

Parts List: Main Module; #Q42499-6 (for serial numbers 3791 and above) Contd

| Index No.         | Schematic Designation                                                                                                                                                                                                                                                     | Description            | Crown Part No. | Qty. | Other Information |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------|------|-------------------|
| <b>Resistors</b>  |                                                                                                                                                                                                                                                                           |                        |                |      |                   |
|                   | R170                                                                                                                                                                                                                                                                      | 10M ohm .25W 10%       | C 3221-6       | 1    |                   |
|                   | R171, R172                                                                                                                                                                                                                                                                | 4.42K ohm .5W 1%       | C 3120-0       | 2    |                   |
|                   | R173                                                                                                                                                                                                                                                                      | 100K ohm Vert Wht Pot  | C 1713-4       | 1    |                   |
|                   | R180, R181                                                                                                                                                                                                                                                                | 500K ohm Vert Trim Pot | C 5209-9       | 2    |                   |
|                   | R199A, R199B                                                                                                                                                                                                                                                              | 620 ohm .25W 5%        | C 3872-6       | 2    |                   |
|                   | R199D                                                                                                                                                                                                                                                                     | 470K ohm .25W 5%       | C 4225-6       | 1    |                   |
| <b>Capacitors</b> |                                                                                                                                                                                                                                                                           |                        |                |      |                   |
|                   | C100, C101,<br>C102, C103,<br>C104, C105,<br>C106, C107,<br>C108, C109,<br>C110, C111,<br>C112, C113,<br>C114, C115,<br>C117, C118,<br>C119, C120,<br>C121, C123,<br>C127, C128,<br>C130, C131,<br>C132, C136,<br>C138, C139,<br>C145, C146,<br>C148, C151,<br>C180, C181 | .02mF 50V Disc         | C 5230-5       | 36   |                   |
|                   | C177, C178                                                                                                                                                                                                                                                                | 22mF 50V NP 10%        | C 5311-3       | 2    |                   |
|                   | C122                                                                                                                                                                                                                                                                      | 39pF 10% Disc          | C 5227-1       | 1    |                   |
|                   | C124, C149,<br>C157                                                                                                                                                                                                                                                       | .47mF 50V              | C 6095-1       | 3    |                   |
|                   | C125, C143,<br>C179                                                                                                                                                                                                                                                       | 100mF 16V              | C 3729-8       | 3    |                   |
|                   | C126                                                                                                                                                                                                                                                                      | 8.2pF 10% N220         | C 5191-9       | 1    |                   |
|                   | C129, C133                                                                                                                                                                                                                                                                | 33pF 10% NPO           | C 5980-5       | 2    |                   |
|                   | C134                                                                                                                                                                                                                                                                      | 12pF 10% NPO           | C 5979-7       | 1    |                   |
|                   | C135                                                                                                                                                                                                                                                                      | 1pF 5% NPO             | C 5982-1       | 1    |                   |
|                   | C137                                                                                                                                                                                                                                                                      | 100pF Mica             | C 3410-5       | 1    |                   |
|                   | C141                                                                                                                                                                                                                                                                      | 220pF Z5U              | C 5978-9       | 1    |                   |
|                   | C142, C161,<br>C163, C175,<br>C176                                                                                                                                                                                                                                        | 4.7mF 63V Vert         | C 6076-1       | 5    |                   |
|                   | C147                                                                                                                                                                                                                                                                      | 82pF Mica              | C 3627-4       | 1    |                   |
|                   | C152, C144                                                                                                                                                                                                                                                                | 220mF 16V Vert         | C 3796-7       | 2    |                   |
|                   | C153, C156                                                                                                                                                                                                                                                                | 3.3mF 25V 10%          | C 6096-9       | 2    |                   |
|                   | C155, C174                                                                                                                                                                                                                                                                | .047mF 200V 5% Film    | C 3978-1       | 2    |                   |
|                   | C158                                                                                                                                                                                                                                                                      | 2200pF                 | D 6018-2       | 1    |                   |
|                   | C159                                                                                                                                                                                                                                                                      | 1000pF                 | C 5636-3       | 1    |                   |
|                   | C160                                                                                                                                                                                                                                                                      | .47mF 100V 10% Poly    | C 4119-1       | 1    |                   |
|                   | C162, C164,<br>C168, C169,<br>C170, C171                                                                                                                                                                                                                                  | 5640pF 63V 2.5%        | D 4466-5       | 6    |                   |

