 75 microsecond pre-emphasis and a band-limiting filter.

Output of this filter is amplified and applied to the modulated oscillator and to the panel meter to indicate audio level.

The output frequency of the modulated oscillator is doubled to provide the desired output frequency in the 70-85 MHz band. The output frequency is then divided by 10 and 2^{14} and is compared to the crystal reference oscillator divider. The reference crystal frequency is divided by 2^{14} and the comparator output is the error voltage of the two divided frequencies. The error voltage is sent through a low pass filter to a correction diode in the modulated oscillator which keeps the output frequency at the desired point. The RF output is adjustable to nominal -10 dBm level and filtered by a multi-section band pass filter.

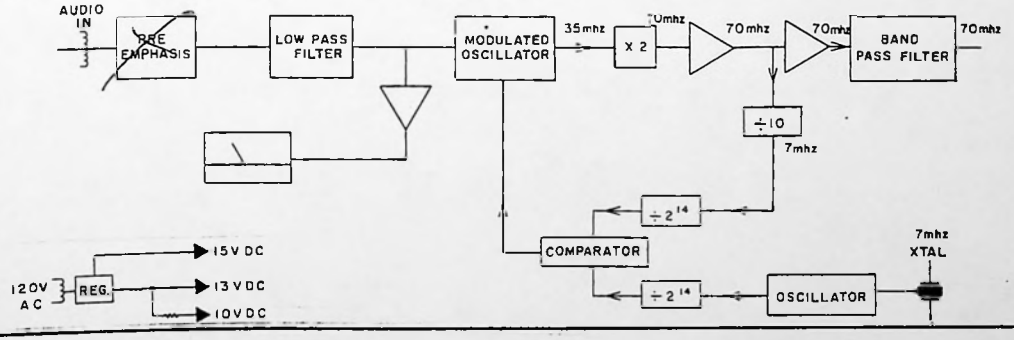


FIGURE 2

2.0 Unpacking and Installation

2.1 Unpacking

Inspect the unit for damage which might be incurred during shipment. Particularly note the condition of the paint, meter face and panel for scratches or dents. If damage is detected, immediately notify the shipper and report the damages.

Observe if there are any loose items rattling within the case. If so, remove all of the top cover screws and observe if all transistors and IC's are seated properly in their sockets. Sometimes severe vibration in shipment can loosen components and hardware. Replace the top cover and the 14 screws.

2.2 Installation

Connect the rear mounted BNC output connector to a suitable 50 to ohm load.

Connect a suitable source of audio to the rear terminal strip TBI. Terminal #1 is ground #2 and #3 is the balanced 600 ohm input. The input level should be approximately +18 dBm peak. Connect the AC plug to a suitable 120 VAC receptacle.

Position the front panel meter switch to the audio position. The meter will now read the sine wave audio level of modulation with 100% on the meter corresponding to $\pm$10 kHz deviation.

The SMR-1 should be mounted in a suitable equipment rack preferably close to the RF load to be connected to the SMR-1. The unit also should not be mounted directly above high heat producing equipment which would allow the ambient temperature to exceed 50^{o}C.

3.0 Operation

3.1 Theory of Operation

Refer to the schematic diagram at the end of the manual.

AUDIO SECTION

The audio input is fed into a transformer coupled input through a matching resistor/attenuator circuit. The transformer output feeds transistor Q1 through Bridged-T network. ~~This and a similar network at Q1 output function to pre-emphasize the signal at 75 microseconds.~~ The output of Q2 drives the 5 kHz low pass filter which is used to limit the highest audio frequency. The output is then further amplified by Q3 - Q4 combination which drives the modulated oscillator varactors.

MODULATED OSCILLATOR

Transistor Q5 functions as a 50 MHz low noise varactor modulated oscillator Audio from the audio section is connected to Varactors VVCI-4 which are connected across the tank coil L1. This oscillator is running at 1/2 the desired output frequency.

The output frequency of Q5 is doubled by Q6 and the amplified to the desired output level by the following Q7-Q8 amplifiers. In the emitter of Q8 is a 100 ohm trimpot which is used to adjust the output level at the desired -10 dBm. Q8 is capable of delivering considerably more power than -10 dBm since a great deal is lost through the multi-section low pass filter. The RF output of amplifier Q7 is sampled and fed to IC5 which is a divide frequency by 10. Output fron IC5 is transformer couplied to two more cascaded dividers which provide a total of 2^{14} divisions. This square wave signal is compared to another swuare wave signal which is similarly derived from a crystal which is operated at exactly one-tenth of the desired operating frequency. The two derived square wave signals are compared in integrated circuit IC2.

