INSTRUCTIONS

for

1 Megacycle

HIGH STABILITY OSCILLATOR

Models

RD-140A, RD-146 and RD-150

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CONTENTS

ILLUSTRATIONS

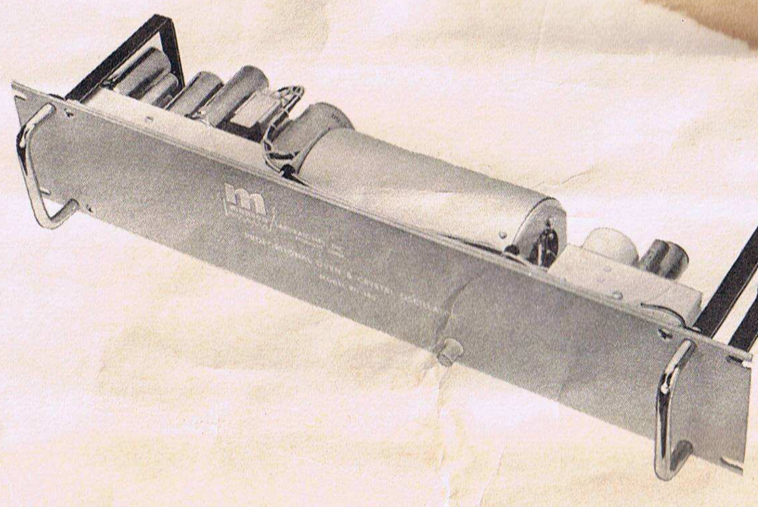


Figure 1. RD-140A

INTRODUCTION

These instructions cover the Manson Model RD-140A High Stability 1 Mc Oscillator (figure 1), and also apply to the following additional models:

RD-146 . . . The refinements of this basic RD-140A include a calibrated front-panel control so that the output frequency of the oscillator can be independently maintained (figure 2).

RD-150 . . . This model consists of the RD-140A with a locked divider to provide an additional output of 100kc. (Divisions other than 10:1 are available on special order.)

All references to the RD-140A apply as well to the model variations listed above. Where applicable, individual differences between models are discussed.

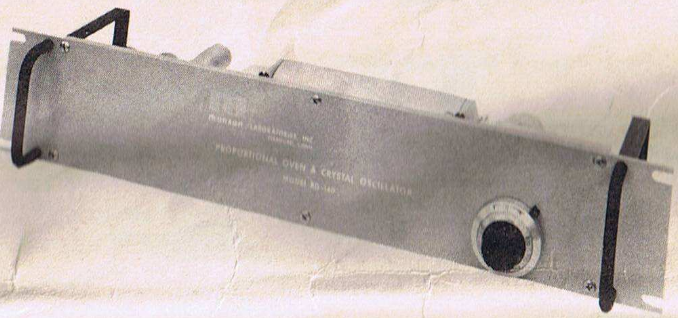


Figure 2. RD-146

INSPECTION

If the instrument is found damaged upon delivery, request the carrier that an inspection be made by its agent. The carrier's claim agent will prepare a report which should be sent to Manson Laboratories, Inc. We will assist in providing repair or replacement of damaged items.

SERIAL NO. [redacted]

Include the instrument type and the above serial number in any correspondence regarding this instrument. The above serial number must match the equipment serial number if parts are to be ordered from the instruction book.

GENERAL DESCRIPTION

The RD-140A is a highly precise crystal oscillator capable of supplying a 1mc sinusoidal output at 1 volt into 10,000 ohms impedance. It can be used as a frequency standard with a stability greater than 1 part in 10^8 per day, as a master oscillator in frequency control systems, as a time standard or as a marker generator. Regardless of application, the oscillator will serve as a reliable source of a stable 1mc frequency. The Model RD-150 supplies in addition to a 1mc signal, a 100kc sine wave at 1 volt into 1000 ohms with a frequency stability equal to that of the 1mc oscillator.

Versatility of the RD-140A may be increased by combining it with one or more additional Manson instruments. The Model RD-125 Regenerative Divider may be attached "piggy-back" to the RD-140A and RD-146 (figure 3) to provide a 10:1 division to a 100kc sine wave (or other division on special order). Using the RD-140A with the Model RD-170 Reference Generator will provide 100mc and 1000mc sine waves with stabilities equal to that of the RD-140A.

