NOTE:

The date of the latest revision as noted in this KelTec Operating Handbook is dated 03/22/78. From reviewing a number of amplifiers, it is apparent the information presented should be considered as a 'guideline' and not definitive to any one KelTec amplifier model.

The page numbering is hand printed, from 1 to 78. A total of 6 pages are included in Appendix A - D (No B section).

Review page 16 of 78 prior to connecting amplifier to any power.
### APPLICATION

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**OPERATING HANDBOOK**

**FOR KELTEC RACK MOUNT**

**100 AND 200 WATT TWT AMPLIFIERS**

**POWER SUPPLY MODEL**

R730-100/200, PART NO. 74D0127-1

**AMPLIFIER MODELS**

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**KELTEC FLORIDA**

FORT WALTON BEACH, FLORIDA

**OPERATING HANDBOOK**

**FOR KELTEC RACK MOUNT**

**100 AND 200 WATT TWT AMPLIFIERS**

**SIZE CODE IDENT NO**

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<tr>
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</tr>
</thead>
</table>

**REV E**
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>1.0 GENERAL</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 SCOPE</td>
<td>5</td>
</tr>
<tr>
<td>1.2 DESCRIPTION</td>
<td>6</td>
</tr>
<tr>
<td>1.3 KELTEC FLORIDA WARRANTY</td>
<td>7</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>2.0 SPECIFICATIONS</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 RF SPECIFICATIONS</td>
<td>8</td>
</tr>
<tr>
<td>2.2 ELECTRICAL SPECIFICATIONS</td>
<td>10</td>
</tr>
<tr>
<td>2.2.1 INPUT POWER</td>
<td>10</td>
</tr>
<tr>
<td>2.2.2 REMOTE CONTROL INPUT</td>
<td>11</td>
</tr>
<tr>
<td>2.2.3 TWT ELEMENTS</td>
<td>11</td>
</tr>
<tr>
<td>2.2.4 PROTECT CIRCUITRY</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2.3 MECHANICAL SPECIFICATIONS</th>
<th>PAGE NO.</th>
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</thead>
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<table>
<thead>
<tr>
<th>3.0 OPERATING INSTRUCTIONS</th>
<th>PAGE NO.</th>
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<tbody>
<tr>
<td>3.1 INSTALLATION</td>
<td>14</td>
</tr>
<tr>
<td>3.2 FRONT PANEL CONTROL AND INDICATOR DESCRIPTION</td>
<td>16</td>
</tr>
<tr>
<td>3.3 OPERATING PROCEDURE</td>
<td>19</td>
</tr>
<tr>
<td>3.3.1 POWER TURN-ON</td>
<td>19</td>
</tr>
<tr>
<td>3.3.2 TIME DELAY</td>
<td>19</td>
</tr>
<tr>
<td>3.3.3 OPERATE</td>
<td>20</td>
</tr>
<tr>
<td>3.3.4 TURN-OFF</td>
<td>20</td>
</tr>
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<table>
<thead>
<tr>
<th>4.0 THEORY OF OPERATION</th>
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<tbody>
<tr>
<td>4.1 GENERAL</td>
<td>21</td>
</tr>
<tr>
<td>4.2 POWER SUPPLY BLOCK DIAGRAM DISCUSSION</td>
<td>22</td>
</tr>
<tr>
<td>4.2.1 LOW POWER CHANNEL (HEATER SUPPLY)</td>
<td>24</td>
</tr>
<tr>
<td>4.2.2 HIGH POWER CHANNEL (HELIIX AND COLLECTOR)</td>
<td>26</td>
</tr>
<tr>
<td>4.2.3 CONTROL CIRCUIT</td>
<td>28</td>
</tr>
<tr>
<td>4.3 DEVELOPMENT OF THE HEATER VOLTAGE</td>
<td>30</td>
</tr>
<tr>
<td>4.4 DEVELOPMENT OF THE CATHODE VOLTAGE</td>
<td>35</td>
</tr>
<tr>
<td>4.5 DEVELOPMENT OF THE COLLECTOR VOLTAGE</td>
<td>41</td>
</tr>
<tr>
<td>4.6 CONTROL CIRCUIT OPERATION</td>
<td>43</td>
</tr>
<tr>
<td>TABLE OF CONTENTS (CONTINUED)</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>PAGE NO.</td>
<td></td>
</tr>
<tr>
<td>5.0 TROUBLESHOOTING GUIDE ..</td>
<td>46</td>
</tr>
<tr>
<td>5.1 AMPLIFIER MALFUNCTIONS ..</td>
<td>47</td>
</tr>
<tr>
<td>5.2 POSSIBLE CAUSES OF FAULTS</td>
<td>48</td>
</tr>
<tr>
<td>5.2.1 NO RF OUTPUT ..........</td>
<td>49</td>
</tr>
<tr>
<td>5.2.2 LOW RF OUTPUT ..........</td>
<td>50</td>
</tr>
<tr>
<td>5.2.3 POWER OUTPUT VARIES WITH LINE VOLTAGE ..........</td>
<td>51</td>
</tr>
<tr>
<td>5.2.4 HIGH RF NOISE ..........</td>
<td>52</td>
</tr>
<tr>
<td>5.2.5 4KHz MODULATION ON RF OUTPUT ..........</td>
<td>52</td>
</tr>
<tr>
<td>5.2.6 HELIX OVERCURRENT OVERLOADS REPEATEDLY ..........</td>
<td>53</td>
</tr>
<tr>
<td>5.2.7 REPEATED THERMAL OVERALDS ..........</td>
<td>54</td>
</tr>
<tr>
<td>5.2.8 EXCESSIVE INPUT CURRENT ..........</td>
<td>54</td>
</tr>
<tr>
<td>5.2.9 LOW FREQUENCY MODULATION OF THE RF OUTPUT ..........</td>
<td>55</td>
</tr>
<tr>
<td>5.2.10 120Hz MODULATION OF THE RF OUTPUT ..........</td>
<td>55</td>
</tr>
<tr>
<td>6.0 POWER SUPPLY CALIBRATION ..........</td>
<td>56</td>
</tr>
<tr>
<td>6.1 INTRODUCTION ..........</td>
<td>56</td>
</tr>
<tr>
<td>6.2 TEST EQUIPMENT REQUIRED ..........</td>
<td>56</td>
</tr>
<tr>
<td>6.3 VOLTAGE ADJUSTMENT PROCEDURE ..........</td>
<td>57</td>
</tr>
<tr>
<td>6.3.1 VOLTAGE ADJUSTMENT ..........</td>
<td>57</td>
</tr>
<tr>
<td>6.3.2 FILAMENT VOLTAGE ADJUSTMENT ..........</td>
<td>58</td>
</tr>
<tr>
<td>6.3.3 COLLECTOR/CATHODE TO HELIX VOLTAGE RANGE SELECTION ..........</td>
<td>60</td>
</tr>
<tr>
<td>6.3.4 COLLECTOR VOLTAGE CHECK ..........</td>
<td>61</td>
</tr>
<tr>
<td>6.3.5 CATHODE TO HELIX VOLTAGE ADJUSTMENT ..........</td>
<td>62</td>
</tr>
<tr>
<td>6.3.6 HELIX CURRENT OVERLOAD ADJUSTMENT ..........</td>
<td>64</td>
</tr>
<tr>
<td>6.3.7 VSWR OVERLOAD ADJUST (OPTIONAL) ..........</td>
<td>65</td>
</tr>
<tr>
<td>7.0 RF RESPONSE CHECK ..........</td>
<td>67</td>
</tr>
<tr>
<td>7.1 INTRODUCTION ..........</td>
<td>67</td>
</tr>
<tr>
<td>7.2 TEST EQUIPMENT REQUIRED ..........</td>
<td>67</td>
</tr>
<tr>
<td>7.3 RF CHECK ..........</td>
<td>68</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS
(CONTINUED)

LIST OF APPENDICES

APPENDIX A - POWER SUPPLY ACCEPTANCE TEST DATA SHEET AND RF RESPONSE DATA SHEET FOR TRAVELING WAVE TUBE AMPLIFIER .. A1

APPENDIX B - KELTEC FLORIDA WARRANTY .. B1

APPENDIX C - DRAWINGS AND SCHEMATICS .. C1

APPENDIX D - TEST DATA SHEET .. D1

LIST OF FIGURES

FIGURE 1 - REMOTE CONTROL MODULE FOR R630-100/200 AMPLIFIERS .. 74

FIGURE 2 - POWER SUPPLY BLOCK DIAGRAM .. 75

FIGURE 3 - LOAD FIXTURE FOR R630-100/200 AMPLIFIERS .. 76

FIGURE 4 - LOCATION OF ADJUSTMENTS .. 77

FIGURE 5 - RF TEST CONNECTIONS FOR R630-100/200 AMPLIFIERS .. 78

LIST OF TABLES

TABLE I - TWT ELEMENT SPECIFICATIONS - 100 WATT UNITS .. 70
TWT ELEMENT SPECIFICATIONS - 200 WATT UNITS .. 71

TABLE II - TROUBLESHOOTING CHART .. 72

TABLE III - COLLECTOR VOLTAGE AND CATHODE TO HELIX VOLTAGE RANGE SELECTION GUIDE .. 73
1.0 GENERAL

1.1 SCOPE

This handbook includes the specifications, proper operating procedures, circuit theory, fault isolation techniques, and calibration procedures for the 100 watt and 200 watt continuous wave, Keltec Florida, traveling wave tube rack mount amplifiers.
1.2 DESCRIPTION

THE KELTEC 100 WATT AND 200 WATT CONTINUOUS WAVE TRAVELING WAVE TUBE AMPLIFIER SERIES DELIVER A MINIMUM OF 100 WATTS OR 200 WATTS OF RF POWER OVER THE L, S, C, X, AND KU FREQUENCY BANDS (1.0 TO 18.0GHz). THE AMPLIFIER IS DESIGNED FOR LABORATORY APPLICATIONS, DATA-LINK TRANSMISSIONS, OR IN ANY GROUND BASE COMMUNICATIONS SYSTEM. THE UNIT FITS IN A STANDARD 19-INCH RACK IN A SPACE 12-1/4 INCHES HIGH AND 25 INCHES DEEP. TWENTY-FOUR INCH CHASSIS SLIDES ARE PROVIDED.

THE POWER SUPPLY USED IN THIS AMPLIFIER IS ADAPTABLE TO ALMOST ANY 100, 200 OR 300 WATT TRAVELING WAVE TUBE SIMPLY BY MAKING THE NECESSARY ADJUSTMENTS. THE SUPPLY HAS A CATHODE TO HELIX VOLTAGE RANGE OF -2,700 TO -10,300VDC, AND A COLLECTOR VOLTAGE RANGE OF 2,750 TO 5,000VDC. THE UNIT UTILIZES SOLID STATE DEVICES AND FEATURES DELAYED HIGH VOLTAGE TURN-ON, CONTROLLED TURN-ON AND TURN-OFF SEQUENCING AND PROTECT CIRCUITRY FOR FAIL-SAFE OPERATION.

THE UNIT IS FORCED AIR COOLED WITH INLETS AT THE FRONT AND REAR AND AN EXHAUST OUTLET AT THE REAR OF THE AMPLIFIER. PRIME POWER REQUIRED BY THE AMPLIFIER IS 115 OR 230VAC, 47 TO 65Hz, SINGLE PHASE, 2,000 WATTS MAXIMUM.
1.3 KELTEC FLORIDA WARRANTY

THE PRODUCTS DELIVERED HEREUNDER, EXCEPT FOR TRAVELING WAVE TUBES, ARE WARRANTED BY KELTEC FLORIDA ("KELTEC") FOR THE TERM OF THIS WARRANTY TO BE FREE OF DEFECTS IN MATERIAL AND WORKMANSHIP AND TO CONFORM TO ALL TECHNICAL SPECIFICATIONS, DRAWINGS OR SAMPLES MUTUALLY AGREED TO IN WRITING BY KELTEC AND BUYER, SUBJECT TO THE LIMITATIONS CONTAINED HEREIN. THE TERM OF THIS WARRANTY IS TWELVE (12) MONTHS AFTER THE DATE OF SHIPMENT BY KELTEC TO BUYER, EXCEPT FOR TRAVELING WAVE TUBES. TRAVELING WAVE TUBES ARE WARRANTED BY THE MANUFACTURER AND SUCH WARRANTY AS IS ISSUED TO KELTEC WILL BE EXTENDED TO THE USER OF KELTEC TRAVELING WAVE TUBE AMPLIFIERS. FOR DETAILS OF THE TRAVELING WAVE TUBE WARRANTY, SEE ATTACHMENTS A, B OR C.