The output of IC2 (a correction DC voltage) is amplified in a 2 transistor differential amplifier consisting of Q9 and Q10. One side of this amplifier drives the correction Varactor VVC-5 and the other side of the differential amplifier drives the front panel meter in the PLL position.

The audio driving the modulated oscillator is sampled just prior to the isolation RF choke. This sample is connected to the input of IC6, the LM380 audio amplifier which drives the meter in the audio position.

The circuitry surrounding IC6 rectifies the audio for the meter and controls the balistics of the meter in the audio position. R78 is the meter zero adjust (set with no modulation) and R87 is the full scale adjust (set for 100% with sine audio input, referenced to a known modulation of 100%). R_3, VVC6, VVC7, and R89 are the netting circuitry for the referency crystal. (VVC7 may be a FIXED MICA.)

POWER SUPPLY

The power supply consists of two power transformers. One is used to provide 12VAC to power the heating element of the crystal oven. The second power transformer which is switched on and off by the front panel switch has a bridge rectifier and a three terminal regulator, IC7, which provides the main 15V buss. The 15V supplies the audio strip and the RF output stages. The 15V is dropped to 13 volts and regulated by D3 to supply power to the divider IC's. The 13 volts is further regulated to 10 volts to supply the power to the modulated oscillator. A sample of the 15 volts regulated supply is used to provide the VCC reference for the front panel meter. The 5V is regulated from the 13V line and is used for the phase comparator and divide by 10 chips (IC2 and IC5).

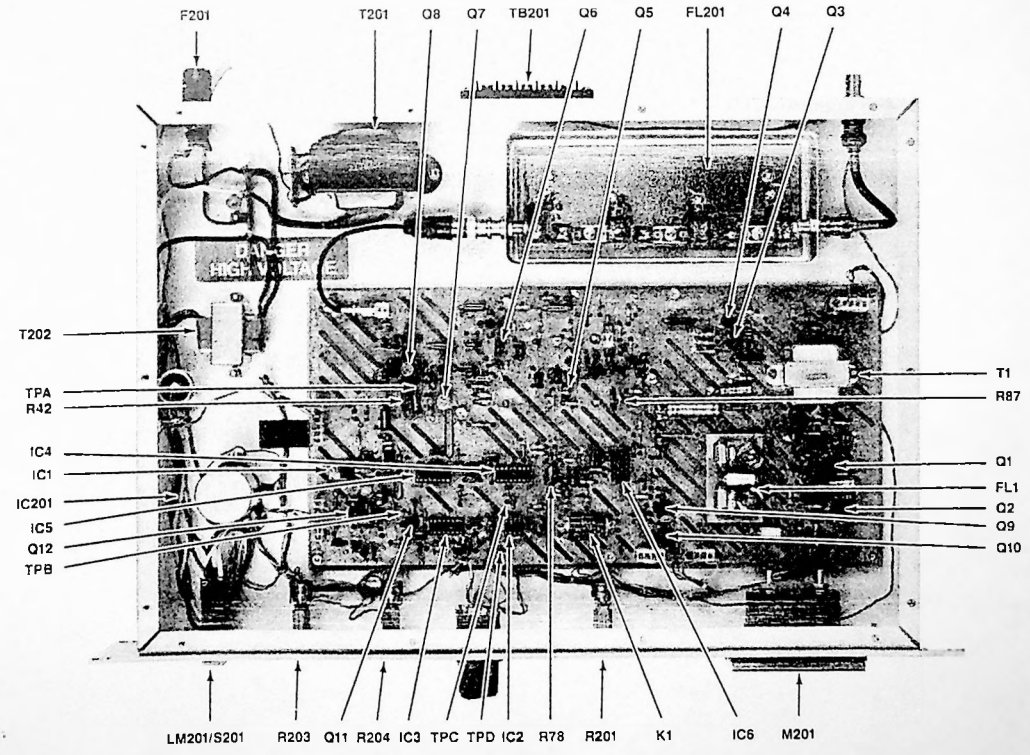
3.2 Controls and Indicators

The modulation sensitivity adjustment located on the front apron is used to set the desired modulation for an input level +18 dBm.