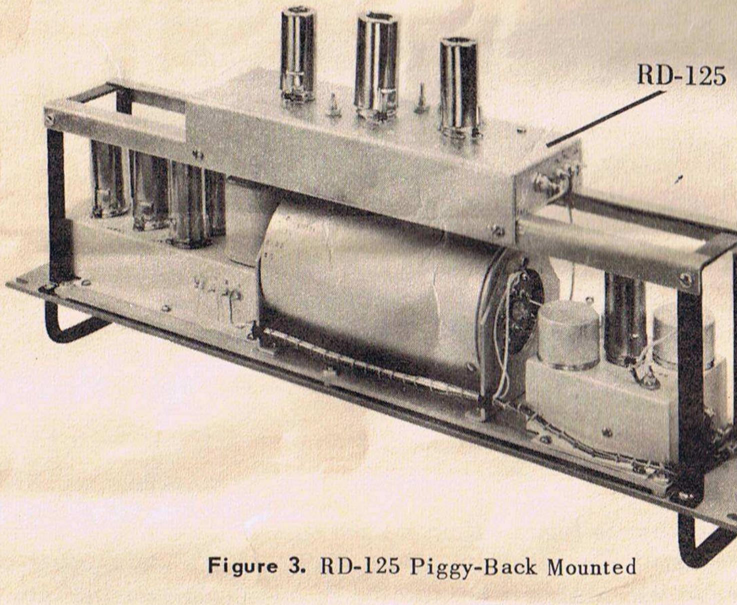


Figure 3. RD-125 Piggy-Back Mounted

SPECIFICATIONS OF FREQUENCY STABILITY

Short term	±5 parts in 10^9 per minute @ 25°C
Long term	1 part in 10^8 per day after initial aging period (see page 5)
Ambient temperature effects . . .	±2 parts in 10^8 @ 0° to 50°C
Voltage variation effects . . .	(a) ±5 parts in 10^9 with ±10% B+ change or 1 part in 10^8 with ± 20% B+ change (b) 1 part in 10^8 with ±10% filament change

The RD-140A and RD-146 require an external 10%-regulated power supply capable of delivering 250vdc @ 60ma (B+) with a maximum ripple voltage of 10mv, and 6.3vac/dc @ 1.8 amperes (filament); the power supply must furnish an additional current of 20ma (B+) and 200ma (filament) for the RD-150.

Mount the set in a standard 19-inch relay rack using the notches at both ends of the front panel. Connect the input power to the terminal board (TB100) located on one side of the oven control amplifier chassis. All terminals are marked for proper connections. (Note that there are two connections for the filament supply to maintain the filaments above ground.) Connect the oscillator output to the load in use: the output is available from a front-panel BNC jack, except on the RD-146 where the jack is found at the rear of the set. If the load has an input impedance lower than 10,000 ohms, it should be preceded with a buffer stage.

To energize the unit, turn on the external power source. The full capability of the RD-140A will be realized if it is installed and operated immediately upon receipt. The set should be kept continuously energized to complete the 30-day crystal-aging period. "Aging" refers to the gradual change in the operating characteristics of a new crystal during its initial period of operation. The factors contributing to this gradual change are numerous, but their net effect is a shift in the resonant frequency of the crystal. The curve in figure 4 depicts the aging rate of the particular crystal used in the RD-140A. To assure that this curve is being followed, the oscillator has undergone an initial pre-aging and test aging in Manson's laboratories. After completing the aging period, the RD-140A requires at least one hour warm-up before each use, although ideally it should be allowed to operate with no interruption; if it is operated intermittently, the overall stability will be reduced to approximately 5 parts in 10^8 per day.