Parts List: Main Module; #Q42499-6 (for serial numbers 3791 and above) Contd

| Index No.                  | Schematic Designation                                                                          | Description              | Crown Part No. | Qty. | Other Information               |
|----------------------------|------------------------------------------------------------------------------------------------|--------------------------|----------------|------|---------------------------------|
| <b>Capacitors</b>          |                                                                                                |                          |                |      |                                 |
|                            | C165                                                                                           | .01mF 200V 10% Film      | C 3161-4       | 1    |                                 |
|                            | C166, C167                                                                                     | .1 mF 63V                | C 5639-7       | 2    |                                 |
| <b>Diodes</b>              |                                                                                                |                          |                |      |                                 |
|                            | D100, D102,<br>D103, D104,<br>D105, D106,<br>D107, D108,<br>D109, D110,<br>D111, D112,<br>D113 | 1N4148                   | C 3181-2       | 13   |                                 |
| <b>Integrated Circuits</b> |                                                                                                |                          |                |      |                                 |
|                            | U100, U101,<br>U102                                                                            | LM703CN IF Amp           | C 5077-0       | 3    |                                 |
|                            | U103                                                                                           | HA11225 IF Op Amp        | C 4956-6       | 1    |                                 |
|                            | U104                                                                                           | LM339N Volt Comparator   | C 4345-2       | 1    |                                 |
|                            | U105                                                                                           | HA11223 PLL St. Demod    | C 4955-8       | 1    |                                 |
|                            | U106                                                                                           | TL074 Quad Op Amp        | C 4696-8       | 1    |                                 |
|                            | U107                                                                                           | HA12401A Detector        | C 5907-8       | 1    |                                 |
|                            | U108                                                                                           | MC14016 Quad Switch      | C 4834-5       | 1    |                                 |
| <b>Transistors</b>         |                                                                                                |                          |                |      |                                 |
|                            | Q100, Q102                                                                                     | 2N5485                   | C 5123-2       | 2    |                                 |
|                            | Q101                                                                                           | J-310 JFET               | C 6049-8       | 1    |                                 |
|                            | Q103, Q104                                                                                     | 2N5770                   | C 5135-6       | 2    |                                 |
|                            | Q105, Q106                                                                                     | PN4250A                  | C 3786-8       | 2    |                                 |
|                            | Q107                                                                                           | SEL TZ-81                | D 2962-5       | 1    |                                 |
| <b>Miscellaneous</b>       |                                                                                                |                          |                |      |                                 |
|                            |                                                                                                | 8 Pin DIL IC Socket      | C 3451-9       | 3    | Sockets for U100,<br>U101, U102 |
|                            |                                                                                                | 16 Pin DIL IC Socket     | C 4508-5       | 3    | Sockets for U103,<br>U105, U107 |
|                            |                                                                                                | 14 Pin DIL IC Socket     | C 3450-1       | 3    | Sockets for U104,<br>U106, U108 |
|                            | FL100                                                                                          | BF-56 Band Pass Filter   | C 5911-0       | 1    |                                 |
|                            | FL101                                                                                          | BL-21 Low Pass Filter    | C 5912-8       | 1    |                                 |
|                            | FL102, FL103                                                                                   | Multiplex Filter         | C 5059-8       | 2    |                                 |
|                            | Y100                                                                                           | 12.665 MHz Crystal       | C 5950-8       | 1    |                                 |
|                            | L100, L103                                                                                     | 15uh Choke 1500017       | D 5121-5       | 2    |                                 |
|                            | L101                                                                                           | 22uh Choke Shielded      | D 5122-3       | 1    |                                 |
|                            | L102                                                                                           | Detector Coil            | C 5948-2       | 1    |                                 |
|                            | SW100                                                                                          | DPDT PC MNT Slide Switch | C 5080-4       | 1    |                                 |
|                            |                                                                                                | 3 Pin Socket Strip       | C 5295-8       | 4    | Ceramic Filter<br>Strip         |
|                            |                                                                                                | 10.7MHz Ceramic Filter   | C 4954-1       | 2    | Fills 3 Pin Socket<br>Strip     |
|                            |                                                                                                | SFE10.7MX-A Filter       | C 5933-4       | 2    | Fills 3 Pin Socket<br>Strip     |
|                            |                                                                                                | 0.0 ohm .25W Jumper      | C 5868-2       | 13   |                                 |