IF THE PRODUCT FAILS TO FUNCTION OR MALFUNCTIONS DURING THE TERM OF THIS WARRANTY AS A RESULT OF DEFECT IN MATERIAL AND WORKMANSHIP, KELTEC WILL REPAIR THE PRODUCT AT ITS PLANT OR REPLACE THE PRODUCT, AT ITS SOLE OPTION, PROVIDED THAT THE BUYER HAS NOTIFIED KELTEC IN WRITING DURING THE TERM OF THIS WARRANTY OF A CLAIM HEREUNDER AND HAS RETURNED THE PRODUCT TO KELTEC'S PLANT WITHIN THIRTY (30) CALENDAR DAYS AFTER DISCOVERY OF THE CLAIMED DEFECT OR NON-CONFORMITY. KELTEC WILL NOT BE RESPONSIBLE FOR ANY COSTS OR REMOVAL OR REINSTALLATION OF THE PRODUCT.

THIS WARRANTY DOES NOT COVER THE FOLLOWING:

A. ANY PRODUCT WHICH HAS BEEN MODIFIED, ALTERED, OR REPAIRED OTHER THAN BY KELTEC OR ITS AUTHORIZED REPRESENTATIVE;
1.3 (CONTINUED)

B. ANY PRODUCT WHICH HAS BEEN SUBJECTED TO IMPROPER INSTALLATION, MAINTENANCE, OVERHAUL, OPERATION, ENVIRONMENT OR STORAGE NOT IN ACCORDANCE WITH INSTRUCTIONS OR SPECIFICATIONS OF KELTEC;

C. ANY PRODUCT WHICH HAS BEEN DAMAGED AS A RESULT OF MISUSE, NEGLIGENCE, NEGLECT OR SHIPPING; AND

D. ANY PRODUCT TO WHICH DAMAGE IS ATTRIBUTABLE TO ANY PART NOT SUPPLIED OR APPROVED BY KELTEC.

THE OBLIGATIONS OF KELTEC UNDER THIS WARRANTY ARE EXPRESSLY CONDITIONED ON BUYER'S MAINTAINING OF RECORDS KEPT IN THE ORDINARY COURSE OF BUSINESS ACCURATELY REFLECTING MAINTENANCE PERFORMED, AND THE COMPLETE NATURE OF ANY UNSATISFACTORY CONDITION. BUYER SHALL MAKE SUCH RECORDS FULLY AVAILABLE TO KELTEC IN THE EVENT OF A WARRANTY CLAIM. KELTEC RESERVES THE RIGHT TO MAKE THE FINAL DECISION AS TO THE EXISTENCE AND NATURE OF ANY DEFECT IN THE PRODUCT, ANY FAILURE BY THE PRODUCT TO CONFORM TO SPECIFICATIONS, AND THE APPLICABILITY AND INTERPRETATION OF THIS WARRANTY. KELTEC RESERVES THE RIGHT TO REPLACE ANY DEFECTIVE PRODUCT OR PART THEREOF WITH A REASONABLY SIMILAR PRODUCT OR PART WHICH WILL CONFORM TO ALL APPLICABLE SPECIFICATIONS IN THE EVENT THAT ORIGINAL MATERIALS ARE NO LONGER AVAILABLE. KELTEC FURTHER RESERVES THE RIGHT TO MAKE CHANGES IN ANY OF ITS PRODUCTS WITHOUT OBLIGATION TO INCORPORATE ANY SUCH CHANGE IN THE PRODUCT COVERED BY THIS WARRANTY.
1.3 CONTINUED

KELTEC MAKES NO OTHER EXPRESS WARRANTY OF ANY KIND WHATSOEVER. ALL IMPLIED WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED AND EXCLUDED FROM THIS WARRANTY. KELTEC DISCLAIMS ALL LIABILITY FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH ANY PRODUCT COVERED BY THIS WARRANTY.

IN THE EVENT OF THE MALFUNCTION OF THE PRODUCT COVERED BY THIS WARRANTY, BUYER SHALL PROMPTLY NOTIFY KELTEC IN WRITING SETTING FORTH THE SERIAL NUMBER OF THE PRODUCT AND ALL AVAILABLE SPECIFIC DATA RELATING TO ITS MALFUNCTION, INCLUDING THE NUMBER OF ACTUAL OPERATING HOURS. NO PRODUCT MAY BE RETURNED TO KELTEC WITHOUT EXPRESS WRITTEN AUTHORIZATION FROM KELTEC. BUYER SHALL SHIP THE PRODUCT, FREIGHT AND INSURANCE PREPAID, TO KELTEC. ANY PRODUCT RETURNED WITHOUT AUTHORIZATION MAY, AT KELTEC'S OPTION, BE REFUSED AND MAY BE RETURNED, FREIGHT COLLECT TO BUYER. IF KELTEC'S INSPECTION DISCLOSES A VALID WARRANTY CLAIM REQUIRING REPAIR OR REPLACEMENT, KELTEC WILL ASSUME THE COST OF RETURN SHIPPING CHARGES TO BUYER NOT TO EXCEED NORMAL SURFACE SHIPPING CHARGES WITHIN THE CONTINENTAL UNITED STATES.

BUYER SHALL NOT DEBIT SELLER FOR PRODUCTS RETURNED UNDER THIS WARRANTY WITHOUT PRIOR WRITTEN AUTHORIZATION FROM SELLER. SUCH UNAUTHORIZED DEBITS SHALL BE SUBJECT TO A SURCHARGE EQUAL TO SELLER'S G & A BURDEN AT THE TIME OF RETURN OF THE PRODUCT TO BUYER.
1.3 (CONTINUED)

THIS WARRANTY SHALL SURVIVE ACCEPTANCE AND SHALL INURE TO THE
BENEFIT OF BUYER, ITS SUCCESSORS, ASSIGNS AND CUSTOMERS.
THIS WARRANTY MAY NOT BE MODIFIED, AMENDED OR EXTENDED UNLESS
IN WRITING AND SIGNED BY A DULY AUTHORIZED REPRESENTATIVE
OF KELTEC.
2.0 SPECIFICATIONS

2.1 RF SPECIFICATIONS

FREQUENCY RANGE:

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<th>FREQUENCY</th>
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<td>1.0 TO 2.0GHz</td>
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<td>LR630-200</td>
<td>L</td>
<td>1.0 TO 2.0GHz</td>
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<td>8.0 TO 12.4GHz</td>
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SATURATED POWER OUTPUT (MINIMUM) 100 WATT UNITS +50dbm

200 WATT UNITS +53dbm.

SEE RF RESPONSE DATA SHEET IN APPENDIX A.

GAIN AT RATED POWER:

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<td>C BAND 40db</td>
<td>SC BAND 45db</td>
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<td>X BAND 35db</td>
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<tr>
<td></td>
<td>KU BAND 35db</td>
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SEE RF RESPONSE DATA SHEET IN APPENDIX A FOR SPECIFIC VALUES.
2.1 (CONTINUED)

MAXIMUM NOISE FIGURE 35db
INPUT VSWR (MAXIMUM) 3.0:1
OUTPUT VSWR (MAXIMUM) 2.0:1

FOR SPECIFIED RF PERFORMANCE AN OUTPUT VSWR OF 1.5:1 SHOULD NOT BE EXCEEDED. AN ADJUSTABLE VSWR OVERLOAD CIRCUIT IS OPTIONAL PER CUSTOMER SPECIFICATIONS.

IMPEDANCE (INPUT AND OUTPUT) 50 OHMS
CONNECTORS

RF INPUT TYPE N FEMALE
RF OUTPUT TYPE N FEMALE

ON X AND KU BANDS, RF OUTPUT IS A WAVEGUIDE EXTENDING FROM THE REAR OF THE AMPLIFIER. ANY OPTIONAL CONNECTOR STYLE IS AVAILABLE PER CUSTOMER SPECIFICATIONS.
2.2 ELECTRICAL SPECIFICATIONS

2.2.1 INPUT POWER

PRIME INPUT POWER
115VAC ±10% OR
230VAC ±10%
47-65Hz, SINGLE PHASE

POWER CONSUMPTION 2,000 WATTS MAXIMUM

CIRCUIT BREAKERS

LOW VOLTAGE
3 AMPS FOR 115VAC
3 AMPS FOR 230VAC

HIGH VOLTAGE
30 AMPS FOR 115VAC
15 AMPS FOR 230VAC

CONNECTOR TYPE P/N 3434 BY ARROW-HART
MATING CONNECTOR P/N 3433 BY ARROW-HART

INPUT POWER CONNECTOR, J1

PIN

W SAFETY GROUND (CHASSIS)

230VAC (ONE SIDE)

POWER NEUTRAL

115VAC OR 230VAC (ONE SIDE)

NOTE: DO NOT USE TWO PHASES OF 115/208VAC, THREE
PHASE POWER FOR THE 230VAC INPUT. ONE PHASE
MAY BE USED FOR THE 115VAC INPUT ONLY.
2.2.2 REMOTE CONTROL INPUT
CONNECTOR TYPE          P/N DBM-25S, ITT CANNON
MATING CONNECTOR       P/N DBM-25P, ITT CANNON

SEE PARA 3.1.1 AND FIGURE 1 FOR FURTHER REMOTE CONTROL DETAILS.

2.2.3 TWT ELEMENTS
TWT ELEMENT VOLTAGES ARE GIVEN IN TABLE I. FOR A MORE DETAILED LIST OF CATHODE TO HELIX AND COLLECTOR VOLTAGE RANGES SEE TABLE III IN SECTION 6.0.

<table>
<thead>
<tr>
<th>HIGH VOLTAGE MODULE</th>
<th>MATING CONNECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1 - CATHODE</td>
<td>PM1SLSH WINCHESTER</td>
</tr>
<tr>
<td>J3 - HEATER</td>
<td>PM1SLSH WINCHESTER</td>
</tr>
<tr>
<td>J4 - COLLECTOR</td>
<td>PM1SLSH WINCHESTER</td>
</tr>
</tbody>
</table>

CHASSIS TERMINAL BOARD
TB1-1 HELIX GROUND, NO. 2 SOLDER LUG
   -2  } TWT THERMAL
   -3  } OVERLOAD (NC), NO. 2 SOLDER LUG
2.2.4 PROTECT CIRCUITRY

TWT THERMAL OVERLOAD (CONNECTIONS ON CHASSIS TB1-2 AND -3).

HELIX CURRENT OVERLOAD (ADJUSTABLE BY R17 ON THE CONTROL CIRCUIT BOARD).

CHASSIS INTERLOCK (HIGH VOLTAGE CUTOFF WHEN TOP OR BOTTOM PANEL REMOVED).

VSWR OVERLOAD (OPTIONAL).

INPUT IS 200MV TO 5VDC ON REMOTE CONNECTOR, J2, PIN 21 TO 22 (GND) ADJUSTABLE BY R1 ON THE CONTROL CIRCUIT BOARD.
2.3 MECHANICAL SPECIFICATIONS

SHAPE
RECTANGULAR - 19-INCH RACK MOUNT

DIMENSIONS
(SEE OUTLINE DRAWING IN APPENDIX B)
HEIGHT
12.22 INCHES
WIDTH
19.00 INCHES
DEPTH
24.00 INCHES

WEIGHT
POWER SUPPLY ONLY
180 POUNDS
AMPLIFIER (TWT INCL)
200 POUNDS

COOLING
INTEGRAL FORCED AIR

ENVIRONMENT
OPERATING ALTITUDE
SEA LEVEL TO 10,000 FEET
OPERATING TEMPERATURE
0 TO 50°C

MOUNTING POSITION
STANDARD 19-INCH RACK WITH
CHASSIS SIDES, 24-INCH LENGTH

FINISH
FRONT PANEL - PAINT (FAWN-BEIGE)
SIDE PANEL- ANODIZED ALUMINUM
OTHER METAL PARTS - ALODINED
3.0 OPERATING INSTRUCTIONS

3.1 INSTALLATION


CONNECTION OF PRIME POWER TO THE AMPLIFIER IS MADE AT THE REAR PANEL WITH CONNECTIONS AS DESCRIBED IN PARA 2.2.1. CONNECT A 50 OHM LOAD TO THE RF OUT CONNECTOR AND AN RF SOURCE TO THE RF IN CONNECTOR. MAXIMUM RF LOAD VSWR ALLOWABLE FOR SAFE OPERATION OF THE AMPLIFIER IS SPECIFIED IN PARA 2.1. CARE SHOULD BE EXERCISED NOT TO OVERDRIVE THE TUBE. MAXIMUM RF DRIVE SHOULD BE LIMITED TO APPROXIMATELY 6dB ABOVE THAT REQUIRED TO SATURATE THE TUBE.
OPERATING HAZARD

Microwave Radiation

Exposure to the human body to microwave radiation in excess of one (1) milliwatt per square centimeter is unsafe and can result in blindness or other injury. Personnel must be fully protected from the microwave energy which radiates from this device. All input and output r-f connections, waveguide flanges, and gaskets must be r-f leakproof and properly engaged. Never operate this device without a microwave-energy-absorbing load attached. Personnel must be prevented from looking into open waveguides or antennas while such a device is energized.