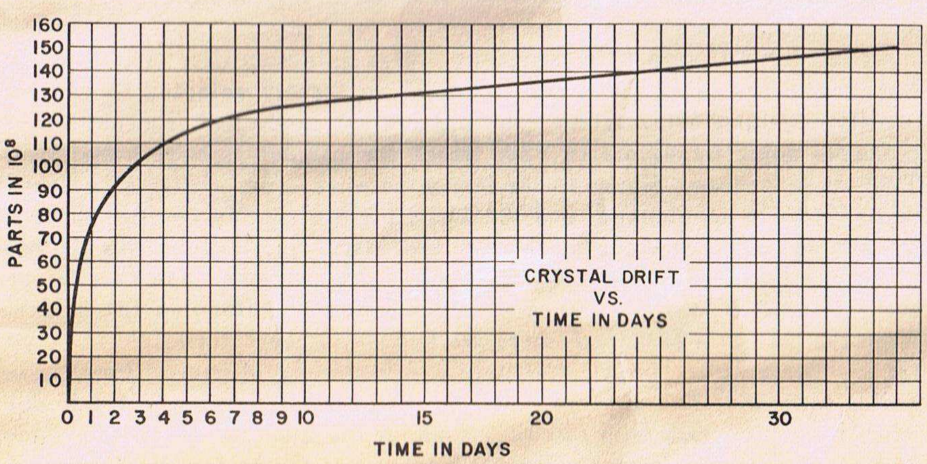


Figure 4. Crystal Aging Curve

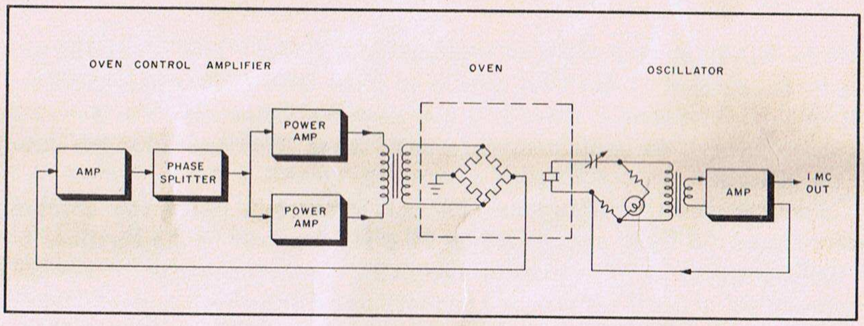


Figure 5. RD-140A Block Diagram

The RD-140A (figure 5) consists of a modified Manson High Stability Oscillator (MHSO), in which the AT-cut crystal of one arm in the bridge is mounted in an oven to maintain the crystal at its optimum operating temperature. An oven control amplifier maintains the oven temperature within less than .001°C for each degree C change of ambient temperature.

The oven (figure 6) comprises a four-element heater winding (HR300) which also functions as a temperature sensing bridge. The four bridge arms are non-inductively wound on (and electrically insulated from) an aluminum tube. The length and composition of each wire are selected so that the resistance of each winding is 100 ohms at 75°C. Under normal operation the bridge is not perfectly balanced, and at an ambient temperture of 25°C there is approximately a 0.6mv signal at the input (grid) of V100. This is successively amplified and fed to the push-pull stage (V102 and V103) in the oven control amplifier. The common tank circuit (consisting of capacitor C108 and the primary of transformer T100) develops a 5kc signal which is fed back to the heater bridge. The feedback signal increases the current through the heater windings, raising their resistance and thereby increasing the heat dissipation. This brings the bridge closer to the balance point and reduces the unbalance potential fed back to the amplifier. With a 0.6mv input to the oven control amplifier, oven temperature variations are reduced to approximately 1/1000 of ambient temperature variations.

The MHSO (figure 6) consists of a high-gain amplifier (V200) and a Wheatstone bridge in which resistor R201 is factory selected to give an oscillator output of 1.2 volts. The application of B+ and filament power produces noise transients in V200 which are coupled through transformer T201 as a feedback signal to the bridge network. The bridge is designed to be initially unbalanced, and the small plate signal is coupled through transformer T200 to the grid of V200 and starts oscillations. As the oscillations build up, the current through RT200 increases and this raises the temperature and resistance of RT200 thereby balancing the bridge. When the bridge is balanced, there are two major characteristics: the crystal arm (which effectively determines the frequency of oscillations) is in series resonance and appears resistive, and the attenuation in the bridge equals the tube gain less circuit losses. If the tube gain decreases (due to a drop in B+ or filament voltage), feedback to the bridge will decrease, resulting in a decreased current and resistance in RT200. This unbalances the bridge, thereby increasing the input drive to the tube. Thus the action of RT200 is similar to an AGC circuit. Should the oscillator components external to the bridge network change value, the oscillator would compensate for this by a shift in frequency. Due to the bridge feedback, however, the change in frequency required for compensation is reduced to a minimum.

