MC MARTIN

TBM—3000
INSTRUCTION MANUAL

McMartin Industries Inc. ■ 4500 South 76th Street ■ Omaha, Nebraska 68127 ■ (402) 331-2000 ■ Telex 484485

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I GENERAL DESCRIPTION

The TBM-3000 FM Frequency Monitor has been designed to meet FCC requirements for measuring the center frequency of an FM Broadcast transmitter in the range of 88 to 108 mc from its assigned frequency.

The accuracy of measurement is well within 1000 cycles (.001%) and is not affected by modulation of the center frequency of the transmitter. It has been designed to provide the ultimate in stability, accuracy and long trouble-free performance. It cannot cause any deleterious effects on the transmitter or affect the signal being transmitted. It is designed for continuous operation, and does not require frequency adjustment to maintain its accuracy. It is not affected by typical changes of power line voltage, changes of input signal level from the transmitter, ambient temperature variations, tube characteristics or component aging during regular service.

II TECHNICAL SPECIFICATIONS

Frequency Range	:	88 to 108 mc - fixed
Deviation Range	:	+4 kc to -4 kc of specified frequency
Ambient Temperature	:	50 to 120 degrees Fahrenheit
Accuracy	:	Better than .001% or better than 1000 cps @ any frequency
Stability	:	Maximum change within 24 hours - 100 cps
RF Input	:	1 to 5 volts @ 50 ohms - 1/2 watt maximum
Front Panel Indicators	:	Modulation meter AC power - neon Crystal oven - 6 v. incandescent
Front Panel Controls	:	Selector Switch (RF Input, Calibrate, Operate) Meter Zero - Crystal Tuning Power (on-off).
Chassis Controls	:	RF LEVEL
Outputs	:	Provision for external remote meter (optionally available)
Tube's & Diodes	:	3-6201 2-6265 1-5814A 1-0B2 1-0A2 4-Silicon diodes
Rectifiers	:	4 silicon 750 ma/600 PIV
Power Supply	:	100-130 VAC; 55 watts; 60 cps; C.C.S. double regulation; fused.
Dimensions	:	Standard rack: 19" width x 8 3/4"hgt. 7 1/2" depth (behind panel)
Shipping Weight	:	18 lbs.

III INSTALLATION and INITIAL ADJUSTMENT

Inspection: Upon receipt of your TBM-3000, remove it from the packing material and inspect for any damage caused in transit due to handling or vibration. If damage is found, notify the shipping agency and advise McMartin Industries, Inc. of such action.

Location: Installation preferably should be made in a standard equipment rack or cabinet which is well connected electrically to the main station ground and away from strong RF fields created by the transmitter. The monitor should be located near the transmitter in order to take an RF sample directly from the transmitter. It has been designed to be insensitive. If a remote application is desired, RF can be fed from the McMartin TBM-2500, RF amplifier.

Connections, Input: Plug the AC line cord into a nominal 117 volt, 60 cps only power source.

Connect a 50 ohm coaxial cable (RG-58 or RG-8) between an RF pick-up loop (or RF amplifier) and the input J1 at the monitor. (Amphenol Type 83-ISP connector is used).

CAUTION: Do not apply more than 4 watts from the pick-up loop or the monitor may be damaged.

When using the TBM-3000 in conjunction with the TBM-3500 modulation monitor or other existing monitor equipment, simultaneous connection of the RF inputs from the same pick-up loop can be made with the use of a "T" connector such as the Amphenol #83-1T. Where other makes of monitors are in use, it may be necessary to incorporate a resistive pad to achieve the correct RF input level for each unit. It is known that some other manufacturer's monitors, found in the field, will create interference detrimental to the accuracy of the TBM-3000 - if, they are both connected to the same pick-up loop or RF amplifier. Separate pick-up loops or the McMartin TBM-2500 RF amplifier should eliminate this factor.

Connections, Output: There are provisions on the rear of the monitor for connecting an external modulation meter. This meter should be connected to terminals "A" and "B". The resistor between "A" and "B" must be removed if an external meter is used. Observe meter polarity.

Due to the special characteristics of this meter, it must be ordered from McMartin Industries, Inc. Model number is "M-1F".

III INSTALLATION and INITIAL ADJUSTMENT (cont)

Initial Adjustments: Turn the power on and allow the monitor to warm-up 1/2 hour for temperature stabilization. The red neon pilot light will indicate that the power is on.

NOTE: It may be observed that the Sola power transformer operates at a high temperature. This is a completely normal condition since it functions on a core saturation principle and in no way indicates a defect or overload condition.