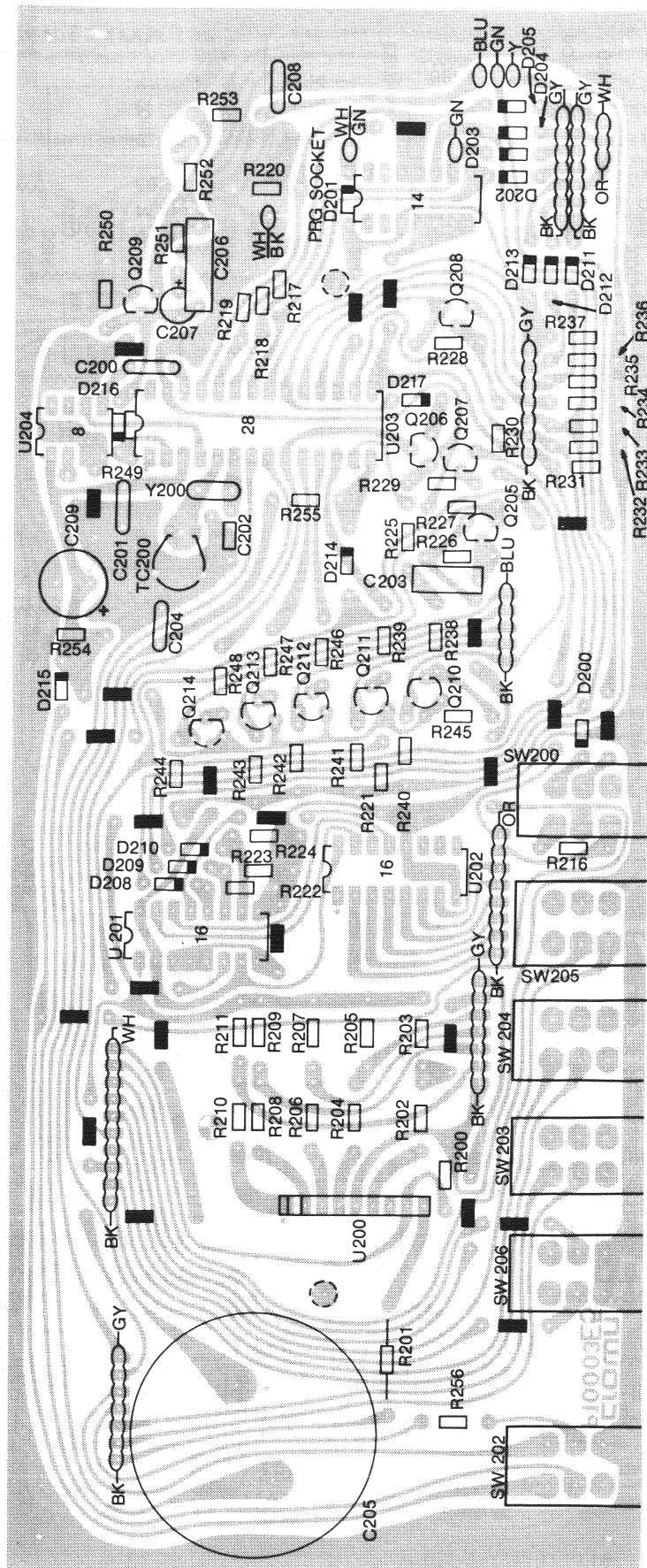


Fig. 6.11 Control Module Component Board Layout; #Q42498-8  
(for serial numbers 3791 and above)