3.1.1 INSTALLATION FOR REMOTE OPERATION

REMOTE OPERATION IS POSSIBLE USING A REMOTE MODULE AS SHOWN IN FIGURE 1. THE MODULE PARALLELS ALL FRONT PANEL CONTROLS AND INDICATORS, AND IS CONNECTED TO THE AMPLIFIER BACK PANEL IN THE REMOTE INPUT CONNECTOR. THE REMOTE MODULE HAS AN ADDITIONAL REMOTE INDICATOR WHICH IS LIGHTED WHEN THE REMOTE STATION IS ACTIVATED BY THE AMPLIFIER MODE SWITCH BEING PLACED IN THE REMOTE POSITION.
3.2 FRONT PANEL CONTROL AND INDICATOR DESCRIPTION

MODE CONTROL SWITCH

OFF     NO POWER IS BEING APPLIED TO THE UNIT.
STANDBY  ONLY FILAMENT AND ANODE VOLTAGES ARE APPLIED TO THE TWT.
OPERATE AFTER THE TIME DELAY, TWT HIGH VOLTAGE COMES ON ALLOWING THE AMPLIFIER TO OPERATE.
REMOTE  THIS TRANSFERS OFF/STANDBY/OPERATE CONTROL FROM THE UNIT THROUGH THE J2 REMOTE CONNECTOR TO A REMOTE STATION.

CIRCUIT BREAKERS

THREE MAIN CIRCUIT BREAKERS PROTECT THE LOW VOLTAGE AND HIGH VOLTAGE CIRCUITRY AS FOLLOWS (ONLY TWO ARE IN USE AT ANY GIVEN TIME):

THE CIRCUIT BREAKER FOR THE LOW VOLTAGE CIRCUITRY IS RATED AT 3 AMPERES AND IS USED WHEN OPERATING FROM EITHER A 115 OR 230 VOLT PRIMARY INPUT.

THE HIGH VOLTAGE CIRCUITRY IS PROTECTED BY ONE OR TWO CIRCUIT BREAKERS DEPENDING UPON THE PRIMARY INPUT VOLTAGE BEING USED.

FOR 115 VOLT OPERATION A SINGLE 30A CIRCUIT BREAKER IS USED TO PROTECT THE HIGH VOLTAGE CIRCUITRY. FOR 230 VOLT OPERATION, THE SAME 30A CIRCUIT BREAKER IS USED AND IN ADDITION, A 15A CIRCUIT BREAKER IS ALSO USED.

HELIX CURRENT METER

INDICATES TWT HELIX CURRENT FROM 0 TO 100mA.
3.2 (CONTINUED)

INDICATORS

TIME DELAY  TURNS ON AS SOON AS PRIME POWER IS TURNED ON. TURNS OFF WHEN THE THREE MINUTE TIME DELAY HAS ELAPSED. INDICATES TWT FILAMENT WARM-UP.

STANDBY  TURNS ON AFTER THREE MINUTE TIME DELAY HAS ELAPSED, ONLY IF UNIT IS IN THE STANDBY MODE. TURNS OFF WHEN UNIT IS PLACED IN OPERATE OR OFF. INDICATES UNIT IS READY FOR OPERATION.

OPERATE  TURNS ON WHEN UNIT IS PLACED IN THE OPERATE MODE.

CURRENT OVERLOAD  INDICATES WHEN TWT HELIX CURRENT HAS EXCEEDED ITS MAXIMUM SAFE OPERATING LIMIT. THE OVERLOAD MUST BE MANUALLY RESET BY PLACING THE UNIT IN STANDBY AND RETURNING IT TO OPERATE. OVERCURRENT TRIP IS FACTORY SET PER SPECIFIC TWT REQUIREMENTS. SEE SECTION 6.0 FOR PROPER OVERLOAD ADJUSTMENT.
3.2 (CONTINUED)

INDICATORS (CONTINUED)

THERMAL OVERLOAD

Indicates when the maximum safe operating temperature of the amplifier traveling wave tube has been exceeded. The overload removes high voltage allowing TWT filament and unit fan to operate. Unit will reset to operate automatically after amplifier has cooled. The normally closed tube thermal switch connects on chassis terminal board, TB1-2 and -3.

VSWR OVERLOAD (OPTIONAL)

Indicates when an excessive voltage standing wave is being reflected back into the TWT RF output. The overload removes high voltage. The unit must be reset by placing it in standby and returning it to operate. Optional VSWR overload indicator is on front panel and on J2 remote connector pin 14 to pin 10. The VSWR input is 200mV to 5VDC on J2 remote connector pin 21 to 22 (GND).
3.3 OPERATING PROCEDURE

WHEN THE PROPER POWER AND RF CONNECTIONS HAVE BEEN MADE, THE UNIT IS READY FOR OPERATION.

3.3.1 POWER TURN-ON

TURN THE MODE CONTROL FROM OFF TO STANDBY.

THE YELLOW TIME DELAY INDICATOR WILL LIGHT,

FILAMENT VOLTAGE WILL BE APPLIED TO THE TWT AND THE THREE MINUTE TIME DELAY WILL START.

3.3.2 TIME DELAY

THE FILAMENT IS GIVEN TIME TO HEAT BEFORE THE TWT HIGH VOLTAGE IS APPLIED. THIS PREHEATING PROLONGS THE LIFE OF THE CATHODE. AFTER APPROXIMATELY THREE MINUTES OF FILAMENT HEATING, THE YELLOW TIME DELAY INDICATOR WILL GO OUT AND THE GREEN STANDBY INDICATOR WILL LIGHT, SIGNIFYING THAT HIGH VOLTAGE CAN BE APPLIED TO THE TWT.
3.3.3 OPERATE

TURN THE MODE CONTROL FROM STANDBY TO OPERATE.
THIS WILL APPLY HIGH VOLTAGE TO THE TWT. THE
GREEN STANDBY INDICATOR WILL GO OUT AND THE
BLUE OPERATE INDICATOR WILL LIGHT. THE HELIX
CURRENT METER WILL REGISTER THE HELIX CURRENT.
THE AMPLIFIER IS THEN READY FOR RF OPERATION.
NOTE: TO PREVENT THE TWT FROM BECOMING GASSY,
THE AMPLIFIER SHOULD BE PLACED IN FULL
OPERATION FOR AT LEAST ONE HOUR EVERY
SIX MONTHS.

3.3.4 TURN-OFF

WHEN TURNING OFF THE AMPLIFIER, PLACE THE
AMPLIFIER IN STANDBY FOR A FEW MINUTES TO
ALLOW THE TWT TO COOL. THIS PROCEDURE WILL
EXTEND TUBE LIFE.

CAUTION: PLACING THE UNIT FROM STANDBY TO
OPERATE TO STANDBY TO OPERATE IN
RAPID SUCCESSION (LESS THAN THREE
SECOND INTERVALS) CAN BE DETRIMENTAL
TO BOTH THE POWER SUPPLY AND THE
TRAVELING WAVE TUBE.
4.0 THEORY OF OPERATION

4.1 GENERAL

THE THEORY OF OPERATION SECTION IS DIVided INTO TWO PARTS. THE POWER SUPPLY BLOCK DIAGRAM DISCUSSION IS GIVEN FIRST. IT IS FOLLOWED BY A MORE DETAILED CIRCUIT DESCRIPTION.

TO AVOID AMBIGUITY IN REFERING TO INDIVIDUAL COMPONENTS THE POWER SUPPLY HAS BEEN DIVIDED INTO SIX MODULES. EACH MODULE HAS BEEN ASSIGNED A NUMBER PREFIXED WITH THE LETTER "A," AS FOLLOWS:

<table>
<thead>
<tr>
<th>MODULE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>A1</td>
<td>CHASSIS</td>
</tr>
<tr>
<td>A2</td>
<td>HIGH VOLTAGE</td>
</tr>
<tr>
<td>A3</td>
<td>HEAT SINK</td>
</tr>
<tr>
<td>A4</td>
<td>CONTROL CIRCUIT</td>
</tr>
<tr>
<td>A5</td>
<td>HELIX-HEATER REGULATOR</td>
</tr>
<tr>
<td>A6</td>
<td>LOW VOLTAGE POWER MODULE</td>
</tr>
</tbody>
</table>

A COMPONENT REFERENCE DESIGNATION WILL BE PREFIXED BY ITS MODULE CODE. EXAMPLE: A3R1 - RESISTOR R1 ON THE HEAT SINK.
4.2 POWER SUPPLY BLOCK DIAGRAM DISCUSSION

THE ELECTRICAL OPERATION OF THE POWER SUPPLY CAN BE SUBDIVIDED INTO FUNCTIONAL BLOCKS AS SHOWN IN FIGURE 2. EACH BLOCK CONTAINS A COMPONENT OR GROUP OF COMPONENTS CONNECTED TO PERFORM THE SPECIFIC ELECTRICAL FUNCTION LABELED ON THAT BLOCK. FIGURE 2 SHOWS THE REQUIRED INTERCONNECTION OF THE BLOCKS TO PERFORM THE COMPLETE ELECTRICAL FUNCTION OF THE POWER SUPPLY.

THE FUNCTION OF THE POWER SUPPLY IS TO PROVIDE CONTROLLED FILAMENT, HELIX AND COLLECTOR VOLTAGE TO A HIGH POWER TRAVELING WAVE TUBE. INDICATORS ARE ALSO PROVIDED TO DISPLAY THE STATE OF THE POWER SUPPLY TO THE OPERATOR.

IN THE POWER SUPPLY THERE IS A LOW VOLTAGE POWER CHANNEL FOR THE HEATER OUTPUT AND A HIGH VOLTAGE POWER CHANNEL FOR THE HELIX AND COLLECTOR OUTPUTS. THE LOW VOLTAGE POWER IS CONTROLLED BY CIRCUIT BREAKER 1 AND SWITCH S1A AND S1B. THE HIGH VOLTAGE POWER IS CONTROLLED BY CIRCUIT BREAKER 2 AND THE POWER RELAY. THE POWER RELAY IS OPERATED BY THE
4.2 (CONTINUED)

CONTROL CIRCUIT. THE CONTROL CIRCUIT TRANSLATES FRONT PANEL (OR REMOTE) SWITCH POSITIONS AND OVERLOAD SIGNALS FROM THE POWER SUPPLY CIRCUITS INTO ELECTRICAL COMMANDS FOR THE POWER SUPPLY CIRCUITS AND INDICATOR SIGNALS FOR THE FRONT PANEL (OR REMOTE) INDICATORS.
4.2.1 LOW POWER CHANNEL (HEATER SUPPLY)

Input power from the main power plug J1 flows through circuit breaker 1 to switch S1A and S1E if the circuit breaker is closed. When S1 is in standby or operate the input power is connected to the time delay relay, the blower, and to input converter No. 1. The time delay relay generates a signal, after three minutes of operation, which is fed to the control circuit. The control circuit inhibits the high voltage power channel until it receives the signal from the relay. This allows the heater of the TWT to warm up before high voltage is applied regardless of front panel switch positions. Input converter No. 1 contains a stepdown transformer, rectifier, and filter to convert the 115VAC (or 230VAC) power into 28VDC for the heater regulator.

The heater regulator is self-starting, and it changes the 28VDC from the input converter to a regulated 23VDC which is used to supply several other circuits, including the magnetic multi-vibrator and heater inverter. The next stage in
4.2.1 (CONTINUED)

THE LOW VOLTAGE CHANNEL IS THE MAGNETIC MULTI-
VIBRATOR. IT IS A SELF-STARTING 4KHz SQUARE
WAVE OSCILLATOR WHICH CHOPS THE 23VDC POWER
AND STEPS IT DOWN TO 8Vpp BASE DRIVE FOR THE
HEATER INVERTER SWITCHING TRANSISTORS. THE
HEATER INVERTER ALSO CHOPS THE 23VDC FROM THE
HEATER REGULATOR AND PROVIDES 6.3VRMS SQUARE
WAVE HEATER POWER FOR THE TWT. THE 6.3VRMS
OUTPUT IS REFERENCED (FLOATED) TO THE CATHODE
OUTPUT. THIS HEATER POWER IS APPLIED TO THE
TWT AS SOON AS CIRCUIT BREAKER 1 IS CLOSED AND
S1 (OR REMOTE S1) IS SWITCHED FROM THE OFF
POSITION.
4.2.2 HIGH VOLTAGE POWER CHANNEL (HELIX AND COLLECTOR)


THE COLLECTOR POWER IS SUPPLIED FROM A HIGH VOLTAGE SECONDARY OF THE COLLECTOR TRANSFORMER AND IS RECTIFIED AND FILTERED AND THEN THE RESULTING HIGH VOLTAGE DC IS APPLIED BETWEEN THE COLLECTOR AND CATHODE OF THE TWT.