When the instrument is first turned on, the green crystal temperature indicator light will appear. As the oven brings the crystal towards its desired temperature, the light will begin to flash off and on. This lamp will light and turn off in a rather fast and erratic manner. (As fast as 3 to 4 times per second occasionally). THIS IS COMPLETELY NORMAL. The oven maintains the crystal temperature within 1/10th of a degree.

Select the CAL position of the function switch on the front panel. The meter should be within a few hundred cycles of zero, and can be set exactly to zero with the METER ZERO control. With the function switch in the RF INPUT position, the meter should indicate 1 kc on the plus side of the meter; if it does not, the pickup loop or RF amplifier output should be adjusted so that with the RF LEVEL control on the rear of the chassis at approximately its mid-range, the meter indicates the desired plus 1 kc. Periodic adjustment of the RF level should be made by means of the RF LEVEL control, keeping the indication at plus 1 kc on the meter.

IV OPERATION

At this time, the function switch can be set to the OPERATE position and any deviation of the transmitter center frequency will be indicated on the zero center meter.

Calibration against an external frequency standard may be made at the station as follows: While in contact with an outside measuring service, the transmitter frequency can be adjusted for the exact assigned frequency. Place the TBM-3000 in CAL position and zero the meter. Then place the function switch in OPERATE position and observe any deviation. If the indication is not zero, remove the front panel snap button for the CRYSTAL TUNING trimmer (C-17) and adjust this control until the meter reads zero.

An alternate method can be used. The frequency of the transmitter is first measured by the frequency measuring service. Then the monitor, after zero centering in the CAL position, is corrected by adjusting the CRYSTAL TUNING trimmer (C-17) so the frequency meter indicates the same frequency as determined by the measuring service. Then, if necessary, the transmitter frequency can be adjusted so that zero deviation is measured on the meter.

V OPERATION (cont)

Twice a day it is suggested that the function switch be turned to the CAL position to be sure that the pointer is on zero. Re-adjust to zero if necessary. This should require very little, if any, adjustment. Then return the function switch to the OPERATE position for accurate logging of center frequency. It is suggested that the RF level be checked at least daily.

Note: The pointer of meter M-1 may peg when switching between RF INPUT, CAL and OPERATE. This is particularly true if there is no incoming signal or if the incoming signal is considerably off frequency. Under the worst conditions, the current through M-1 will not exceed 50% of its maximum overload capability, therefore the meter cannot be damaged.

VI CIRCUIT DESCRIPTION

The signal will be traced through the TBM-3000 referring to the schematic.

The sample RF is fed through the input connector J1 to a variable attenuator pad (AT-1). This pad offers a nominal input impedance of 50 ohms to the input signal. The output of AT-1 is coupled to the cathode of V3A which is a triode mixer.

Refer now to tube V1A. This is a precisely controlled, RF crystal oscillator. Frequency control of this oscillator is maintained by a quartz crystal housed within a temperature controlled oven. The oven maintains the temperature within 1/10th of a degree at approximately 75 C. Vernier adjustment of the frequency may be accomplished by the front panel control, C-17. The developed frequency appears at the plate, pin #1 which is coupled to the second section of V1B which is a frequency quadrupler. L2 is tuned to 4 times the crystal frequency. This frequency appearing at the plate of V1B is then coupled to the grid of V3A. The quadrupled frequency impressed on the grid of V3A is chosen so that it will be exactly 200 kc below the input frequency which is to be monitored. All of the sum and difference frequencies would appear at the plate (pin #6) of V3A but for the low pass characteristic of a filter made up of R-43, C-2 and C-3. The selection of these components is designed to eliminate all frequencies except the heterodyned beat of 200 kc. The 200 kc signal is then coupled to the grid of V3B which is a limiter-amplifier.

The diode D5, connected from grid (pin #2) to ground, rectifies the 200 kc signal. At the plate of V3B, rectified pulses at a frequency of 200 kc appear. This signal is then coupled to V4 which further limits and shapes the 200 kc signal. The signal now is in the form of square wave pulses. At the output of V4 is a test point "TPB" which merely serves as a convenience to accurately measure the frequency at this point

VI CIRCUIT DESCRIPTION (cont)

and to also observe the wave form with an oscilloscope. The plate output of V4 is then coupled to the grid of V5 which is a phase inverter. Exactly equal but opposite in polarity, signals appear at the plate and cathode. These equal and opposite pulses are then coupled to the grids of both sections of V6 which serves as an additional limiter stage and in turn produces constant amplitude pulses at both plate outputs.