The frequency adjust is used to set the center frequency of the crystal. This adjustment sets the voltage on voltage-variable-capacitors VVC6 and VVC7, which in turn alters the crystal frequency.

The PL adjust is used to set the range of the locking window within the center of the desired area. Using the meter in the PL position, adjust this control for 100%.

The meter switch has three positions; one is explained above; two, VVC, should display the power supply voltage of the 15V regulated supply; three shows the presense of modulation.



3.3 Checkout Procedure

EQUIPMENT REQUIRED:

SDR-1 of known performance

HP-333 Distortion Analyzer

Low Distortion AF Generator

HP-432A Wattmeter (milliwatts)

VOM

Spectrum Analyzer

General Purpose Oscilloscope

GENERAL

1. Check for mechanics and electrical workmanship.
   a. Metal and silkscreens.
   b. PCB, coils, pots, etc. in correct vertical position.
2. Plug SMR-1 into variac and check output of (IC7) 15V regulator from 105 to 130 VAC.

REFERENCE OSCILLATOR (Q11, Q12 and IC3)

1. Connect scope to TP-D and observe waveform. It should be very close to that shown in Fig.1. This verifys operation of cyrstal oscillator and 2^{14} (Q11, Q12, and IC3).
2. If the above waveform does not appear, put voltmeter at TP-B. Reading should be 3V showing oscillation 2.7V, no oscillation. Remove crystal to verify about a .3V change.

RF CHAIN (Q5-8)

1. Put DC voltmeter at TP-A and tune L2 for maximum, L3 for slight dip.
2. Connect scope to TP-C and note waveform. It shoulp appear as in Fig.2.

Make sure lock range control is centered (R4, main frame).

3. Compare frequency at TP-C with frequency at TP-D. (Oscilloscope is sufficiently accurate.) NOTE: Both Fig. 1 and Fig. 2 show 2.6 cycles indicating similar frequencies. If the two are not the same, tune L1 until they are. If waveform at TP-C disappears, retune L2 and L3 as before at TP-A. If L1 appears to have insufficient range, C15 may need to be changed; 56 pf to raise, 82 pf to lower. Corresponding changes may be required to C25 (add) C30 and C35.
4. Once the two frequencies are close it should aquire lock. Lock alarm indicator should change from red to green. Set L1 so that PL meter is about 1/2 way between the two lock points. This should be done with R4 centered. (100% typical.)
5. Connect RF milliwatt meter to output and peak L2, L3, L4.
6. Observe output on spectrum analyzer and milliwatt meter. Tune FL1 for best output with least spurs. (Observe out to 1.5 GHz)
7. Set R42 for an output level of -10 dBm. If there is insufficient range, replace R92 with different values until -10 dBm is in the range of R42. R-42 should be able to change the output level at least 3 dB above or below the -10 dBm reference. NOTE: The two most important specs are FM noise and spurs, spurs >-70dB, harmonics >-30dB, noise >-60dB.
8. With a frequency counter set the carrier to the desired frequency by adjusting R3 (main frame), to $\pm$ 10 Hz.
9. Set meter to audio and adjust R78 for zero.
10. Connect audio generator to 600 ohm input. Set for 400 Hz and +18 dBm. Adjust R1 for $\pm$10KHz deviation on calibrated receiver and set R87 for 100% on meter. Remove audio and check noise.
11. Run frequency response curve to 8KHz to verify audio filter cuts off

at 5 KHz and pre-emphasis is in a standard 75 micro-seconds curve, also check that distortion is less than 1%.

Frequency	+18 dB Reference	
	Max.	Min.
100 - 400	+.2	-0
1K	+1	+.5
2K	+2.8	+2.3
3K	+4.8	+4.3
4K	+6.5	+6
5K	+8.2	+7.7

12. Check for indicator corrections: LED should be green in locked condition, meter reads 15V in VCC position, PLL and audio, PWR switch lit and working, oven warm.

3.4 Operating Instructions and Procedures

The power switch should be lit showing power is applied to the unit. After the SMR-1 has been operating for at least 30 minutes, verify the operating frequency by connecting a frequency counter to the RF output BNC connector. If the output frequency is not exactly on frequency, adjust the front panel mounted fine frequency adjust labeled frequency with a small screwdriver. Rotate the control until the desired frequency is obtained. If the frequency does not seem to move, it is likely that the unit is not in phase lock. The modulator has mounted directly above the PL-ADJ control a two-color LED. The LED should normally be indicating green. If the color is red, adjust the PL-ADJ with a small screwdriver until the light indicates green. Then position the meter switch to PLL. In this position the meter is indicating the comparator output voltage which is correcting the modulated oscillator. Adjust the PLL-ADJ until the meter is indicating 100%.