THE HELIX POWER SUPPLIED BY THE LOW VOLTAGE SECONDARY OF THE COLLECTOR TRANSFORMER IS SUPPLIED TO THE HELIX DC TO DC CONVERTER WHERE IT IS CHOPPED, REGULATED, AND TRANSFORMER TO HIGH VOLTAGE AND THEN RECTIFIED. THE RECTIFIED HIGH VOLTAGE IS FILTERED AND SURGE LIMITED AND THEN APPLIED BETWEEN THE CATHODE AND HELIX OF THE TWT. THE HELIX VOLTAGE APPLIED TO THE
4.2.2 (CONTINUED)

TWT is tightly regulated because the DC to DC converter base drive is controlled through the Helix regulator. The Helix regulator receives a feedback signal from the cathode output and compares it with an internal reference to generate an error signal for the Helix converter base drive controller. The controller then adjusts the base drive input to the converter so that the desired output is maintained.
4.2.3 CONTROL CIRCUIT

The inputs to the Control Circuit are the Front Panel (or Remote) switch positions, overload signals, time delay relay signal, and DC power from the heater regulator. The main function of the Control Circuit is to operate the power relay in order to control the generation of high voltage. A secondary function is to generate indicator signals for displaying the operation state of the power supply. The circuit indications are:

A. Time delay (Warm-up).
B. Standby.
C. Operate.
D. Overload.

The overload state is distinguished as to the type of overload which has occurred: either thermal, helix current or VSWR. VSWR is optional indication although circuit components are in place except the lamp. All of the functions of the Control Circuit can be obtained at a remote location by proper connections to J2.
4.2.3 (CONTINUED)

THE FOLLOWING SECTIONS WILL DISCUSS CIRCUIT OPERATION WITHIN THE VARIOUS BLOCKS OF FIGURE 2. IN ORDER TO MAINTAIN AN UNDERSTANDING OF THE CIRCUIT FUNCTION IN RELATION TO THE OVERALL POWER SUPPLY OPERATION FREQUENT REFERENCE TO FIGURE 2 WILL BE NECESSARY.
4.3 DEVELOPMENT OF THE HEATER VOLTAGE

THE CIRCUITS WHICH DEVELOP THE HEATER VOLTAGE ARE IN THE TOP LINE OF BLOCKS IN FIGURE 2. THESE BLOCKS COM普RE THE LOW VOLTAGE POWER CHANNEL DISCUSSED IN SECTION 4.1.

POWER FOR THE LOW VOLTAGE POWER CHANNEL ENTERS THE POWER SUPPLY THROUGH THE MAIN POWER INPUT J1 AND FLOWS THROUGH CIRCUIT BREAKER 1 (3A RATING). FROM THE CIRCUIT BREAKER IT FLOWS TO SWITCH S1A AND S1B, LOCATED ON THE FRONT PANEL. IF S1 IS NOT IN THE "OFF" POSITION THE POWER CONTINUES TO INPUT CONVERTER NO. 1, THE TIME DELAY RELAY, AND THE BLOWER MOTOR. THE TIME DELAY IS INITIATED AT THIS TIME AND THE BLOWER IS ENERGIZED ALSO.

INPUT CONVERTER NO. 1 IS AN AC TO DC CONVERTER CONSISTING OF A STEPDOWN TRANSFORMER, A6T1, A BRIDGE RECTIFIER A6CR1 AND A FILTER CAPACITOR A6C1. THIS ASSEMBLY CONVERTS THE 115VAC 28VDC FOR THE HEATER REGULATOR. THE ELAPSED TIME METER, A1M2, OPERATES FROM THIS 28VDC BUS.
4.3 (CONTINUED)

THE HEATER REGULATOR IS STARTED BY CURRENT THROUGH DIODE A5CR1. CURRENT FLOWS THROUGH THE DIODE, THROUGH A5R2 AND INTO THE BASE OF A5Q1. THE TRANSISTOR AMPLIFIES THE CURRENT AND TURNS ON A3Q10 AND A3Q9, THE PASS TRANSISTOR FOR THE HEATER REGULATOR. AS THEY TURN ON, THE HEATER BUS VOLTAGE AT THE CENTER TAP OF A5T1 RISES. AS THE HEATER BUS VOLTAGE RISES, CURRENT FLOWS THROUGH A5R8 TO THE BASE OF A5Q3 (OR A5Q4) AND INITIATES SWITCHING ACTION IN THE MAGNETIC MULTIVIBRATOR. WHEN THE BUS VOLTAGE REACHES 23VDC THE VOLTAGE AT THE BASE OF A5Q2 HAS INCREASED TO SUFFICIENTLY TURN ON A5Q2 AND THE COLLECTOR CURRENT OF A5Q2 PREVENTS FURTHER INCREASE IN THE VOLTAGE AT THE BASE OF A5Q1. SINCE THE VOLTAGE AT THE BASE OF A5Q1 IS STABILIZED THE HEATER BUS VOLTAGE AT THE EMITTER OF A3Q9 IS ALSO STABILIZED AND REMAINS AT 23VDC.

THE BUS VOLTAGE CAN BE ADJUSTED BY A5R24 IF THE FILAMENT VOLTAGE OUTPUT OF THE POWER SUPPLY IS NOT CORRECT. THIS ADJUSTMENT PROCEDURE IS COVERED IN THE CALIBRATION SECTION.
4.3 (CONTINUED)

THE MULTIVIBRATOR CONSISTS OF SWITCH TRANSISTORS A5Q3, A5Q4, AND TRANSFORMER A5T1 AND ASSOCIATED COMPONENTS. THE SATURATION OF A5T1 SETS THE SWITCHING FREQUENCY AT 4KHz ALTHOUGH IT WILL VARY IF THE HEATER BUS VOLTAGE IS ADJUSTED AWAY FROM 23VDC. THE VOLTAGE ON THE COLLECTORS OF A5Q3 AND A5Q4 IS A 46Vpp SQUARE WAVE AT 4KHz. THE VOLTAGE AT THE CATHODE OF A5CR2 AND A5CR3 IS 46VDC. THIS VOLTAGE REFERENCE BIOSES A5CR1 AND FURNISHES THE SUPPLY FOR A5R1 AND A5R2.

THE FOLLOWING COMPONENTS NOT ALREADY MENTIONED PERFORM THE FOLLOWING FUNCTIONS:

A5CR8 IS THE REFERENCE FOR THE REGULATOR. IT IS A NINE VOLT ZENER DIODE. ITS ZENER VOLTAGE IS COMPARED WITH THE VOLTAGE AT THE TAP OF A5R24 BY A5Q1. THE DIFFERENCE VOLTAGE CONTROLS THE HEATER BUS VOLTAGE.

A5CR4-CR7 LIMITS THE VOLTAGE DROP ACROSS THE BASE Emitter JUNCTIONS OF THE HEATER PASS TRANSISTORS AND A3R17 AND HENCE THE MAXIMUM CURRENT THAT CAN BE APPLIED BY THE HEATER BUS IS LIMITED. THE PURPOSE OF THIS FEATURE IS TO LIMIT THE CURRENT SUPPLIED TO A COLD (LOW RESISTANCE) FILAMENT.
4.3 (CONTINUED)
A5C1 STABILIZES THE REGULATOR WITH NEGATIVE AC FEEDBACK.

A5R4 SUPPLIES "KEEP ALIVE" CURRENT TO A5CR8.

A5R6 AND R7 LIMIT THE BASE CURRENT TO THE SWITCHING TRANSISTORS.

A5CR9 PROVIDES TEMPERATURE COMPENSATION FOR THE HEATER REGULATOR.

A5CR10 PROVIDES A LOW IMPEDANCE SOURCE FOR SWITCHING TRANSISTOR BASE CURRENT AND REFERENCE TO THE CENTER TAP OF THE BASE DRIVE WINDING OF A5T1 TO GROUND.

THE HEATER BUS SUPPLIES CURRENT TO THE HEATER INVERTER, THE HELIX REGULATOR AND THE CONTROL CIRCUIT.
4.3 (CONTINUED)

4.4 DEVELOPMENT OF THE CATHODE VOLTAGE

THE CATHODE VOLTAGE IS DEVELOPED BY A DC TO DC CONVERTER. THE CATHODE VOLTAGE IS THE HIGHEST VOLTAGE IN THE POWER SUPPLY; HOWEVER, THE POWER AVAILABLE FROM THE CATHODE SUPPLY IS CONSIDERABLY LESS THAN THAT AVAILABLE FROM THE COLLECTOR SUPPLY. THE CATHODE VOLTAGE IS NEGATIVE WITH RESPECT TO GROUND AND TIGHTLY REGULATED. THE CATHODE VOLTAGE IS ALSO ADJUSTABLE AND THE CATHODE SUPPLY IS PROTECTED ELECTRONICALLY FROM OVERLOADS SUCH AS THOSE CAUSED BY TWT ARCS.

4.4 (CONTINUED)

PROVISION IS MADE FOR DISCHARGING A6C2 WHEN THE CATHODE SUPPLY IS SHUTDOWN. TO ACCOMPLISH THE DISCHARGE A CONTACT OF THE POWER RELAY CONNECTS A1R2 ACROSS A6C2 AS A BLEEDER. DISCHARGE IS AUTOMATIC EVERY TIME HIGH VOLTAGE IS SHUTDOWN. THE OUTPUT OF THE FILTER IS UNREGULATED AND IT IS USED AS THE MAIN SUPPLY TO THE CATHODE DC TO DC CONVERTER.

4.4 (CONTINUED)
OUTPUT VOLTAGE VARIES WITH THE CONTROL CURRENT RECEIVED AND THUS THE HIGH VOLTAGE CHANGES IN RESPONSE TO THE REGULATOR ERROR CURRENT OUTPUT. THE REGULATION IS PLUS OR MINUS ONE PERCENT (+1%) OR BETTER FOR LINE AND LOAD CHANGES.

THE REGULATOR CONSISTS OF A5Q5 AND A5Q7, A5CR13, CR14 AND ASSOCIATED RESISTORS. A5CR14 IS THE NINE VOLT REFERENCE FOR THE REGULATOR. A5Q5 COMPARES THIS REFERENCE VOLTAGE WITH THE FEEDBACK RECEIVED FROM A5R17 AT THE DESIRED RATIO SET BY A5R16. NORMALLY, A5Q5 IS BALANCED WITH EQUAL COLLECTOR CURRENTS IN THE "A" AND "B" SIDES. IF THE OUTPUT VOLTAGE OF THE CATHODE SUPPLY CHANGES OR IF THE OPERATOR ADJUSTS A5R16 THEN A5Q5 WILL UNBALANCE. A DIFFERENCE CURRENT WILL FLOW IN A5R15 AND A5Q7 BASE. CONSEQUENTLY, A5Q7 COLLECTOR CURRENT WILL CHANGE AND THIS CHANGE WILL BE FELT BY THE HELIX CONVERTER CONTROL A5Q6 AND A3Q14. THE HELIX DC TO DC CONVERTER BASE INPUT WILL CHANGE AND HENCE, THE CONVERTER OUTPUT WILL CHANGE. THE OUTPUT CHANGE WILL BE SENSED IN THE FEEDBACK CIRCUIT AND A5Q5 WILL RETURN TO THE BALANCED CONDITION AT THE DESIRED CATHODE OUTPUT VOLTAGE.
4.4 (CONTINUED)


THE HELIX DC TO DC CONVERTER CONSISTS OF EIGHT POWER SWITCHING TRANSISTORS A3Q1-Q8, TRANSFORMERS A2T1 AND A2T2 AND TWO HIGH VOLTAGE BRIDGE RECTIFIERS. THE SWITCHING TRANSISTORS CHOP THE 65VDC BUS AT A 4KHz RATE. THE RESULTING SQUARE WAVE ON THE TRANSISTOR COLLECTORS IS TANSFORMED TO HIGH VOLTAGE AND RECTIFIED. THE TRANSISTORS OPERATE IN PAIRS. TWO TRANSISTORS SWITCH EACH SIDE OF THE PRIMARY OF EACH TRANSFORMER. THE TRANSISTORS DO NOT SATURATE AND THE DEGREE TO WHICH THEY CONDUCT IS DETERMINED BY THE CURRENT OUTPUT OF THE HELIX BASE DRIVE CONTROLLER. EACH SET OF TWO PAIRS OF TRANSISTORS OPERATE IN SYNCHRONISM. THE COLLECTOR VOLTAGE ON EACH TRANSISTOR IS APPROXIMATELY A 130Vpp SQUARE WAVE.
4.4 (CONTINUED)

THE OUTPUTS OF THE TWO BRIDGE RECTIFIERS ARE ADDED TO DEVELOP THE FULL CATHODE VOLTAGE. THIS REDUCES THE STRESS ON INDIVIDUAL COMPONENTS. THE HIGH VOLTAGE FILTER AND SURGE LIMIT IS A CAPACITOR FILTER WITH SERIES RESISTANCE TO LIMIT THE PEAK RATE OF CAPACITOR DISCHARGE. THE FEEDBACK RESISTOR NETWORK IS ALSO IN THIS SECTION WHICH IS ENCAPSULATED. THE FEEDBACK NETWORK ALSO SERVES AS A BLEEDER TO DISCHARGE THE HIGH VOLTAGE CAPACITORS AT SHUTDOWN.