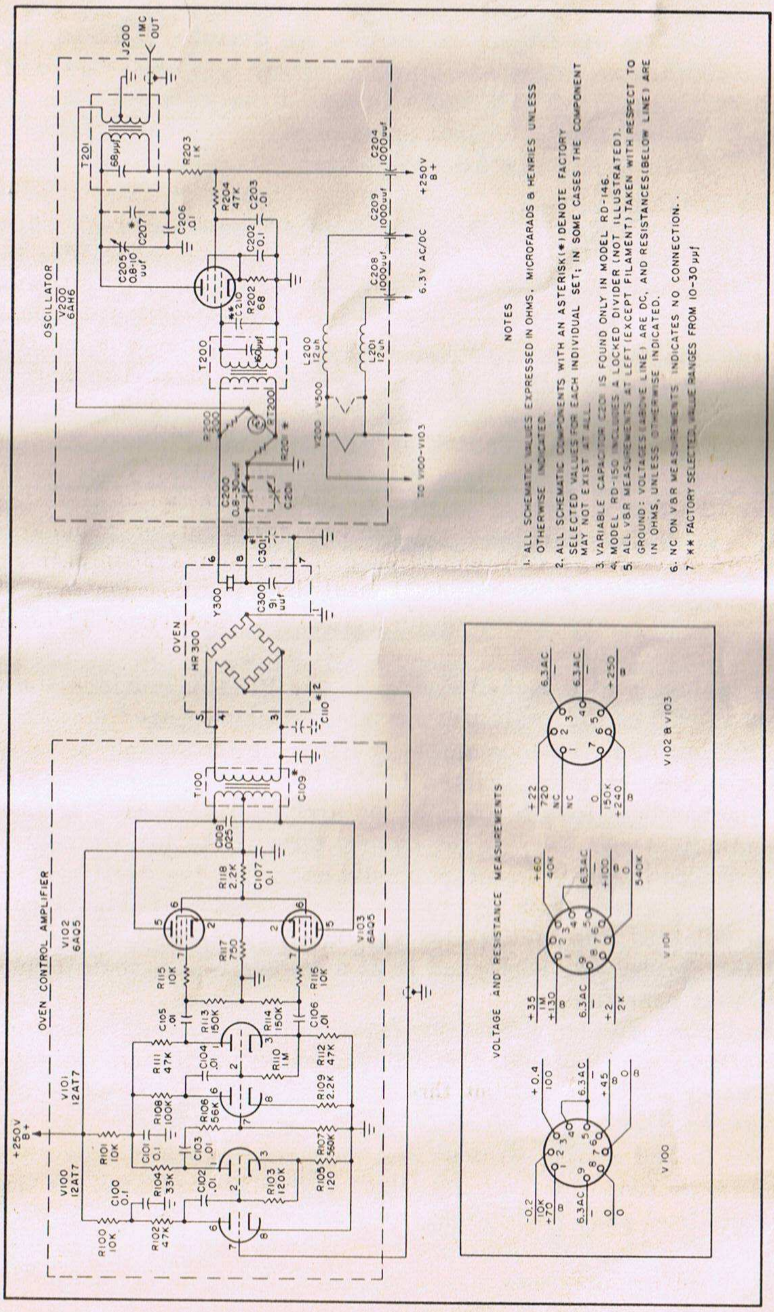
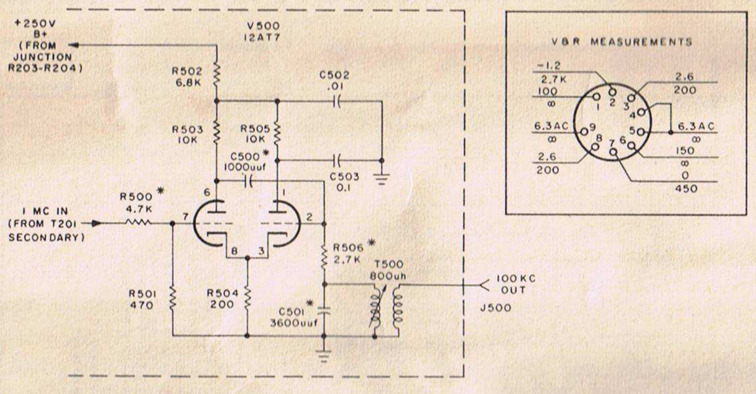