The VCC position on the meter shows the proper operation of the 15V regulator IC7. The unit is designed to be operated continucusly.

NORMAL INDICATORS: Power lamp on, LED green, meter in PLL position should indicate approximately 100%.

4.0 Maintenance

The SMR-1 modulator has been aligned and calibrated at the factory and should require no realignment in normal operation.

Understanding of the theory of operation as described in section 3.1 is necessary to successfully align this equipment. In addition, proper test equipment is required. It is recommended that the unit be returned to the factory if proper test equipment is not available. If proper test equipment is available, adjustments may be made as described in section 3.3, Checkout Procedures.

4.1 List of Required Test Equipment

The following test equipment is called out in the alignment procedures. This or equivalent equipment is recommended:

SDR-1 of known performance

Distortion analyzer / AF voltmeter

Low distortion AF generator

RF milliwatt meter

VOM

General purpose oscilloscope

RF Spectrum analyzer (if output filter is to be adjusted)

Frequency counter

4.2 General Alignment Procedure

1. Apply 120VAC to line cord. Depress off-on switch. Verify that 12 VAC is applied to the crystal oven.
2. With a DC voltmeter observe the presence of 15 VDC ± 1V at the output of IC7.
3. Insert a crystal into the crystal socket.
4. With a sensitive oscilloscope, observe the waveform at the collector of Q11. This will demonstrate the crystal oscillator is functioning.
5. Connect a sensitive oscilloscope to the base of Q6. This should be near the desired operating frequency also.
6. Successively follow the RF through the succeeding stages Q6, Q7, and Q8. Tune L2, L3, and L4 for maximum output at the output of Q8.
7. Using a oscilloscope, verify that the IC5 (95H90) is dividing by 10 producing a 7 MHz square wave at the input of IC4. (Pin #10)
8. Position the meter switch in the PLL position and adjust oscillator coil slightly for a 100% reading on the meter with the PLL adjust, R4, positioned in the center of its range.
9. The meter will normally exhibit a small amount of searching just before phase lock is obtained.
10. Position the meter switch to audio and adjust the meter zero adjustment R78 for a zero reading.
11. Apply 5,000 Hz audio to the input and set the modulation to 100% using an external deviation meter.
12. Adjust the modulation CAL to read 100% on the modulation meter.
13. Remove the audio from the input and observe the signal to noise ratio to be equal to 55dB or less, using an external deviation meter.
14. With the modulator phase locked, the front panel indicating LED should appear green, turning the PLL adjust sufficiently to one side or the other

should change the color to red as it looses lock.

15. With the LED showing green, remove the AC power and reapply the AC power. The unit should relock within 10 secondes and again indicate green.

16. Apply a sweeping 70 MHz RF generator to the input of the BP filter using RF sweeper adjust all controls of the bandpass filter for a maximum sharpness as observed by stopband rejection.

17. Connect the output of the modulated oscillator circuit board to the input of the BP filter and connect a suitable power indicating device to the rear terminal of the modulator.

18. Adjust the RF output level. Adjust R42 for an output power of -10 dBm ± 1 dB.

19. Verify frequency response and distortion performance as listed in the specifications.

5.0 Parts List for Ordering

The majority of the components in the SMR-1 are of standard value and tolerance and generally available from local electronic parts distributors. Those items of McMartin manufacture or of special value or tolerance are listed:

CHASSIS PARTS

SYMBOL	P/N	DESCRIPTION
C-201	600040	Capacitor, 1000 uf/63V Elect.
C-202	640003	Capacitor, .01 uf/500V Disc
C-203	650046	Capacitor, 33 pf/500V Mica
D-201,204	210008	Diode, Rectifier IN4004
F-201	280001	Fuse, .5 amp Slo-Blo
FL-201	935073	Filter, Output
IC-201	230084	Circuit, Intergrated 15V LM-340T15
LED-201	220052	Diode, light emitting, Green MV-2553
LM-201	290014	Lamp, 6V #337
M-201	700079	Meter
R-201	401013	Pot, 1K ohm 1/2 W RV6
R-202	502154	Resistor, 560K ohm +5% 1/2 W
R-203,204	401016	Pot, 10K ohm 1/2 W RV6
R-205	502090	Resistor, 1.2K ohm +5% 1/2 W
SW-201	484024	Switch, Push Button SPDT
SW-202	492025	Switch, Rotary 2 Pole, 5 Pos.
T-201	9000101	Transformer 12V F-25X
T-202	9000100	Transformer, Power 2-P 191A