These pulses charge the output coupling capacitors (located in the counter rectifier assembly, CR-1) to a voltage that is linearly proportional to the frequency of the pulses. This voltage is then rectified by diodes in the CR-1 assembly producing a DC current which is also proportional to the frequency. This voltage is then applied directly to meter M1 through the function switch SW-1. The steady DC current resulting from the exact 200 kc signal is balanced out by applying a reverse voltage. This voltage is derived from R-17 which has the total current from both halves of V6 flowing through it. Therefore if there is any change in current flowing through V6 due to any cause that would result in a change in the output pulse amplitude, there will be a compensating change across R-17 which will keep the meter at zero. V6 is also arranged so that a balance between the two sections is constantly maintained by a large amount of degenerative feed-back in the cathode resistor, R-16. R-22, the front panel METER ZERO control adjusts the compensating current mecessary to maintain the meter reading at exactly zero. The operating range of R-22 is established by adjustment of R-21. R-23 is an adjustable shunt across the meter M-1. R-23 controls the deviation sensitivity of the meter and is accurately adjusted at the factory.

In order to be certain that the meter circuit is accurately monitoring an exace 200 kc signal, a calibrating oscillator is fed through the complete limiting and metering circuits. V2A is an untuned Pierce oscillator which is accurately controlled by a crystal, also included within the same crystal oven as the operating crystal. The frequency of the calibrating crystal is cut to a very close tolerance at 200 kc. This grid of V2B which is a cathode follower. The cathode output of V2B is adjusted so that the amplitude of the 200 kc signal impressed on the grid of V3A is exactly the same as the amplitude of the heterodyned 200 kc signal derived from the RF input and operating oscillator. The position of the front panel switch (SW-1) determines which crystal oscillator output is fed to the limiting circuits.

The third position of switch SW-1 is RF INPUT. In this position, meter M-1 merely measures the current produced in the grid circuit of V4 which is proportional to the amount of RF voltage applied at the input J1.

The heart of the power supply is a constant voltage, regulated transformer. The primary is fused and RF filtered. C-31 and the high voltage secondary winding form a resident circuit at 60 cycles. This factor plus a saturated core provide voltage regulation of 3% with line voltages ranging between 105 and 130 VAC. This degree of regulation is

VI CIRCUIT DESCRIPTION (cont)

also reflected into the filament winding. The high voltage AC is full wave rectified and filtered. Further B^+ regulation is afforded by the gaseous voltage regulators V7 and V8. The filaments of RF tubes are adequately by-passed for RF. To indicate that the oven controlling the temperature of both crystals is operating normally, there is an incandescent lamp on the front panel (PL-2) which alternately lights and turns off. The lamp is connected in parallel with a portion of the heater circuits in the oven to accomplish this. The oven is temperature controlled by a bi-metal thermostat

An external frequency meter may be used by connecting to terminals "A" and "B" on the chassis. An external jumper must first be removed. The external meter is merely connected in series with the internal meter.

VII TBM-3000 Frequency Meter Socket Voltages

Tube Types	Position	Pin #1	2	3	4	5	6	7	8	9	Remarks
6201 w/signal	V-1 Z	150	-7.0	X	X	X	250	-10*	0	X	X
6201	V-2 Y	105	-9*	1.5	X	X	125	0	6.5**	X	X
6201	V-3 Z	50	.35*	X	X	X	170		0	X	X
6265	V-4 Y	-4.5*	1.8	X	X	110	150	0		-	-
6265	V-5 Y	-.8*	18	X	X	125	125	125		-	-
5114A	V-6 Y	215	65	75	X	X	215	65	75	X	X

NOTES:

Test Point "B" 22-24V AC is in the calibrate or operate position.

* Use a one meg resistor in series with VTVM.

** Without crystal or crystal failure will read 3.0 volts. Readings will vary when "pot" is in R-33 position.

All measurements made with 11 megohm VTVM to chassis.

X- Filament pins - The AC waveform produced by the Solo transformer to supply voltage for the filaments is <u>not</u> a sine wave. There are harmonics present and therfore the voltage as measured by a typical rms voltmeter will be approximately 7.0 volts. The effective heating voltage remains 6.3V AC.

Y- All measurements with function switch in CAL position.

Z- All measurements with function switch in OPERATE position.