THE NEGATIVE OUTPUT OF THE HELIX SUPPLY IS CONNECTED TO THE CATHODE OUTPUT. THE POSITIVE SIDE OF THE SUPPLY IS GROUNDED THROUGH A SERIES RESISTOR AND CONNECTED TO THE TWT HELIX. THE CURRENT IN THE HELIX IS PROPORTIONAL TO THE VOLTAGE DROPPED ACROSS THE SERIES RESISTOR. WHEN THE HELIX CURRENT EXCEEDS A PREDETERMINED MAXIMUM VALUE THE HELIX OVERLOAD CIRCUIT SHUTS DOWN THE HELIX SUPPLY BY GROUNDING THE INPUT TO THE HELIX BASE DRIVE CONTROLLER. WHEN THIS OCCURS A3Q14 TURNS OFF AND NO BASE CURRENT IS FURNISHED TO THE DC TO DC CONVERTER SWITCHING TRANSISTORS.
4.4 (CONTINUED)

Therefore, the cathode voltage drops to zero. The current at which the overload trips is adjustable by varying A4R17. The overload circuit can be reset by switching from operate to standby and back.
4.5 DEVELOPMENT OF THE COLLECTOR VOLTAGE

THE COLLECTOR VOLTAGE IS DEVELOPED IN THE HIGH VOLTAGE POWER CHANNEL DISCUSSED IN SECTION 4.2. POWER FOR THE COLLECTOR SUPPLY FLOWS TO CIRCUIT BREAKER 2 FROM THE INPUT CONNECTOR. IF THE CIRCUIT BREAKER IS CLOSED IT CONTINUES TO THE POWER RELAY. THE RELAY IS OPERATED BY THE CONTROL CIRCUIT. IF THE RELAY IS CLOSED THE POWER ENTERS THE PRIMARY OF THE COLLECTOR TRANSFORMER, A1T1.


THE POSITIVE TERMINAL OF THE COLLECTOR SUPPLY OUTPUT IS CONNECTED TO THE TWT COLLECTOR. THE NEGATIVE TERMINAL IS CONNECTED TO THE TWT CATHODE. THE COLLECTOR VOLTAGE IS UNREGULATED AND CAPABLE OF DELIVERING HIGH BEAM CURRENTS. BOTH TERMINALS OF
4.5 (CONTINUED)

THE COLLECTOR SUPPLY ARE INSULATED FOR FULL CATHODE VOLTAGE. THE COLLECTOR VOLTAGE IS CLAMPED AT A MAXIMUM OF 2,000V WITH RESPECT TO GROUND FOR THE CONDITION OF NO CATHODE VOLTAGE.

CAUTION: AT NO TIME SHOULD THE COLLECTOR SUPPLY BE OPERATED WITHOUT THE PROPER LOAD AT ITS OUTPUT. OPERATION OF THE UNIT WITH THE COLLECTOR OUTPUT UNLOADED MAY RESULT IN PREMATURE UNIT FAILURE AND VOID THE WARRANTY.
4.6 CONTROL CIRCUIT OPERATION

THE CONTROL CIRCUIT OPERATES THE POWER RELAY AND PROVIDES POWER SUPPLY STATUS INDICATIONS. THE INPUTS TO THE CONTROL CIRCUIT ARE 23VDC FROM THE FILAMENT BUS, S1 SWITCH POSITIONS FROM THE FRONT PANEL, OVERLOAD SIGNALS FROM THE POWER SUPPLY AND THE TIME DELAY RELAY OUTPUT.

THE STATE OF THE POWER RELAY IS DETERMINED BY THE VOLTAGE ON THE BUS WHICH CONNECTED TO A3Q11 BASE. IF THIS BUS IS 20VDC THE RELAY WILL BE CLOSED, BUT IF THE BUS IS LOW THE RELAY WILL BE OPEN AND HIGH VOLTAGE OUTPUTS WILL BE INHIBITED. ANY ONE OF THE FOLLOWING CONDITIONS WILL MAKE THE BUS LOW:

A. TIME DELAY IN PROGRESS.
B. S1 IN STANDBY.
C. HELIX OVERLOAD.
D. THERMAL OVERLOAD.
E. VSWR OVERLOAD (OPTIONAL).
4.6 (CONTINUED)

WHEN S1 IS SWITCHED TO STANDBY FROM OFF RELAY A6K1 WILL BEGIN TIMING AND A4Q5 WILL BE ON. THE TIME DELAY LIGHT DS5 ON THE FRONT PANEL WILL BE LIGHTED. AT THE END OF THREE MINUTES A6K1 CONTACTS 1 AND 3 WILL CLOSE TO TURN OFF A4Q5 AND TURN ON A5Q4. THE TIME DELAY LAMP DS5 WILL EXTINGUISH AND THE STANDBY LAMP DS4 WILL LIGHT. THE POWER SUPPLY CAN NOW BE SWITCHED TO OPERATE.

WHEN S1 IS SWITCHED TO OPERATE THE STANDBY LIGHT WILL EXTINGUISH AND THE OPERATE LAMP WILL LIGHT INDICATING HIGH VOLTAGE IS BEING GENERATED. AT THIS TIME A1K1 WILL BE CLOSED AND THE VOLTAGE AT THE BASE OF A3Q11 WILL BE 20VDC.

IF A HELIX OVERLOAD OCCURS A4Q2 WILL FIRE AND PULL DOWN THE BUS AT A3Q11 BASE. THE POWER RELAY WILL OPEN, THE OPERATE LAMP WILL EXTINGUISH AND THE CURRENT OVERLOAD LAMP WILL LIGHT. S1 MUST NOW BE SWITCHED TO STANDBY AND BACK TO OPERATE TO RESET A4Q2 AND RESUME OPERATION.
4.6 (CONTINUED)


IF A VSWR OVERLOAD OCCURS (IN UNITS INCORPORATING THIS OPTION), A4Q1 WILL FIRE AND PULL DOWN THE CONTROL BUS. THE POWER RELAY WILL OPEN, THE OPERATE LAMP WILL EXTINGUISH AND THE VSWR OVERLOAD LAMP DS1 WILL LIGHT. S1 MUST NOW BE SWITCHED FROM OPERATE TO STANDBY AND BACK TO RESUME OPERATION.

TO SUMMARIZE, THE CONTROL CIRCUIT OPERATES THE POWER RELAY AND PROVIDES THE FOLLOWING INDICATIONS AS NECESSARY:

A. TIME DELAY.
B. STANDBY.
C. OPERATE.
D. HELIX CURRENT OVERLOAD.
E. THERMAL OVERLOAD.
F. VSWR OVERLOAD (OPTIONAL).
5.0  TROUBLESHOOTING GUIDE

NOTE:  DO NOT ATTEMPT TO REPAIR THE AMPLIFIER IF IT IS WITHIN THE WARRANTY PERIOD.  RETURN IT TO THE FACTORY FOR REPAIR.

WARNING:  LETHAL VOLTAGES ARE PRESENT IN THIS EQUIPMENT WHEN IT IS OPERATING NORMALLY. WHEN IT IS MALFUNCTIONING HIGH VOLTAGES MAY BE PRESENT IN UNEXPECTED LOCATIONS. USE EXTREME CAUTION WHEN SERVICING THIS EQUIPMENT.
5.1 AMPLIFIER MALFUNCTIONS

MALFUNCTIONS OF THE AMPLIFIER ARE MANIFESTED IN SEVERAL WAYS. SOME OF THESE ARE:
A. IMPROPER RF OUTPUT (OR NO RF OUTPUT).
B. REPEATED FAULT INDICATIONS.
C. NO RESPONSE TO CONTROLS.
D. EXCESSIVE INPUT CURRENT.
E. ARCING SOUNDS OR BURNT COMPONENT ODORS.

THE FIRST PRIORITY IN LOCATING A FAULT IS ISOLATING IT TO THE TRAVELING WAVE TUBE OR POWER SUPPLY. A TROUBLESHOOTING CHART IS PROVIDED AS TABLE II TO AID IN THIS PHASE OF THE DIAGNOSIS. IF THE FAULT CANNOT BE ISOLATED TO THE TWT WITH THE CHART THE NEXT STEP IS TO DISCONNECT THE TWT AND FOLLOW THE CALIBRATION PROCEDURE GIVEN FOR THE POWER SUPPLY. IF THE POWER SUPPLY CALIBRATES PROPERLY AND THERE ARE NO OVERT SIGNS OF POWER SUPPLY MALFUNCTION, THE TWT MAY BE ASSUMED FAULTY AND REPLACEMENT IS THE ONLY COURSE OF ACTION.
5.2 POSSIBLE CAUSES OF FAULTS

IF THE FAULT IS ISOLATED TO THE ENCAPSULATED
SECTIONS OF THE EQUIPMENT DURING THE TESTS
DESCRIBED IN THIS SECTION, IT SHOULD BE RETURNED
TO THE FACTORY FOR REPAIR. LETHAL VOLTAGES ARE
GENERATED IN THE POTTED SECTION AND NO ATTEMPT
SHOULD BE MADE TO REPAIR THE POTTED SECTION IN
THE FIELD.
5.2.1 NO RF OUTPUT

A. CHECK THAT SUFFICIENT RF INPUT POWER IS APPLIED IN THE CORRECT FREQUENCY BAND.

B. CHECK THAT THE OPERATE LAMP (BLUE) IS LIGHTED.

C. CHECK THAT CORRECT LINE VOLTAGE IS APPLIED AND THAT BOTH CIRCUIT BREAKERS ARE CLOSED.

D. CHECK THAT THE HELIX CURRENT METER INDICATES SEVERAL MILLIAMPERES OF CURRENT.

E. CHECK ALL RF CONNECTIONS.

F. IF ALL THE ABOVE CHECKS GIVE GOOD RESULTS, IT IS LIKELY THAT THE TWT IS FAULTY. HOWEVER, TO BE SURE, THE POWER SUPPLY SHOULD BE CONNECTED TO THE DUMMY CALIBRATION LOAD AND CHECKED PER THE CALIBRATION PROCEDURE.

G. POWER SUPPLY FAULTS THAT COULD RESULT IN NO RF OUTPUT ARE LOW OF HIGH VOLTAGE, OVERLOAD, LOSS OF HEATER VOLTAGE, AND CONTROL CIRCUIT FAULTS. ALL OF THESE FAULTS CAN BE DETECTED WITH THE CALIBRATION PROCEDURE.
5.2.2 LOW RF OUTPUT

A. CHECK THAT SUFFICIENT RF DRIVE POWER IN THE PROPER FREQUENCY RANGE IS APPLIED.

B. CHECK ALL RF CONNECTIONS AND INPUT/OUTPUT VSWR ≤ 2.0:1.

C. POSSIBLE CAUSES OF LOW RF OUTPUT ARE LOW GAIN TWT, LOW CATHODE EMISSION IN THE TWT, LOW HEATER VOLTAGE, IMPROPER CATHODE VOLTAGE. THE POWER SUPPLY SHOULD BE CHECKED PER THE CALIBRATION PROCEDURE. IF IT CHECKS SATISFACTORY ON ALL OUTPUTS THE TWT IS PROBABLY FAULTY.
5.2.3 POWER OUTPUT VARIES WITH LINE VOLTAGE

A. THIS IS CAUSED BY LOSS OF HELIX VOLTAGE
REGULATION. THE FOLLOWING COMPONENTS IN THE
POWER SUPPLY COULD CAUSE THIS CONDITION.
A5CR14, CR13 NOT STABLE AT 9.0V +5%.
+5% - COULD BE CAUSED BY A5R11 HIGH RESISTANCE.
A5R12 OPEN.
A5Q5 SHORTED OR OPEN.
A5Q7 SHORTED OR OPEN.
A5CR15 OPEN.
A5R20 OPEN.
A5Q6 SHORTED OR OPEN.
A3Q14 SHORTED OR OPEN.
A5R16 FOULED CONTACT OR OPEN.
A5R17 OPEN.
A2R9-R12 OPEN (POTTED).
A3Q1-Q8 OPEN (ONE OR TWO TRANSISTORS).
5.2.4 HIGH RF NOISE
TERMINATE THE INPUT WITH 50 OHMS. IF THE NOISE PERSISTS, THERE IS A FAULT IN THE TWT, MOST LIKELY IT IS OSCILLATING. INCORRECT VOLTAGES FROM THE POWER SUPPLY COULD CONCEIVABLY CAUSE OSCILLATION SO THE POWER SUPPLY SHOULD BE CHECKED PER THE CALIBRATION PROCEDURE BEFORE REPLACING THE TWT.