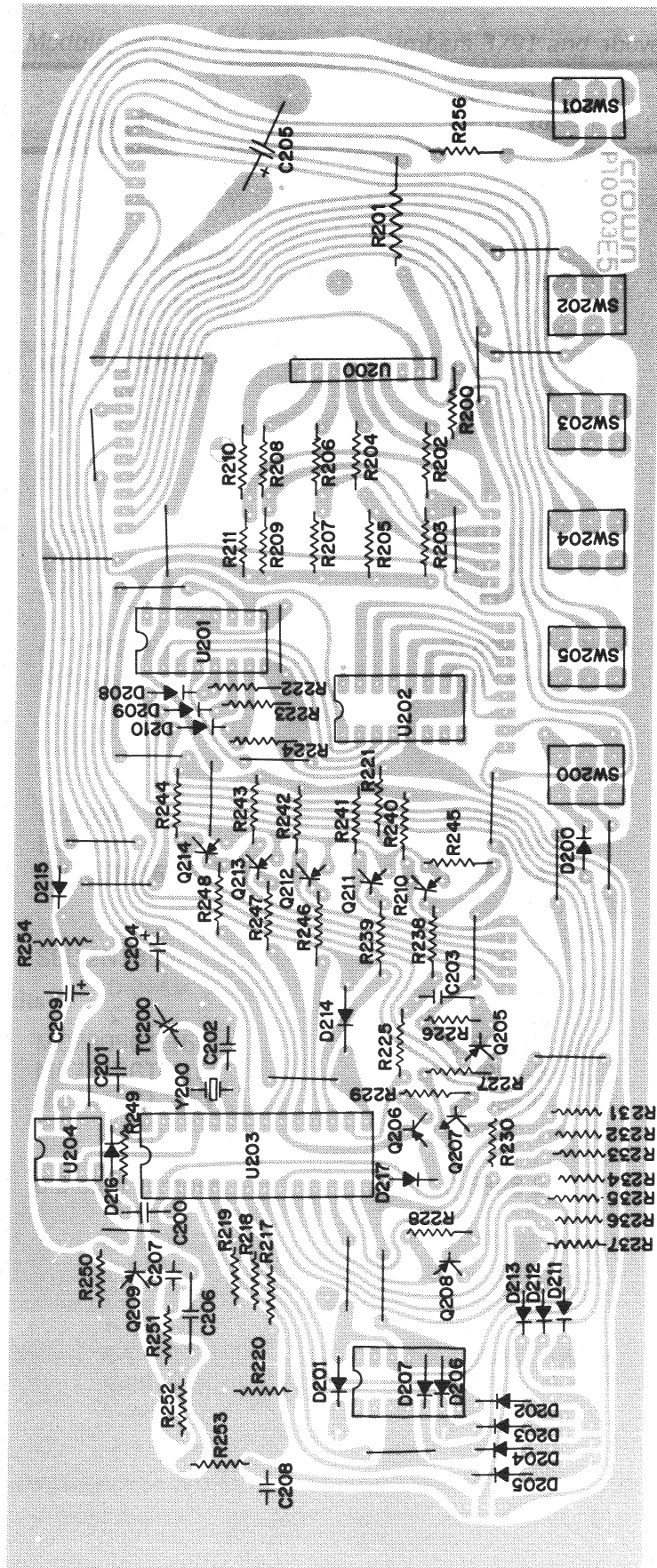


Fig. 6.12 Control Module Foil Board Layout; #Q42498-8  
(for serial numbers 3791 and above)

Parts List: Control Module; #Q42498-8 (for serial numbers 3791 and above)