Addendum No. 1

TBM-3000
Instruction Booklet

Add: RF Oscillator Alignment

Should it be necessary to re-align the RF oscillator, follow this procedure:

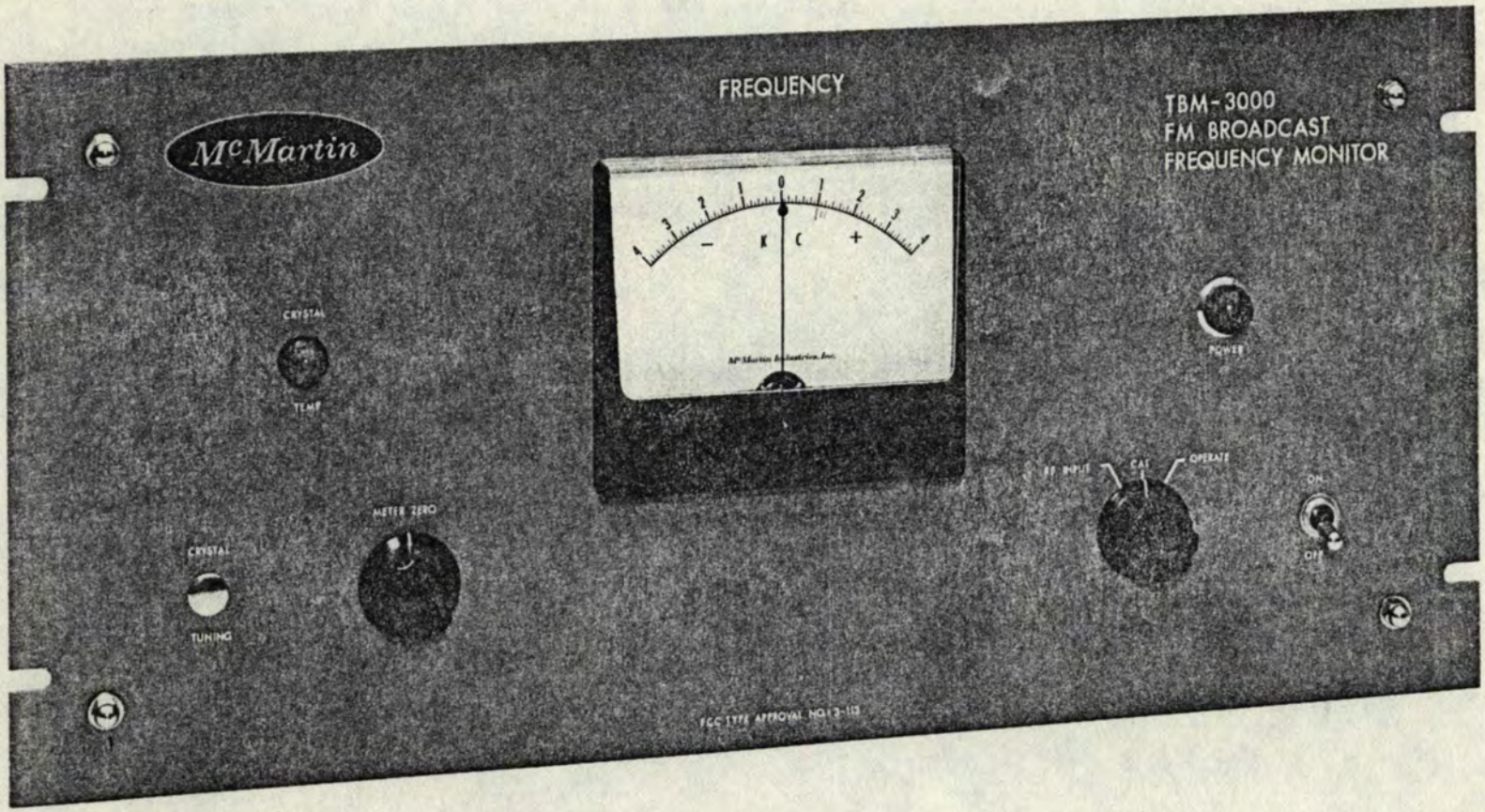
1) Connect a VTVM (isolated with a 1 megohm resistor) to the grid (pin #7) of V1B.