Figure 6. RD-140A Schematic Diagram



NOTES

1. ALL SCHEMATIC VALUES EXPRESSED IN OHMS, MICROFARADS, AND HENRIES UNLESS OTHERWISE INDICATED.
2. ALL SCHEMATIC COMPONENTS WITH AN ASTERISK (*) DENOTE VALUES THAT VARY ACCORDING TO DIVISION RATIO; THOSE SHOWN ARE FOR A 10:1 DIVISION.
3. ALL V&R MEASUREMENTS AT RIGHT (EXCEPT FILAMENT) TAKEN WITH RESPECT TO GROUND: VOLTAGES (ABOVE LINE) ARE DC, AND RESISTANCES (BELOW LINE) ARE IN OHMS, UNLESS OTHERWISE INDICATED.

Figure 7. RD-150 Locked Divider Schematic Diagram

The inclusion of a locked divider in the RD-150 provides a slug adjustment (T500) on the oscillator chassis, which may need resetting if the divided frequency becomes unstable or if circuit components are replaced. With a frequency meter connected to the 100kc output (J500), adjust the control for the best lock-in state of the divider, indicated by a sharp and clear audio beat note. Varying the control through the lock-in range by rotating it ½ turn in either direction should not affect the quality or frequency of the audio tone. Set the control to the center of this range. When properly adjusted, the tuning slug should be almost fully in; if it is too far out the divider may be locked in at a lower division ratio (higher frequency) than specified.

The locked divider (figure 7), found on the oscillator chassis, is a free-running, cathode-coupled oscillator whose natural frequency is an approximate submultiple of the 1mc output of V200. (In the schematic diagram, the division is 1/10 for 100kc.) The incoming 1mc signal synchronizes the locked divider to the exact required frequency. The output developed in the tuned tank circuit (C501 and primary of T500) is link coupled to the front-panel BNC jack.

A set of voltage and resistance measurements is given for servicing the single-tube stage. Note that a loss of stability in the locked-divider output indicates an absence of the 1mc synchronizing signal.

As the oscillator crystal ages, it becomes necessary to add a compensating capacity to the circuit so that the 1mc operating frequency can be maintained. To accomplish this, a variable capacitor is provided to take care of approximately two-years' aging. On the RD-140A and RD-150 this trimmer (marked XTAL) is located at the rear on the oscillator chassis; on the RD-146 the trimmer shaft is extended to a calibrated dial on the front panel. To insert the correct amount of compensation needed, beat the oscillator output against a known 1mc primary standard, and using a phase comparator as an indicator, adjust the trimmer so that the frequency of the RD-140A is the same as that of the standard. This procedure should be performed approximately once a month to maintain the oscillator at optimum stability.

On the RD-146, using the front-panel dial in conjunction with the individual calibration curve supplied with each set allows the aging rate of the crystal to be accurately determined. Note the frequency for the initial dial position and the frequency of the new position set to compensate for crystal aging. Divide their difference by the time period between these dial settings to obtain the crystal aging rate. Using this value, subsequent aging compensation on the RD-146 can be made without the use of a primary standard. In addition, the front-panel dial can be used to precisely tune the oscillator within 0 to 6 cycles of the 1mc frequency. An additional trimmer (C201) on the oscillator chassis can be adjusted so that the zero position on the dial always corresponds to 1mc and the dial generally follows the calibration curve.

When the crystal trimmer (on all models) reaches its maximum value, a fixed capacitor of high enough value (30uuf) may be inserted in the circuit and the trimmer returned to its minimum value. The capacitor must be a high quality NPO (zero temperature coefficient) type, and is connected across terminals 6 and 7 of the oven. (If there is an existing capacitor across these terminals, the new capacitor may replace or parallel this component.)