SYMBOL	P/N	DESCRIPTION
C-1	650049	Capacitor, 8200 pf/500V Mica
C-1A	650017	Capacitor, 910 pf/500V Mica
C-2,7	670004	Capacitor, 2.2 uf/20V 10% Tant.
C-3,26,70	650010	Capacitor, 82 pf/500V Mica
C-4,32,33,34	650023	Capacitor, 47 pf/500V Mica
C-5,47	600005	Capacitor, 47 uf/10V Elect.
C-6*	650025	Capacitor, 470 pf/500V Mica
C-8	600060	Capacitor, 35 uf/50V Elect.
C-9	600033	Capacitor, 4.7 uf/63V Elect.
C-10,12	670007	Capacitor, 4.7 uf/50V 10% Tant.
C-11	600006	Capacitor, 64 uf/63V Elect.
C-13	650046	Capacitor, 33 pf/500V Mica
C-14	640010	Capacitor, 27 pf/500V Disc
C-15,36	650016	Capacitor, 68 pf/500V Mica
C-16	640027	Capacitor, .005 uf/500V Disc
C-17	650019	Capacitor, 24 pf/500V Mica
C-18,21,22,23, 28,56,61	640049	Capacitor, .001 uf/50V Disc
C-19,39,41,43,45,49, 50,52,58,69,75	670025	Capacitor, 22 uf/16V 20% Tant.
C-20	650031	Capacitor, 5 pf/500V Mica
C-24,31,42,46, 53,60,74	640047	Capacitor, .01 uf/50V Disc
C-25,57,65,67,68	670013	Capacitor, 100 uf/20V 20% Tant.
C-27,30	650013	Capacitor, 330 pf/500V Mica
C-29,35,64	650035	Capacitor, 20pf/500V Mica
C-37	650020	Capacitor, 10pf/500V Mica
C-40,51	640032	Capacitor, .05 uf/12V Disc

SYMBOL	P/N	DESCRIPTION
C-44,71	670026	Capacitor, 1 uf/35V 20% Tant.
C-48,54	670020	Capacitor, .1 uf/35V 10% Tant.
C-55,62,63	650012	Capacitor, 150 pf/500V Mica
C-59	650018	Capacitor, 220 pf/500V Mica
C-66	670015	Capacitor, 33 uf/15V 10% Tant.
C-73	670022	Capacitor, 4.7 uf/20V 20% Tant.
VVC-1-7	680034	Capacitor, Voltage Variable MV-2205
D-1,2,5,6	220005	Diode, IN-3604
D-4	210008	Diode, Rectifier, IN-4004
D-7,8	220006	Diode, IN-87
FL-1	935059	Filter, 5 kHz Low-Pass
IC-1	230043	Intergrated Circuit UGH-7805
IC-2	230047	Intergrated Circuit 567
IC-3,4	230082	Intergrated Circuit CD-4020
IC-5	230042	Intergrated Circuit 95H90
IC-6	230037	Intergrated Circuit LM-380N
K-1	470031	Relay, Reed SPDT 2000 ohm 10V
L-1	930101	Coil, Yellow 4 1/2 Turns
L-2,4	930240	Coil, Orange Oscillator
L-3	930102	Coil, Red 2 1/2 Turns
Q-1,11,12	201050	Transistor, NP-4010
Q-2	201056	Transistor 2N-3569
Q-3,9,10	201049	Transistor, PN-4002
Q-4	201033	Transistor, 2N-2102
Q-5,6	201079	Transistor, 2N-5179
Q-7,8	201081	Transistor, 2N-3866