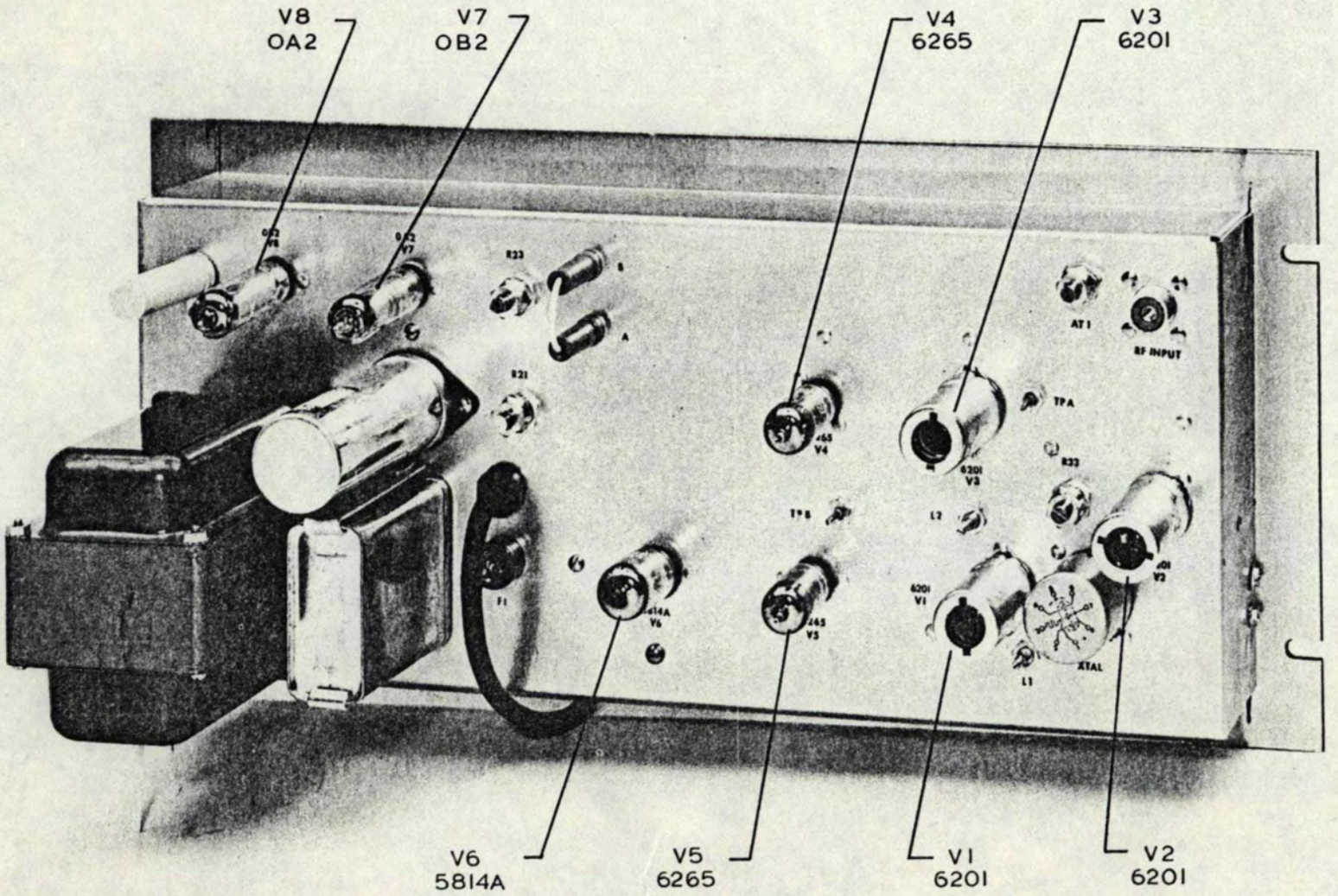
2) Adjust L-1 for a peak negative voltage. Now turn L-1 in a counter clockwise direction to a point 15% below the peak reading.

3) With a normal signal (from the transmitter) at J-1, and the function switch in RF INPUT position, tune L-2 for maximum indication on meter M-1. By use of the RF LEVEL control, maintain the correct plus 1 kc meter indication while tuning L-2 for maximum.

4) The above adjustments will have some effect on the oscillator frequency. At this point, the frequency must be accurately checked by an FCC Approved method. This is done according to the procedure outlined in the OPERATION section of this manual. If any deviation from center frequency was corrected by the trimmer C-17 - repeat the preceeding steps 1, 2, and 3.

5) Again determine the frequency accuracy as in step 4. If the frequency is now correct, alignment is completed.