5.2.5 4KHz MODULATION ON THE RF OUTPUT

A. THIS IS CAUSED BY EXCESSIVE RIPPLE ON THE CATHODE TO HELIX VOLTAGE. THIS CAN OCCUR IF THE HIGH VOLTAGE FILTER OPENS OR THE REGULATOR IS MALFUNCTIONING OR THE REGULATOR HAS REDUCED HIGH FREQUENCY GAIN.

B. CHECK A5C3 FOR AN OPEN CONDITION.

C. CHECK A2R9-R12 FOR OPEN CONDITION.

D. IF A CAPACITANCE BRIDGE IS AVAILABLE THE CATHODE TO GROUND CAPACITANCE CAN BE CHECKED. IT SHOULD BE 0.2uf ±10%.
5.2.6 HELIX OVERCURRENT OVERLOADS REPEATEDLY

A. THIS CAN BE CAUSED BY ARC PATHS IN THE TWT OR HIGH VOLTAGE SECTION OF THE POWER SUPPLY OR A4R17 MAY BE SET TOO LOW.

B. DISCONNECT THE TWT AND CHECK FOR OVERLOADS. IF THE POWER SUPPLY DOES NOT OVERLOAD AT NO LOAD EITHER THE TWT IS ARCING OR A4R17 IS ADJUSTED TOO LOW. CONNECT A DUMMY LOAD TO THE CATHODE OUTPUT AND SET A4R17 FOR THE MAXIMUM DESIRED HELIX CURRENT. RECONNECT THE TWT. IF THE AMPLIFIER STILL OVERLOADS CHECK A4C7 FOR OPEN CONDITION.
5.2.7 REPEATED THERMAL OVERLOADS

A. THIS CAN BE CAUSED BY INSUFFICIENT COOLING OR A FAULTY THERMAL SWITCH OR A4Q3 SHORTED. IF THE TW T IS HOT AND THERE IS A THERMAL OVERLOAD CHECK A4Q3 FOR A SHORT AND CHECK THE THERMAL SWITCH FOR A SHORT.

B. IF THE TW T IS HOT CHECK THE AIRFLOW PASSAGE FOR A BLOCK. CHECK THE TW T MOUNTING FOR GOOD THERMAL CONTACT TO THE HEAT SINK. CHECK THAT THE BLOWER IS OPERATING.

5.2.8 EXCESSIVE INPUT CURRENT

A. THIS IS ALMOST CERTAINLY CAUSED BY A SHORT IN ONE OF THE INPUT COMPONENTS OR WIRING. A CIRCUIT BREAKER SHOULD OPEN.

B. ALSO IT COULD BE CAUSED BY A3Q1-Q8 SHORTED.

C. MAKE AN OHM METER CHECK OF THE FILAMENT BUS, THE HELIX BUS, AND THE TWO INPUT TRANSFORMERS.
5.2.9 LOW FREQUENCY MODULATION OF THE RF OUTPUT

A. THIS IS AN INDICATION OF HELIX REGULATOR OSCILLATION.

B. CHECK A2R9-R12 FOR OPEN CONDITION.

5.2.10 120Hz MODULATION ON THE RF OUTPUT

A. THIS INDICATES HIGH RIPPLE ON AND/OR CATHODE VOLTAGE OUTPUT OF THE POWER SUPPLY.

B. REGULATOR, REFERENCE MODULATING OR FEEDBACK SHIELD BROKEN.

C. FAILURE OF A1L1 AND A1C1 COULD CAUSE THIS CONDITION. THEY ARE NOT POTTED SO THEY CAN BE CHECKED WITH AN IMPEDANCE BRIDGE.

CAUTION: BE SURE POWER IS DISCONNECTED AND A1C1 IS DISCHARGED. ALSO CHECK FOR DISCHARGED CATHODE SUPPLY.
6.0 POWER SUPPLY CALIBRATION

6.1 INTRODUCTION

BEFORE RECONNECTING THE TWT AFTER REPAIR, OR WHEN REPLACING THE TWT, A VOLTAGE CALIBRATION OF THE POWER SUPPLY IS NECESSARY TO PREVENT POSSIBLE DAMAGE TO THE TWT OR THE POWER SUPPLY.

6.2 TEST EQUIPMENT REQUIRED

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>MANUFACTURER</th>
<th>MODEL NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOM</td>
<td>TRIPLETT</td>
<td>630-NA</td>
</tr>
<tr>
<td>OSCILLOSCOPE</td>
<td>TEKTRONIX</td>
<td>545B</td>
</tr>
<tr>
<td>OSCILLOSCOPE PLUG-IN</td>
<td>TEKTRONIX</td>
<td>B or H</td>
</tr>
<tr>
<td>RMS VOLTMETER</td>
<td>HEWLETT-PACKARD</td>
<td>3400A</td>
</tr>
<tr>
<td>LOAD FIXTURE</td>
<td>(SEE FIGURE 3)</td>
<td></td>
</tr>
<tr>
<td>VSWR SIMULATOR, POWER SUPPLY 0 TO 5VDC (OPTIONAL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CAUTION: AT NO TIME SHOULD THE COLLECTOR SUPPLY BE OPERATED WITHOUT THE PROPER LOAD AT ITS OUTPUT. OPERATION OF THE UNIT WITH THE COLLECTOR SUPPLY UNLOADED MAY RESULT IN PREMATURE UNIT FAILURE AND VOID THE WARRANTY.
6.3 VOLTAGE ADJUSTMENT PROCEDURE

6.3.1 REPLACE THE TWT WITH THE LOAD FIXTURE, AS SHOWN IN FIGURE 3. SELECT LOAD APPROPRIATE TO THE TWT CURRENT DEMAND. NO TAPS ON A11 (COLLECTOR TRANSFORMER) SHOULD BE CHANGED UNLESS THE FREQUENCY BAND IS TO BE CHANGED.

CAUTION: THE FILAMENT VOLTAGE ADJUSTMENT, R24, AS DESCRIBED HEREIN IS FACTORY SET FOR A 2.4AMP FILAMENT. THE ADJUSTMENT SHOULD NOT NEED CHANGING. IF, HOWEVER, THE USER FEELS A NEED TO ADJUST THE FILAMENT, USE THE UTMOST PRECAUTION.

CAUTION: WHEN THE SUPPLY IS IN THE OPERATE MODE, LETHAL VOLTAGES ARE PRESENT. WHEN CHECKING TWT ELEMENT VOLTAGES BE SURE THE TWT AMPLIFIER IS OFF DURING VOMETER CONNECTIONS.
6.3.2 FILAMENT VOLTAGE ADJUSTMENT

NOTE 1: THIS VOLTAGE SHOULD NOT NEED TO BE ADJUSTED UNLESS COMPONENT CHANGES HAVE AFFECTED THE VALUES OR A NEW TWT IS BEING INSTALLED.

NOTE 2: TO OBTAIN AN ACCURATE FILAMENT VOLTAGE ADJUSTMENT, THE LEAD LENGTH OF THE FILAMENT LOAD SHOULD ABOUT EQUAL TO THE NORMAL LEAD LENGTH TO THE TWT AND THE MEASUREMENT SHOULD BE TAKEN AT THIS NORMAL LENGTH.

CAUTION: DO NOT PLACE UNIT IN THE OPERATE MODE DURING THIS ADJUSTMENT.
6.3.2.1  THE FILAMENT VOLTAGE ADJUSTMENT IS R24 ON THE HELIX HEATER REGULATOR BOARD, PART NUMBER 74D0045-1. SEE FIGURE 4 FOR THE PROPER LOCATION OF R24. ROTATING R24 CLOCKWISE, DECREASES THE FILAMENT VOLTAGE.

6.3.2.2  PLACE THE RMS VOLTMETER FROM FILAMENT TO CATHODE.

6.3.2.3  PLACE THE AMPLIFIER IN STANDBY AND MEASURE THE FILAMENT VOLTAGE, COMPARING IT TO SPECIFIC TWT VOLTAGE REQUIREMENTS.

6.3.2.4  TURN OFF THE AMPLIFIER AND DISCONNECT THE VOLTMETER.
6.3.3 COLLECTOR/CATHODE TO HELIX VOLTAGE RANGE SELECTION

NOTE: THIS PROCEDURE SHOULD BE FOLLOWED IF TWT TYPE IS CHANGED (E.G., DIFFERENT FREQUENCY BAND).

6.3.3.1 THE COLLECTOR AND CATHODE TO HELIX VOLTAGE RANGE IS SELECTED BY USING THE APPROPRIATE COMBINATION OF TAPS ON THE COLLECTOR TRANSFORMER. THE TAPS ARE MARKED 1 THROUGH 17 AND ARE EASILY ACCESSIBLE FROM THE TOP OF THE UNIT. TABLE III SHOWS A MATCH OF COLLECTOR VOLTAGE AND CURRENT AND AN APPROPRIATE CATHODE TO HELIX VOLTAGE RANGE FOR USE WITH A SELECTION OF TRAVELING WAVE TUBES FROM L TO KU BAND, 100 AND 200 WATTS.

WIRES TO TAPS 1, 7 AND 13 ALWAYS REMAIN FIXED. THE TWO ORANGE WIRES, ALWAYS TOGETHER, CAN VARY BETWEEN TAPS 2 THROUGH 6. THE ONE RED WIRE CAN VARY BETWEEN TAPS 8 THROUGH 12. THE FOUR BROWN WIRES, ALWAYS TOGETHER, CAN VARY BETWEEN TAPS 14 THROUGH 17. THE ORANGE AND RED WIRES SELECT THE APPROPRIATE WINDINGS AND PHASING OF THE TRANSFORMER PRIMARY. THE BROWN WIRES SELECT THE APPROPRIATE LOW VOLTAGE SECONDARY OUTPUT TAP.
6.3.4 COLLECTOR VOLTAGE CHECK

6.3.4.1 PLACE THE HIGH VOLTAGE DC VOLTMETER POSITIVE LEAD TO THE COLLECTOR AND NEGATIVE LEAD TO THE CATHODE.

CAUTION: THE METER NEGATIVE WILL BE FLOATING AT THE HIGH NEGATIVE CATHODE POTENTIAL.

NOTE: BE SURE THE COLLECTOR LOAD RESISTOR SIZE IS CALCULATED TO ACCOMMODATE THE CORRECT CURRENT DESIRED.

6.3.4.2 APPLY 115 OR 230VAC TO THE UNIT AND PLACE IN THE OPERATE MODE. ALLOW THE THREE MINUTE TIME DELAY TO ELAPSE.

6.3.4.3 MEASURE THE COLLECTOR VOLTAGE.

6.3.4.4 TURN OFF THE AMPLIFIER AND DISCONNECT THE VOLTMETER.
6.3.5 CATHODE TO HELIX VOLTAGE ADJUSTMENT

6.3.5.1 THE CATHODE TO HELIX VOLTAGE HAS TWO ADJUSTMENTS, COARSE, R16, AND FINE, R26, ON THE HELIX/HEATER REGULATOR BOARD, PART NUMBER 74D0045-1. SEE FIGURE 4 FOR THE LOCATION OF R16 AND R26. ROTATING R16 AND R26 CLOCKWISE INCREASES THE CATHODE TO HELIX VOLTAGE.

6.3.5.2 PLACE THE HIGH VOLTAGE DC VOLTMETER NEGATIVE LEAD TO CATHODE AND POSITIVE LEAD TO HELIX GROUND. CAUTION: DO NOT ADJUST THE CATHODE TO HELIX VOLTAGE WITHOUT MONITORING.

6.3.5.3 APPLY 115 OR 230VAC TO THE UNIT AND PLACE THE UNIT IN THE OPERATE MODE. ALLOW THE THREE MINUTE TIME DELAY TO ELAPSE.
6.3.5.4 ADJUST THE COARSE ADJUSTMENT, R16, TO OBTAIN THE APPROXIMATE VOLTAGE DESIRED, WITHIN ±100VDC. THEN ADJUST THE FINE ADJUSTMENT, R26 TO THE CORRECT VOLTAGE DESIRED. THE FINE ADJUSTMENT BECOMES MORE USEFUL AT HIGHER CATHODE TO HELIX VOLTAGES.