SYMBOL	P/N	DESCRIPTION
RFC-1	930099	Choke, .5 M.H.
RFC-2-7	930018	Choke, Parasitic Suppressor
R-3,43,73	500030	Resistor, 180 ohm ±5% 1/4 W
R-4,8,15,24,63,77,85	500012	Resistor, 4.7K ohm ±5% 1/4 W
R-5,37,39,66,84	500003	Resistor, 470 ohm ±5% 1/4 W
R-6,13,21	500024	Resistor, 15K ohm ±5% 1/4 W
R-7	500016	Resistor, 27K ohm ±5% 1/4 W
R-9,10,11,25,31,45,46 65,81,86,88	500014	Resistor, 10K ohm ±5% 1/4 W
R-12,33,35,71	500010	Resistor, 2.7K ohm ±5% 1/4 W
R-14	500041	Resistor, 56K ohm ±5% 1/4 W
R-16,22	500031	Resistor, 220 ohm ±5% 1/4 W
R-17,29,38,52,69	500006	Resistor, 1K ohm ±5% 1/4 W
R-18	502156	Resistor, 680K ohm ±5% 1/2 W
R-19	500029	Resistor, 330K ohm ±5% 1/4 W
R-20,23, 76	500008	Resistor, 1.5K ohm ±5% 1/4 W
R-26,90	500004	Resistor, 560 ohm ±5% 1/4 W
R-27,49	500027	Resistor, 220K ohm ±5% 1/4 W
R-30,36,60	500001	Resistor, 100 ohm ±5% 1/4 W
R-32,80	500013	Resistor, 6.8K ohm ±5% 1/4 W
R-34,56	500019	Resistor, 47K ohm ±5% 1/4 W
R-40,74	502056	Resistor, 47 ohm ±5% 1/2 W
R-41	500042	Resistor, 150 ohm ±5% 1/4 W
R-42,78	400050	Pot, 250 ohm 30% PCB Blue
R-44,89	500021	Resistor, 100K ohm ±5% 1/4 W
R-47,48	500011	Resistor, 3.3K ohm ±5% 1/4 W
R-50	500054	Resistor, 82K ohm ±5% 1/4 W

SYMBOL	P/N	DESCRIPTION
R-51	500037	Resistor, 120K ohm ±5% 1/4 W
R-53,67	500020	Resistor, 68K ohm ±5% 1/4 W
R-54,64,70,91	500005	Resistor, 680 ohm ±5% 1/4 W
R-55,62,75	500034	Resistor, 10 ohm ±5% 1/4 W
R-57,58,82	500015	Resistor,22K ohm ±5% 1/4 W
R-59	500046	Resistor, 68 ohm ±5% 1/4 W
R-61	511003	Resistor, 10 ohm ±10% 1 W
R-72	500026	Resistor, 150K ohm ±5% 1/4 W
R-79	500002	Resistor, 330 ohm ±5% 1/4 W
R-83	500033	Resistor, 2.7 ohm ±5% 1/4 W
R-87	400042	Pot, 50K ohm 30% PCB Blue
R-92,93	500044	Resistor, 47 ohm ±5% 1/4W
T-1	910046	Transformer, Audio, 2-A-102
T-2	930239	Transformer, 6T/25T
XTAL-1	020000	Crystal
Z-1,2	220030	Diode, zener10V 1W IN-4740A
Z-3,4	220018	Diode, zener 6.8V 1W IN-4736A
Z-5	220007	Diode, zener 13V 1W IN-4743A
	700031	Crystal, oven 12V