PARTS LIST

AT-1	R.F. attenuator assembly		McMartin Ind.Inc.
R-1	470 ±10% 1w	composition carbon fixed resistor	Allen-Bradley Type J
R-2	18K ±10% 1 w	" " "	" "
R-3	10K ±10% 1w	" " "	" "
R-4	150 ±10% 1 w	" " "	" "
R-5	100K ±10% 1 w	" " "	" "
R-6	27K ±10% 2 w	" " "	" "
R-7	18K ±10% 1 w	" " "	" "
R-8	68 ±5% ½ w	" " "	" "
R-9	150 ±10% 1 w	" " "	" "
R-10	5600 ±10% 2 w	" " "	" "
R-11	47K ±10% 1 w	" " "	" "
R-12	4700 ±5% 2 w	" " "	" "
R-13	4700 ±5% 2 w	" " "	" "
R-14	33K ±5% 1 w	" " "	" "
R-15	33K ±10% 1 w	" " "	" "
R-16	Adjust at factory, nominal value (2500 ±10% 10 w) wirewound fixed, vit ous enamel resistor		Milwaukee Res.
R-17	Adjust at factory, nominal value (800 ±10% 5 w) wirewound fixed, vitreous enamel resistor		Milwaukee Res.
R-18	2500 ±10% 5 w	wirewound fixed vitreous enamel resistor	" "
R-19	2500 ±10% 5 w	" " "	" "
R-20	1.5K ±10% 2 w	wirewound fixed bathtub sandstone resistor	Hamilton-Hall
R-21	1000 ±10% 5 w	composition carbon potention meter linear taper	Allen-Bradley Type J

PARTS LIST (cont)

R-22	100 ±10% 2 w	carbon potention meter, linear taper	Allen-Bradley Type
R-23	100K ±10% 2 w	" " "	" "
R-24	Adjust at factory, nominal value (100 ±10% 2 w)	wirewound fixed, bathtub sandstone	Hamilton-Hall
R-25	10 ±10% 1 w	Composition carbon fixed resistor	Allen-Bradley
R-26	100K ±10% 1 w	" " "	" "
R-27	33K ±10% 1 w	" " "	" "
R-28	270K ±10% 1 w	" " "	" "
R-29	1200 ±10% 1 w	" " "	" "
R-30	10 meg ±10% 1 w	" " "	" "
R-31	1200 ±10% 1 w	" " "	" "
R-32	100K ±10% 1 w	" " "	" "
R-33	5000 ±10% 2 w	carbon potention meter, linear taper	Allen-Bradley Type J
R-34	1000 ±10% 1 w	composition carbon fixed resistor	" "
R-35	47K ±10% 1 w	" " "	" "
R-36	18K ±10% 1 w	" " "	" "
R-37	5000 ±10% 10 w	wirewound fixed vitreous enamel resistor	Milwaukee Res.
R-38	Adjust at factory, nominal value (2K ±10% 20 w)	wirewound fixed resistor, vertical mount	" " Topside
R-39	470 K ±10% ½ w	composition carbon, fixed resistor	Allen-Bradley
R-40	470 K ±10% ½ w	" " "	" "
R-41	470 K ±10% ½ w	" " "	" "
R-42	470 K ±10% ½ w	" " "	" "
R-43	150 ±10% 1 w	" " "	" "

PARTS LIST (contd)