The RD-140A can withstand a supply voltage variation of ± 20% B+ and ± 10% filament, without adversely affecting its frequency stability. To insure minimum shift in output frequency resulting from changes in the B+ voltage, the plate circuit of the oscillator tube (V200) is tuned by a trimmer (C205) marked PLATE. This variable capacitor must not be adjusted since proper compensation has been made at the factory.

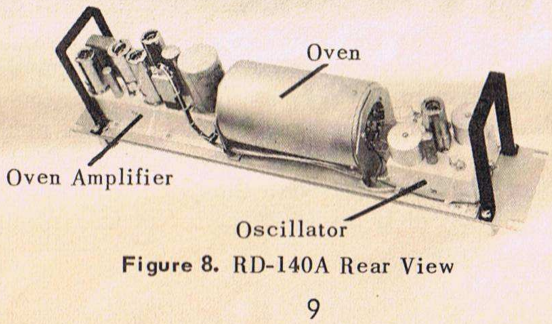


Figure 8. RD-140A Rear View

SERVICING

The RD-140A will provide long dependable service. Nevertheless, should any failure occur in the oven or oscillator (figure 8) which normal maintenance (such as tube replacement) cannot correct, the set should be returned to Manson Laboratories for repair, due to the highly precise nature of these circuits. The manufacturer cannot guarantee the stability and accuracy of the oscillator if any repairs or unnecessary adjustments are made to the oscillator and oven.

An indication of possible oven failure would be a drift of 10 to 30 cycles above the 1mc output frequency. A quick check of oven operation can be made by measuring the voltage at test points 3 and 4 located at one side of the oven control amplifier chassis. The voltage from each terminal to ground should be approximately 5 volts, and they must be equal; unequal voltages are a symptom of oven failure. When it is reasonably certain that the oven is malfunctioning, return the entire RD-140A to Manson Laboratories for repair.

The oven control amplifier, however, may be reasonably serviced, and a complete set of voltage and resistance measurements is supplied with the schematic diagram (figure 6) for this purpose. To check the performance of the amplifier, inject a 1mv 5kc signal at the input (pin 7) of V100 or at test point 2 on the oven control amplifier chassis. The amplifier output measured across the secondary of transformer T100, or between pins 3 and 4 on the amplifier chassis, should be about 10 volts. If there is no output, yet all voltage and resistance readings are normal, suspect a shorted capacitor C108. This capacitor and the primary of transformer T100 form a parallel resonant circuit which develops the 5kc output signal. If a considerable time is required for oven stabilization, or if the 1mc oscillator output drifts substantially, check for a defective V102 or V103. A failure in one of these tubes will not disable the circuit; instead, the remaining tube will (unsuccessfully) assume the load of both tubes.

WARRANTY

Manson Laboratories, Inc. warrants this instrument to be free from defects in material and workmanship. The period of the warranty is one year after the date of shipment of the instrument to the original purchaser. Our obligation under the warranty is limited to servicing the instrument and replacing defective parts when the instrument is returned to the factory with transportation charges prepaid. (Prepare two failure reports describing the nature of the trouble: forward one copy in advance to our service department and enclose the other copy with the instrument.) No other warranty may be implied.

The warranty will be void if the instrument has been repaired or altered by unauthorized persons in any way so as, in our judgement, to injure its stability or reliability, or if the instrument has been subject to misuse, negligence or accident, or if the instrument has been connected, installed, operated or adjusted otherwise than in accordance with the instructions furnished by us, or if the instrument has had its serial number removed, altered or effaced.

NOTE: All capacitors are fixed, ceramic, rated at 500vdcw, and all resistors are fixed, carbon composition, ±10% tolerance, rated at ½ watt, unless otherwise indicated.