WARRANTY

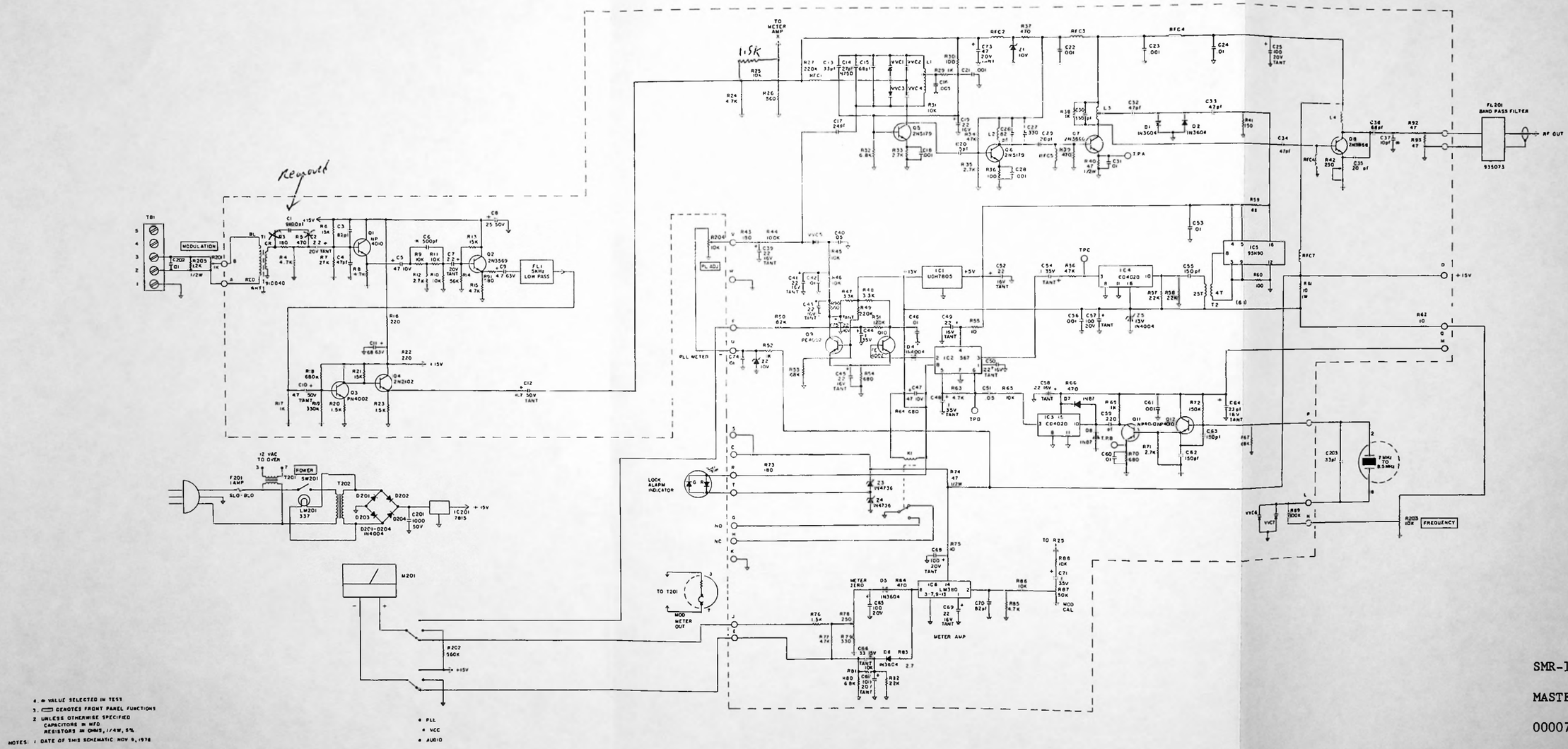
McMartin products are warranted to be free from defects in materials and workmanship for a period of one year after shipping date, when subjected to normal usage and service. All warranties are void if (a) equipment has been altered or repaired by others without McMartin's specific prior authorization; or (b) equipment is operated under environmental conditions or circumstances other than those specifically described in McMartin literature or instruction manuals.

Upon notification within the applicable warranty period, McMartin agrees without charge, to repair, replace, or supply replacement parts for any properly maintained equipment or parts that are defective as to design, materials or workmanship and that are returned in accordance with McMartin's instructions to the Buyer. At McMartin's sole discretion, the Buyer may be requested to return the defective part or equipment to McMartin, FOB Omaha, Nebraska. Parts or equipment may be returned only with McMartin's prior authorization and must be identified by a return authorization number previously issued by McMartin's Customer Service Department. All merchandise so returned must be sent transportation prepaid, at Buyer's risk. Full details of the failure or malfunction should be included so as to expedite repair or replacement. Repair parts or repaired or replaced equipment will be returned to the Buyer, FOB factory.

The above warranty does not extend to other equipment, such as tubes, transistors, I.C.'s lamps or fuses manufactured by others, which are subject to only such adjustment as McMartin may obtain from the suppliers thereof. McMartin shall not be liable for consequent damages resulting from the use of, or the inability to use, the equipment; nor for any loss, damage or expense incurred thereby; nor from any other cause.

Except as set forth herein, and except as to title, there are no warranties, or any affirmations of fact or promises by McMartin, with reference to the equipment, or to merchantability, fitness, for particular application, signal coverage, infringement, or otherwise, which extend beyond the description of the equipment on the face hereof.

MARTIN



SMR-1

MASTER SCHEMATIC

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January 24, 1979