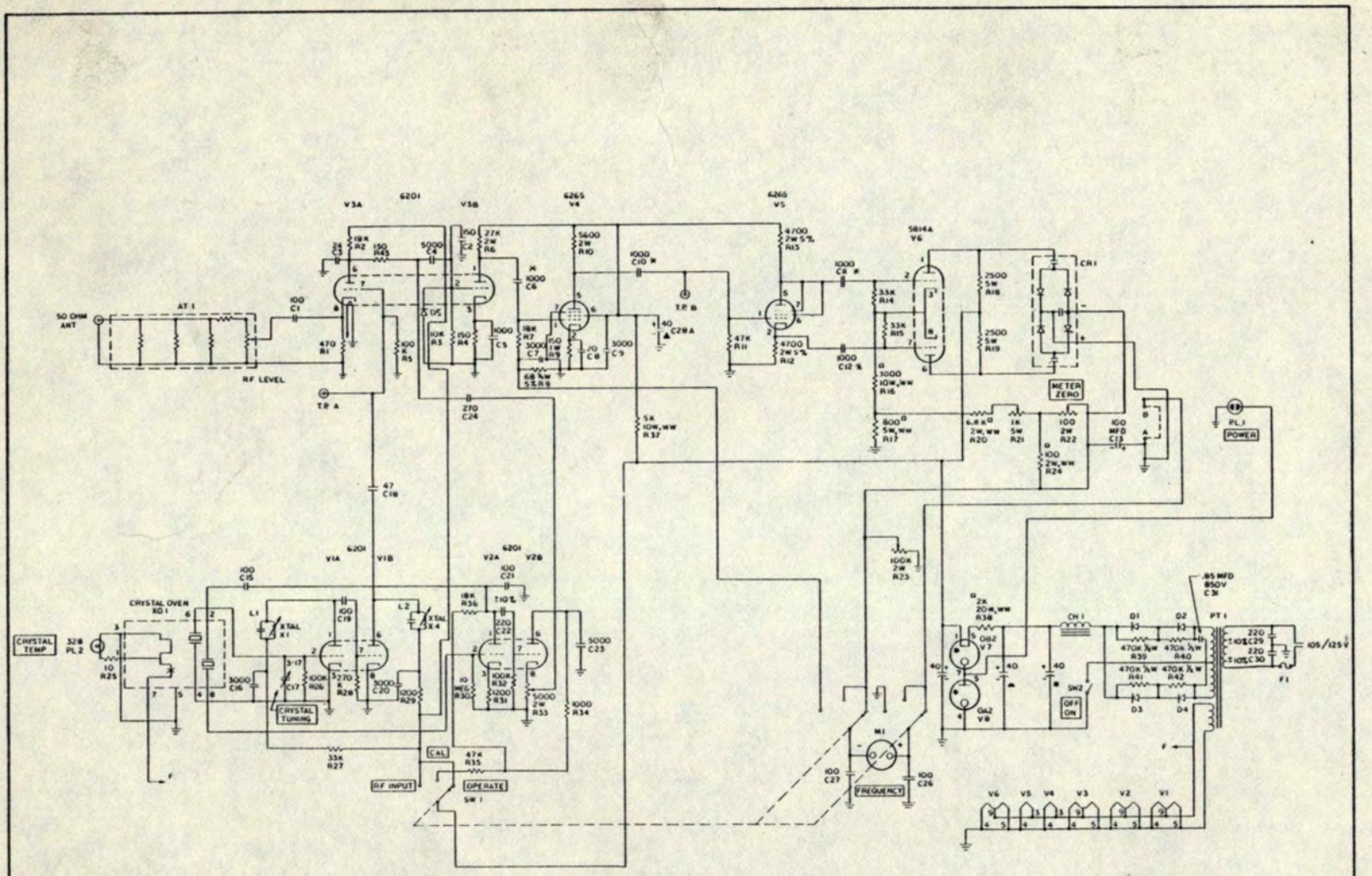
C-1	100 mmf ±5%	dipped mica capacitor, fixed 500V	Cornell Dubilier
C-2	150 mmf ±5%	" " "	" "
C-3	24 mmf ±5%	" " "	" "
C-4	5000 mmf ±5%	" " "	" "
C-5	1000 mmf ±5%	" " "	" "
C-6	1000 mmf ±5%	molded sil.mica cap. fixed 500V	" "
C-7	3000 mmf ±5%	dipped mica capacitor, " "	" "
C-8	20 mmf ±5%	" " "	" "
C-9	3000 mmf ±5%	" " "	" "
C-10	1000 mmf ±5%	molded sil. mica " "	" "
C-11	1000 mmf ±5%	" " "	" "
C-12	1000 mmf ±5%	" " "	" "
C-13	100 mf 25 V	tubular electro. phenolic case	P.R.Mallory KETA
C-15	100 mmf ±5%	dipped mica, capacitor fixed 500V	Cornell Dubilier
C-16	3000 ±5%	" " "	" "
C-17	3.3 -17 mmf	Ceramic trimmer, air variable	E.F. Johnson 15J12
C-18	47 mmf ±5%	dipped mica, capacitor fixed 500V	Cornell Dubilier
C-19	100 mmf ±5%	" " "	" "
C-20	3000 mmf ±5%	" " "	" "
C-21	100 mmf ±5%	" " "	" "
C-22	220 mmf ±5%	" " "	" "
C-23	5000 mmf ±5%	" " "	" "
C-24	270 mmf ±5%	" " "	" "
C-26	100 mmf ±5%	dipped mica, capacitor fixed 500V	" "
C-27	100 mmf ±5%	" " "	" "
C-28	40 mfd/450 V	4 section twist prong,electrolytic,alum,can.	Sprague TVL

PARTS LIST (cont)