SYMBOL	DESCRIPTION
C100 . . .	CAPACITOR: disc; 0.1uf +80/−20%
C101 . . .	Same as C100
C102 . . .	CAPACITOR: disc; .01 uf +100/−0%; 100vdcw
C103 . . .	Same as C102
C104 . . .	Same as C102
C105 . . .	Same as C102
C106 . . .	Same as C102
C107 . . .	Same as C100
C108 . . .	CAPACITOR, PAPER: molded; .025uf ±20%; 600vdcw
C109 . . .	CAPACITOR, DURMICA: 1500-5000uuf ±5%; factory selected value
C110 . . .	CAPACITOR, MICA: 0-200uuf ±1%; factory selected value
C200 . . .	CAPACITOR, GLASS, VARIABLE: 0.8–30uuf; 1000vdcw
C201** . .	CAPACITOR, GLASS, VARIABLE: 0.8–18uuf; 1000vdcw
C202 . . .	Same as C100
C203 . . .	CAPACITOR: disc; .01 uf +100/−0%; 500vdcw
C204 . . .	CAPACITOR: feedthrough; 1000uuf ±20%
C205 . . .	CAPACITOR, QUARTZ, VARIABLE: 0.8–10uuf; 1000vdcw
C206 . . .	Same as C203
C207 . . .	CAPACITOR: 0–25uuf; N3300 TC; factory selected value
C208 . . .	Same as C204
C209 . . .	Same as C204
C300 . . .	CAPACITOR, MICA: 91uuf ±1%
C500*† . .	CAPACITOR, DURMICA: 1000uuf ±5%; 300vdcw
C501*† . .	CAPACITOR, DURMICA: 3600uuf ±5%; 300vdcw
C502* . . .	Same as C102
C503* . . .	Same as C100
HR300 . . .	HEATER
J200 . . .	CONNECTOR, R-F: BNC type UG1094/U
J500* . . .	Same as J200
L200 . . .	CHOKE, R-F: 12uh ±10%
L201 . . .	Same as L200
R100 . . .	RESISTOR: 10K ohms
R101 . . .	Same as R100
R102 . . .	RESISTOR: 47K ohms
R103 . . .	RESISTOR: 120K ohms
R104 . . .	RESISTOR: 33K ohms
R105 . . .	RESISTOR: 120 ohms

PARTS LIST (continued)

SYMBOL	DESCRIPTION
R106 . . .	RESISTOR: 56K ohms
R107 . . .	RESISTOR: 560K ohms
R108 . . .	RESISTOR: 100K ohms
R109 . . .	RESISTOR: 2.2K ohms
R110 . . .	RESISTOR: 1M ohms
R111 . . .	Same as R102
R112 . . .	Same as R102
R113 . . .	RESISTOR: 150K ohms
R114 . . .	Same as R113
R115 . . .	Same as R100
R116 . . .	Same as R100
R117 . . .	RESISTOR, WIREWOUND: 750 ohms ±5%; 5W
R118 . . .	RESISTOR: 2.2K ohms ±2%; 1W
R200 . . .	RESISTOR, FILM: 200 ohms ±1%
R201 . . .	RESISTOR: 20–30 ohms; factory selected value
R202 . . .	RESISTOR: 68 ohms
R203 . . .	RESISTOR: 1K ohms
R204 . . .	Same as R102
R500*† . .	RESISTOR: 4.7K ohms
R501* . . .	RESISTOR: 470 ohms
R502* . . .	RESISTOR, FILM: 6.8K ohms ±1%
R503* . . .	RESISTOR, FILM: 10K ohms ±1%
R504* . . .	RESISTOR, FILM: 200 ohms ±1%; ¼W
R505* . . .	Same as R503
R506* . . .	RESISTOR, FILM: 2.7K ohms ±1%
RT200. . .	RESISTOR, THERMAL
T100 . . .	TRANSFORMER, R-F: 5mc; toroidal
T200 . . .	TRANSFORMER, R-F
T201 . . .	TRANSFORMER, R-F
T500* . . .	TRANSFORMER, R-F: 0.2-1.5mc; 440-800uh turnable range
TB100. . .	TERMINAL BOARD: 5-contact
TB101. . .	TERMINAL BOARD: 14-contact
TB102. . .	Same as TB101
V100 . . .	TUBE: 12AT7
V101 . . .	Same as V100
V102 . . .	TUBE: 6AQ6
V103 . . .	Same as V102
V200 . . .	TUBE: 6AH6
V500* . . .	Same as V100
Y100 . . .	CRYSTAL, PIEZOELECTRIC: 999.967kc ±2 cps

*Parts found only in RD-150 **Part found only in RD-146

†Parts in the RD-150 which vary according to division ratio. Those listed are for a 10:1 division.