6.3.5.5 TURN OFF THE AMPLIFIER AND DISCONNECT THE VOLTMETER.
6.3.6 HELIX CURRENT OVERLOAD ADJUSTMENT

6.3.6.1 THE HELIX CURRENT OVERLOAD ADJUSTMENT IS R17 ON THE CONTROL BOARD, PART NUMBER 74D0114-1. SEE FIGURE 4 FOR THE PROPER LOCATION OF R17. ROTATING R17 CLOCKWISE INCREASES THE HELIX CURRENT TRIP POINT.

6.3.6.2 CALCULATE AND SET UP THE APPROPRIATE CATHODE TO HELIX LOAD TO OBTAIN THE DESIRED CURRENT FOR OVERLOAD.

6.3.6.3 ADJUST R17 FULLY COUNTERCLOCKWISE.

6.3.6.4 APPLY 115 OR 230VAC INPUT AND PLACE THE UNIT IN THE OPERATE MODE. ALLOW THE THREE MINUTE TIME DELAY TO ELAPSE.

6.3.6.5 ADJUST R17 CLOCKWISE UNTIL THE UNIT OVERLOADS.

6.3.6.6 TURN OFF THE AMPLIFIER AND REMOVE THE EXCESSIVE HELIX LOAD.
6.3.7 VSWR OVERLOAD ADJUST (OPTIONAL)

6.3.7.1 AN ADDITIONAL POWER SUPPLY, 0 TO 5VDC, MUST BE USED FOR THIS ADJUSTMENT. THE VSWR OVERLOAD ADJUST IS R1 ON THE CONTROL BOARD, PART NUMBER 74D0114-1. SEE FIGURE 4 FOR PROPER LOCATION OF R1.

6.3.7.2 THE VSWR INPUT IS PIN 21 AND PIN 22 (FOR GROUND) OF THE J1 REMOTE CONTROL CONNECTOR.

6.3.7.3 ADJUST R1 FULLY COUNTERCLOCKWISE.

6.3.7.4 APPLY 115 OR 230VAC INPUT AND PLACE THE UNIT IN THE OPERATE MODE. ALLOW THE THREE MINUTE TIME DELAY TO ELAPSE.

6.3.7.5 APPLY THE DESIRED VSWR TRIP VOLTAGE POSITIVE TO J1 PIN 21 AND NEGATIVE TO PIN 22.

6.3.7.6 ADJUST R1 CLOCKWISE UNTIL THE UNIT OVERLOADS.

6.3.7.7 TURN OFF THE AMPLIFIER AND REMOVE THE VSWR SIMULATOR POWER SUPPLY.
6.3.8 ALL ADJUSTMENTS ARE COMPLETE. REMOVE THE LOAD FIXTURE AND REPLACE THE TRAVELING WAVE TUBE. TURN TO SECTION 7.0 TO PERFORM AN RF OPERATIONAL CHECK.
7.0 RF RESPONSE CHECK

7.1 INTRODUCTION

AFTER THE POWER SUPPLY CALIBRATION, AN RF RESPONSE CHECK WILL DETERMINE IF AMPLIFIER MEETS RF SPECIFICATIONS.

7.2 TEST EQUIPMENT REQUIRED

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>MANUFACTURER</th>
<th>MODEL NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF SWEEP GENERATOR*</td>
<td>ALFRED</td>
<td>650</td>
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<tr>
<td>OSCILLATOR PLUG-IN</td>
<td>ALFRED</td>
<td></td>
</tr>
<tr>
<td>(FOR L BAND)</td>
<td>651K</td>
<td></td>
</tr>
<tr>
<td>(FOR S BAND)</td>
<td>652K</td>
<td></td>
</tr>
<tr>
<td>(FOR C BAND)</td>
<td>653K</td>
<td></td>
</tr>
<tr>
<td>(FOR X BAND)</td>
<td>655K</td>
<td></td>
</tr>
<tr>
<td>(FOR KU BAND)</td>
<td>657K</td>
<td></td>
</tr>
<tr>
<td>RF POWER METER (2)</td>
<td>HEWLETT-</td>
<td>413C</td>
</tr>
<tr>
<td></td>
<td>PACKARD</td>
<td></td>
</tr>
<tr>
<td>DIRECTIONAL COUPLER (-20db)</td>
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</tr>
<tr>
<td>(QUANTITY 3)</td>
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<td>PAD (20db)</td>
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<tr>
<td>RF LOAD (500 WATTS)</td>
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</tr>
<tr>
<td>RF LOAD (20 WATTS)</td>
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</tr>
</tbody>
</table>

*ANY RF SIGNAL GENERATOR MAY BE USED THAT IS CAPABLE OF DELIVERING A 20dBm RF SIGNAL ACROSS THE BAND WIDTH DESIRED.

WARNING: RF INPUT SIGNALS GREATER THAN 500MW WILL DAMAGE THE TWT AND VOID THE UNIT WARRANTY.
7.3 RF CHECK

7.3.1 CONNECT THE RF TEST CONNECTIONS AS SHOWN IN FIGURE 5.

7.3.2 PLACE THE AMPLIFIER IN OPERATE AND ALLOW THE TIME DELAY TO ELAPSE.

7.3.3 USING THE DATA SHEET IN APPENDIX A, LIST UNDER FREQUENCY, FROM 8 TO 10 INCREMENTS OF THE AMPLIFIER BAND WIDTH.

7.3.4 A SMALL SIGNAL GAIN OR GAIN AT RATED POWER.

7.3.4.1 APPLY A 0dbm RF INPUT TO THE AMPLIFIER AT THE BAND LOW FREQUENCY.

7.3.4.2 MEASURE AND RECORD THE AMPLIFIER RF OUTPUT IN dbm.

7.3.4.3 INCREASE THE RF INPUT FREQUENCY TO EACH SUCCEEDING INCREMENT, WHILE HOLDING A 0dbm LEVEL, AND MEASURE AND RECORD THE RESPECTIVE POWER OUTPUT READINGS.

7.3.4.4 SUBTRACT THE RF INPUT FROM THE RF OUTPUT AND RECORD THE GAIN AT EACH INCREMENT.
7.3.5 Saturated Power Output

7.3.5.1 Return the input to the band low frequency and increase the RF input until the TWT amplifier RF power output is saturated.

7.3.5.2 Measure and record the RF input and saturated RF output.

7.3.5.3 Repeat the previous two steps for each increment of the amplifier band width.

7.3.6 Turn off the amplifier and remove the test equipment.

The test is complete.
<table>
<thead>
<tr>
<th>TWT ELEMENT</th>
<th>POWER SUPPLY DATA</th>
<th>AMPLIFIER</th>
<th>MIN VOLTAGE</th>
<th>NOM VOLTAGE</th>
<th>MAX VOLTAGE</th>
<th>CURRENT</th>
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</thead>
<tbody>
<tr>
<td>FILAMENT</td>
<td>REFERENCED TO CATHODE</td>
<td>LR630-100</td>
<td>6.0 VDC</td>
<td>6.3 VDC</td>
<td>6.6 VDC</td>
<td>1.8A NOM</td>
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<tr>
<td></td>
<td>ADJUSTABLE 5.0 TO 7.0VRMS</td>
<td>SR630-100</td>
<td>6.0 VDC</td>
<td>6.3 VDC</td>
<td>6.6 VDC</td>
<td>3.0A NOM</td>
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<tr>
<td></td>
<td>REGULATED 1%</td>
<td>CR630-100</td>
<td>6.0 VDC</td>
<td>6.3 VDC</td>
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<td>3.5A NOM</td>
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<tr>
<td></td>
<td>CURRENT SURGE 10AMPS MAX.</td>
<td>XR630-100</td>
<td>6.0 VDC</td>
<td>6.3 VDC</td>
<td>6.6 VDC</td>
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<tr>
<td></td>
<td></td>
<td>KUR630-100</td>
<td>6.0 VDC</td>
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<td>CATHODE</td>
<td>REFERENCED NEGATIVE WITH RESPECT TO HELIX GROUND.</td>
<td>LR630-100</td>
<td>-2.75KV</td>
<td>-3.08KV</td>
<td>-3.04KV</td>
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<td>ADJUSTABLE TO TUBE SPECIFICATION.</td>
<td>SR630-100</td>
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<td>360mA MAX</td>
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<td>REGULATED 1%</td>
<td>CR630-100</td>
<td>-4.2 KV</td>
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<td>265mA MAX</td>
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<td>RIPPLE 30V MAX.</td>
<td>XR630-100</td>
<td>-4.9 KV</td>
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<td></td>
<td></td>
<td>KUR630-100</td>
<td>-8.5 KV</td>
<td>-8.8 KV</td>
<td>-9.1 KV</td>
<td>230mA MAX</td>
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<td>HELIX</td>
<td>AT CHASSIS GROUND</td>
<td>LR630-100</td>
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<td>20mA MAX</td>
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<tr>
<td>COLLECTOR</td>
<td>REFERENCED POSITIVE WITH RESPECT TO CATHODE (THUS APPROACHING GROUND).</td>
<td>LR630-100</td>
<td>2.75KV</td>
<td>3.08KV</td>
<td>3.40KV</td>
<td>290mA NOM</td>
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<td>ADJUSTABLE TO TUBE SPECIFICATION.</td>
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<td></td>
<td>UNREGULATED.</td>
<td>CR630-100</td>
<td>2.7 KV</td>
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<tr>
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<td>RIPPLE 150Vpp MAX.</td>
<td>XR630-100</td>
<td>2.8 KV</td>
<td>3.4 KV</td>
<td>4.0 KV</td>
<td>230mA NOM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KUR630-100</td>
<td>3.9 KV</td>
<td>4.35KV</td>
<td>4.8 KV</td>
<td>210mA NOM</td>
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<td>TWT ELEMENT</td>
<td>POWER SUPPLY DATA</td>
<td>AMPLIFIER</td>
<td>MIN VOLTAGE</td>
<td>NOM VOLTAGE</td>
<td>MAX VOLTAGE</td>
<td>CURRENT</td>
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<tr>
<td>FILAMENT</td>
<td>REFERENCED TO CATHODE</td>
<td>LR630-200</td>
<td>6.0 VDC</td>
<td>6.3 VDC</td>
<td>6.6 VDC</td>
<td>1.8A NOM</td>
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<tr>
<td></td>
<td>ADJUSTABLE 5.0 TO 7.0VRMS</td>
<td>SR630-200</td>
<td>6.0 VDC</td>
<td>6.3 VDC</td>
<td>6.6 VDC</td>
<td>2.5A NOM</td>
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<tr>
<td></td>
<td>REGULATED 1%</td>
<td>CR630-200</td>
<td>6.0 VDC</td>
<td>6.3 VDC</td>
<td>6.6 VDC</td>
<td>1.8A NOM</td>
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<td></td>
<td>CURRENT SURGE 10AMPS MAX.</td>
<td>XR630-200</td>
<td>6.0 VDC</td>
<td>6.3 VDC</td>
<td>6.6 VDC</td>
<td>1.8A NOM</td>
</tr>
<tr>
<td>CATHODE</td>
<td>REFERENCED NEGATIVE WITH RESPECT TO HELIX GROUND.</td>
<td>LR630-200</td>
<td>-3.1 KV</td>
<td>-3.5 KV</td>
<td>-3.9 KV</td>
<td>475mA MAX</td>
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<td></td>
<td>ADJUSTABLE TO TUBE SPECIFICATION.</td>
<td>SR630-200</td>
<td>-3.2 KV</td>
<td>-3.7 KV</td>
<td>-4.2 KV</td>
<td>450mA MAX</td>
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<tr>
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<td>REGULATED 1%</td>
<td>CR630-200</td>
<td>-8.0 KV</td>
<td>-8.5 KV</td>
<td>-9.0 KV</td>
<td>320mA MAX</td>
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<td></td>
<td>RIPPLE 30V MAX.</td>
<td>XR630-200</td>
<td>-8.7 KV</td>
<td>-9.0 KV</td>
<td>-9.3 KV</td>
<td>350mA MAX</td>
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<tr>
<td>HELIX</td>
<td>AT CHASSIS GROUND</td>
<td>LR630-200</td>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td>65mA MAX</td>
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<td></td>
<td>SR630-200</td>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td>70mA MAX</td>
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<td></td>
<td></td>
<td>CR630-200</td>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td>25mA MAX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>XR630-200</td>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td>20mA MAX</td>
</tr>
<tr>
<td>COLLECTOR</td>
<td>REFERENCED POSITIVE WITH RESPECT TO CATHODE (THUS APPROACHING GROUND).</td>
<td>LR630-200</td>
<td>3.1 KV</td>
<td>3.5 KV</td>
<td>3.9 KV</td>
<td>410mA NOM</td>
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<tr>
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<td>ADJUSTABLE TO TUBE SPECIFICATION.</td>
<td>SR630-200</td>
<td>2.6 KV</td>
<td>2.9 KV</td>
<td>3.2 KV</td>
<td>380mA NOM</td>
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<td>UNREGULATED</td>
<td>CR630-200</td>
<td>4.2 KV</td>
<td>4.6 KV</td>
<td>5.0 KV</td>
<td>295mA NOM</td>
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<tr>
<td></td>
<td>RIPPLE 150V MAX.</td>
<td>XR630-200</td>
<td>4.2 KV</td>
<td>4.4 KV</td>
<td>4.8 KV</td>
<td>330mA NOM</td>
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# TABLE II