C-29	220 mmf ±5% dipped mica, capacitor 500 V	Cornell Dubilier
C-30	220 mmf ±5% " " "	" "
C-31	.85 mf @ 850V oil filled paper capacitor	Aerovox
CR-1	Counter rectifier assembly	McMartin Ind, Inc.
F-1	Fuse, 3/4A @ 125V Slo-Blo	Littel-fuse 3AG
PL-1	Pilot lite assembly, neon, complete	Lee Craft
L-1	Oscillator coil assembly, tunable with 47 mmf ±5% 500V dipped mica capacitor	McMartin Ind, Inc.
L-2	Quadruplar coil assembly, tunable with 5 mmf ±5% 500V dipped mica capacitor	" "
XO-1	Crystal & oven assembly	" "
M-1	25-0-25 ua meter, frequency meter	" "
D-1	Rectifier, 1N2095 silicon	P.R.Mallory
D-2	" "	" "
D-3	" "	" "
D-4	" "	" "
CH-1	Choke, filter 150 ma, 2.3 hy	Quality 14-X-3
SW-1	Function switch, 4 pole, 3 pos. 2 non-shorting, 2 shorting, single section, one circuit unused	Centralab PA 070-574
SW-2	Power switch, SPST toggle	Cutler-Hammer
PT-1	Reg. power transformer	Sola Electric CVE-3

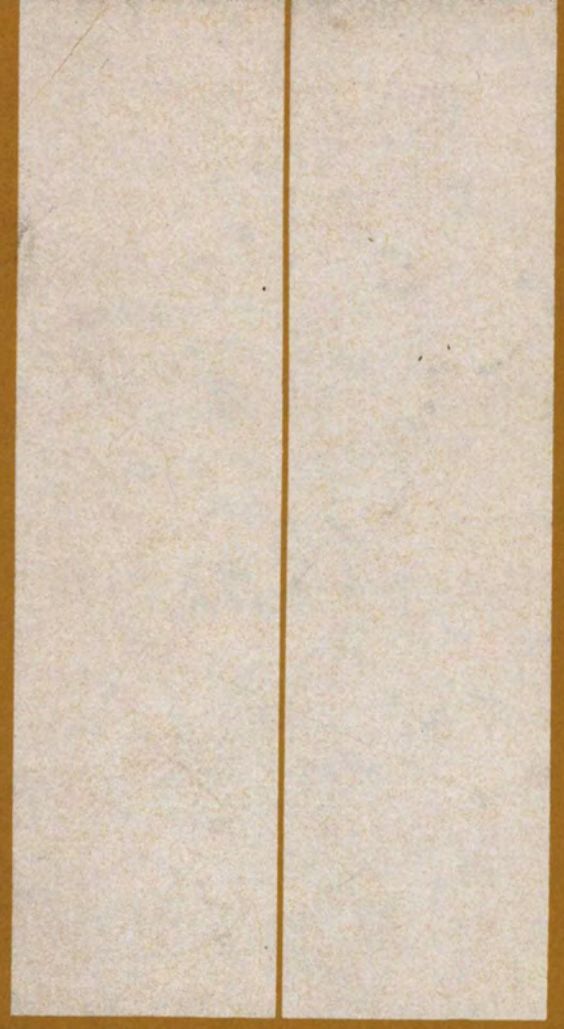
PARTS LIST (cont)

V-1	6201 tube — 12AT7	General Electric
V-2	6201	" "
V-3	6201	" "
V-4	6265 — 6EM7	" "
V-5	6265 —	" "
V-6	5814A — 12AU7	" "
V-7	OB2 VR tube 105V	Amperex
V-8	OA2 " 150V	"
J-1	Connector, 50 ohm input	Amphenol #83-1R



NOTES
1. ALL RESISTORS 1 WATT ±10% UNLESS OTHERWISE SPECIFIED
2. ALL CAPACITORS MICA ±5% UNLESS OTHERWISE SPECIFIED
3. X SILVER MICA ±5%
4. DECIMALS IN MFD.
5. WHOLE NO'S IN MMF.
6. POLARITY IND. ON ELECTROLYTICS
7. [ ] REPRESENTS FRONT PANEL FUNCTION
8. Ω REPRESENTS NOMINAL VALUE

CONTINENTAL MANUFACTURING INC. OMAHA, NEBRASKA		
TITLE: MSMARTIN TBK 3000 SCHEMATIC		
DR BY BOOHSHA	DATE 12-1-61	
CHK. BY HEDLUND	SCALE NONE	
D 1039		



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