TROUBLESHOOTING CHART

<table>
<thead>
<tr>
<th>PARA</th>
<th>AMPLIFIER FAULT SYMPTOM</th>
<th>FAULTY UNIT</th>
<th></th>
<th>EITHER</th>
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<tr>
<td></td>
<td></td>
<td>TWT</td>
<td>P.S.</td>
<td>TWT, P.S. OR BOTH</td>
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<tr>
<td>5.2.1</td>
<td>NO RF OUTPUT</td>
<td></td>
<td></td>
<td>✓</td>
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<td>5.2.2</td>
<td>LOW RF OUTPUT</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>5.2.3</td>
<td>POWER OUTPUT VARIES WITH LINE VOLTAGE</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>5.2.4</td>
<td>HIGH RF NOISE</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>5.2.5</td>
<td>4KHz MODULATION ON RF OUTPUT</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>5.2.6</td>
<td>HELIX OVERCURRENT OVERLOADS REPEATEDLY</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>5.2.7</td>
<td>REPEATED THERMAL OVERLOADS</td>
<td>✓</td>
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<td></td>
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<tr>
<td>5.2.8</td>
<td>EXCESSIVE INPUT CURRENT</td>
<td>✓</td>
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<tr>
<td>5.2.9</td>
<td>LOW FREQUENCY MODULATION OF THE RF OUTPUT</td>
<td>✓</td>
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<td>5.2.10</td>
<td>120Hz MODULATION ON THE RF OUTPUT</td>
<td>✓</td>
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<tr>
<td>TWT BAND AND WATTAGE</td>
<td>COLLECTOR VOLTAGE AND CURRENT</td>
<td>CATHODE TO HELIX VOLTAGE RANGE AND MAXIMUM CURRENT</td>
<td>TAP SELECTION</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------</td>
<td>-----------------------------------------------</td>
<td>---------------</td>
<td></td>
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<td></td>
<td></td>
<td>ORANGE WIRES</td>
<td>RED WIRE</td>
<td>BROWN WIRES</td>
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<tr>
<td>L BAND 100 WATT</td>
<td>2750 TO 3400VDC 330mA</td>
<td>-2750 TO -3400VDC 50mA MAX.</td>
<td>5</td>
<td></td>
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<tr>
<td>L BAND 200 WATT</td>
<td>3100 TO 3900VDC 450mA</td>
<td>-3100 TO -3900VDC 65mA MAX.</td>
<td>4</td>
<td></td>
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<tr>
<td>S BAND 100 WATT</td>
<td>2000 TO 2700VDC 350mA</td>
<td>-2600 TO -3400VDC 40mA MAX.</td>
<td>6</td>
<td></td>
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<tr>
<td>S BAND 200 WATT</td>
<td>2600 TO 3200VDC 420mA</td>
<td>-3200 TO -4200VDC 70mA MAX.</td>
<td>5</td>
<td></td>
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<tr>
<td>G BAND (2.6-5.2) 200 WATT</td>
<td>2700 TO 3300VDC 430mA</td>
<td>-4100 TO -4700VDC 40mA MAX.</td>
<td>5</td>
<td></td>
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<tr>
<td>C BAND 100 WATT</td>
<td>2700 TO 3600VDC 260mA</td>
<td>-4200 TO -4800VDC 15mA MAX.</td>
<td>5</td>
<td></td>
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<td>C BAND 200 WATT</td>
<td>4000 TO 5000VDC 300mA</td>
<td>-8000 TO -9000VDC 25mA MAX.</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CX BAND (7-11) 100 WATT</td>
<td>2800 TO 4000VDC 240mA</td>
<td>-4900 TO -5600VDC 20mA MAX.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>X BAND 100 WATT</td>
<td>2800 TO 4000VDC 240mA</td>
<td>-4900 TO -5600VDC 20mA MAX.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>X BAND 200 WATT</td>
<td>4000 TO 5000VDC 350mA</td>
<td>-8300 TO -9500VDC 25mA MAX.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>KU BAND 100 WATT</td>
<td>3800 TO 5000VDC 230mA</td>
<td>-8400 TO -9100VDC 20mA MAX.</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** TAPS 1, 7 AND 13 ALWAYS REMAIN FIXED.
NOTES

1. ALL LAMPS ARE 28 V. EXCEPT OPR. (18 V)

2. THE REMOTE LAMP IS LIGHTED WHEN THE UNIT MODE SWITCH IS IN THE REMOTE POSITION.

FIG. 1 - REMOTE CONTROL MODULE FOR R630-100/200 AMPLIFIERS
FIG. 2 POWER-SUPPLY BLOCK DIAGRAM
PMIPLSHIO, WINCHESTER

TO COLL.

PMIPLSHIO

TO FIL.

PMIPLSHIO

TO CATH.

R2 3000W

R3 500W

NOTES

1. R2 & 3 MUST BE CAPABLE OF WITHSTANDING HIGH VOLTAGE.

2. THE VALUE AND WATTAGE OF EACH RESISTOR MUST BE DETERMINED FROM SPECIFIC TWT VOLTAGE REQUIREMENTS.

FIG. 3 - LOAD FIXTURE FOR R630-100/200 AMPLIFIERS

HELIX

TC1-2

NC - TWT THERMAL SWITCH
(IN TWT)

TC1-3
FIG. 4 - LOCATION OF ADJUSTMENTS

on -1 units
FIG 4 - LOCATION OF ADJUSTMENTS
ON -2 UNITS
RF Test Connections for 200 Watt Amplifiers

FIG. 5
APPENDIX A

POWER SUPPLY ACCEPTANCE TEST DATA SHEET
FOR KELTEC STANDARD FULL RACK AMPLIFIERS
MODELS R630-100/200 AND R730-100/200

RF RESPONSE DATA SHEET
TRAVELING WAVE TUBE AMPLIFIER
### POWER SUPPLY ACCEPTANCE TEST DATA SHEET FOR KELTEL STANDARD FULL RACK AMPLIFIERS MODELS R630-100/200 AND R730-100/200

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>REQUIREMENT</th>
<th>DATA</th>
<th>SERIAL NO.</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FILAMENT VOLTAGE</td>
<td>6.3 ±0.13VRMS</td>
<td>___________________ VRMS</td>
<td></td>
<td>AMP FIL LOAD</td>
</tr>
<tr>
<td>COLLECTOR VOLTAGE (WITH RESPECT TO CATHODE)</td>
<td>TO _____KV AT _____mA LOAD</td>
<td>SET TO _____VDC AT _____mA LOAD</td>
<td></td>
<td>115 OR 230VAC INPUT</td>
</tr>
<tr>
<td>COLLECTOR RIPPLE</td>
<td>__________Vpp MAX</td>
<td>___________________ Vpp</td>
<td></td>
<td>115 OR 230VAC INPUT</td>
</tr>
<tr>
<td>CATHODE VOLTAGE ADJUST</td>
<td>TO _____KV</td>
<td>___________________ VMAX ___________ VMIN</td>
<td></td>
<td>115 OR 230VAC INPUT</td>
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<tr>
<td>CATHODE REGULATION</td>
<td>SET TO _____KV</td>
<td>___________________ VDC</td>
<td></td>
<td>103.5 OR 207VAC, _____mA LOAD(HIGH)</td>
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<tr>
<td>(LINE AND LOAD)</td>
<td>Δ _____VDC MAX</td>
<td>___________________ VDC</td>
<td></td>
<td>126.5 OR 253VAC, _____mA LOAD (LOW)</td>
</tr>
<tr>
<td>CATHODE RIPPLE</td>
<td>__________Vpp MAX</td>
<td>___________________ Vpp</td>
<td></td>
<td>115 OR 230VAC, _____mA LOAD(HIGH)</td>
</tr>
<tr>
<td>CATHODE RISE TIME PLUS DELAY</td>
<td>500MS MAX</td>
<td>___________________ MS</td>
<td></td>
<td>TImED FROM OPERATE WITH</td>
</tr>
<tr>
<td>CATHODE RISE TIME</td>
<td>50MS MAX</td>
<td>___________________ MS</td>
<td></td>
<td>_____mA HELIX LOAD</td>
</tr>
<tr>
<td>CATHODE TIME ON BEFORE OVERLOAD</td>
<td>50 TO 75MS</td>
<td>___________________ MS</td>
<td></td>
<td>_____mA COLL. LOAD</td>
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<tr>
<td>COLLECTOR RISE TIME</td>
<td>50MS MAX</td>
<td>___________________ MS</td>
<td></td>
<td></td>
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</table>

### CURRENT OVERLOAD AND CONTROL AND INDICATOR CHECK

- HELIX CURR OVERLOAD SET AT _____(✓) OPERATE IND. _____(✓)
- CURRENT OVERLOAD IND. _____(✓) VSWR IND. (AND J1 PIN 14) (OPTIONAL) _____(✓)
- THERMAL OVERLOAD IND. _____(✓) INTERLOCK OVERLOAD _____(✓)
- TIME DELAY IND. _____(✓) J2 REMOTE FUNCTION _____(✓)
- STANDBY IND. _____(✓) OTHER _____(✓)

### COLX FMFR RUN TAP USED _____ TIME
- Q.A. SIGN __________
- TESTED BY __________
- DATE __________

74A0213 SH A2 OF A2
APPENDIX C
DRAWINGS AND SCHEMATICS

HEATSINK SCHEMATIC 74D0029
CONTROL BOARD SCHEMATIC 74D0038
HELIX-HEATER REGULATOR BOARD SCHEMATIC 74D0040
FRONT PANEL ASSEMBLY 74D0042
HELIX-HEATER REGULATOR BOARD ASSEMBLY 74D0045
OUTLINE DRAWING 73D1052
HEATSINK ASSEMBLY 74D0096
LOW VOLTAGE MODULE SCHEMATIC 74C0097
LOW VOLTAGE MODULE 74D0103
CONTROL BOARD ASSEMBLY 74D0114
DECK PLATE ASSEMBLY 74D0124
POWER SUPPLY ASSEMBLY 74D0127
SCHEMATIC, CHASSIS/INTERCONNECTING 74H0136 or 74D0125

NOTE: DRAWING LIST IS FOR UNITS WITH -1 PART NUMBERS.
APPENDIX C
DRAWINGS AND SCHEMATICS

HEAT SINK SCHEMATIC 791311
CONTROL BOARD SCHEMATIC 74D0038
HELIX-HEATER REGULATOR BOARD SCHEMATIC 74D0040
FRONT PANEL ASSEMBLY 791340
HELIX-HEATER REGULATOR BOARD ASSEMBLY 74D0045
OUTLINE DRAWING 002903
HEAT SINK ASSEMBLY 791310
CONTROL BOARD ASSEMBLY 74D0114
DECK PLATE ASSEMBLY 791320
POWER SUPPLY ASSEMBLY 791300
WIRING DIAGRAM (CHASSIS) 791302

NOTE: DRAWING LIST IS FOR UNITS WITH -2 PART NUMBERS.
APPENDIX D

TEST DATA SHEET
### FINAL TEST DATA

**PRESENT POWER SUPPLY VOLTAGES**

- HEATER
- HELIX
- COLLECTOR
- GRID
- ANODE

**MODEL NO**

**PART NO**

**SERIAL NO**

**Fw MONITOR**

**Iw MONITOR**

**Ip MONITOR**

<table>
<thead>
<tr>
<th>FREQUENCY GHz</th>
<th>POWER OUT dbm</th>
<th>GAIN db</th>
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</tr>
</tbody>
</table>

**TWT TYPE**

**TIME DELAY**

**HELIX CURRENT**

**NOISE P out**

**TWT S/N**

**WEIGHT**

**E.T.I. RDG**

**TESTED BY**

**DATE**

**LBS**

**HRS**

An affiliate of D