| Index No.         | Schematic Designation                                                                                               | Description          | Crown Part No. | Qty. | Other Information |
|-------------------|---------------------------------------------------------------------------------------------------------------------|----------------------|----------------|------|-------------------|
| <b>Resistors</b>  |                                                                                                                     |                      |                |      |                   |
|                   | R200                                                                                                                | 8.2K ohm .25W 5%     | C 2877-6       | 1    |                   |
|                   | R201                                                                                                                | 220 ohm .25W 5%      | C 5047-3       | 1    |                   |
|                   | R203, R205,<br>R207, R209,<br>R11                                                                                   | 200K ohm .25W 5%     | C 3622-5       | 5    |                   |
|                   | R221, R222,<br>R223, R224,<br>R225, R226,<br>R227, R228,<br>R229, R238,<br>R240, R245,<br>R249, R252,<br>R254       | 10K ohm .25W 5%      | C 2631-7       | 15   |                   |
|                   | R239, R246,<br>R247, R248,                                                                                          | 47K ohm .25W 5%      | C 2880-0       | 4    |                   |
|                   | R202, R204,<br>R206, R208,<br>R231, R232,<br>R233, R234,<br>R235, R236,<br>R237, R241,<br>R242, R243,<br>R244, R256 | 100K ohm .25W 5%     | C 2883-4       | 16   |                   |
|                   | R200                                                                                                                | 8.2K ohm .25W 5%     | C 2877-6       | 1    |                   |
|                   | R216                                                                                                                | 150 ohm .25W 5%      | C 3799-1       | 1    |                   |
|                   | R217, R218,<br>R219, R220                                                                                           | 33K ohm .25W 5%      | C 4346-0       | 4    |                   |
|                   | R230                                                                                                                | 620K ohm .25W 5%     | C 4227-2       | 1    |                   |
|                   | R250                                                                                                                | 150K ohm .25W 5%     | C 4216-5       | 1    |                   |
|                   | R251                                                                                                                | 2.2K ohm .25W 5%     | C 2628-3       | 1    |                   |
|                   | R253                                                                                                                | 20K ohm .25W 5%      | C 5046-5       | 1    |                   |
|                   | R255                                                                                                                | 300 ohm .25W 5%      | C 3801-5       | 1    |                   |
| <b>Capacitors</b> |                                                                                                                     |                      |                |      |                   |
|                   | C200, C201,<br>C204, C208                                                                                           | .02mF 50V Disc       | C 5230-5       | 4    |                   |
|                   | C202                                                                                                                | 20pF Tubular Cer.    | C 3535-9       | 1    |                   |
|                   | C203                                                                                                                | .0047mF 200V 5% Film | C 3996-3       | 1    |                   |
|                   | C205                                                                                                                | .47mF 5V             | C 5952-4       | 1    |                   |
|                   | C206                                                                                                                | .022mF 200V 5% Film  | C 3977-3       | 1    |                   |
|                   | C207                                                                                                                | 3.3mF 25V 10% Tant   | C 5180-2       | 1    |                   |
|                   | C209                                                                                                                | 220mF 16V Vert       | C 3796-7       | 1    |                   |

Parts List: Control Module; #Q42498-8 (for serial numbers 3791 and above) Contd

| Index No.                  | Schematic Designation                                                                                                        | Description                       | Crown Part No. | Qty. | Other Information        |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|----------------|------|--------------------------|
| <b>Diodes</b>              |                                                                                                                              |                                   |                |      |                          |
|                            | D200, D201,<br>D202, D203,<br>D204, D205,<br>D206, D207,<br>D208, D209,<br>D210, D211,<br>D212, D213,<br>D215, D216,<br>D217 | 1N4148                            | C 3181-2       | 17   |                          |
|                            | D214                                                                                                                         | 1N4004                            | C 2851-1       | 1    |                          |
| <b>Transistors</b>         |                                                                                                                              |                                   |                |      |                          |
|                            | Q205, Q208,<br>Q210, Q211,<br>Q212, Q213,<br>Q214                                                                            | PN4250-A                          | C 3786-8       | 7    |                          |
|                            | Q206                                                                                                                         | 2N4125                            | C 3625-8       | 1    |                          |
|                            | Q207                                                                                                                         | SEL 2N3859A                       | D 2961-7       | 1    |                          |
|                            | Q209                                                                                                                         | 2N6428A                           | C 4695-0       | 1    |                          |
| <b>Integrated Circuits</b> |                                                                                                                              |                                   |                |      |                          |
|                            | U200                                                                                                                         | 5 Element DIS DRVR                | C 6484-7       | 1    |                          |
|                            | U201                                                                                                                         | 4035 4BIT SHFT RGSTR              | C 5965-6       | 1    |                          |
|                            | U202                                                                                                                         | 74LS42 BCD-DCM Decoder            | C 5966-4       | 1    |                          |
|                            | U203                                                                                                                         | UPD1703C-011 DIG. CTL             | C 5937-5       | 1    |                          |
|                            | U204                                                                                                                         | UPB553A Prescaler                 | C 5936-7       | 1    |                          |
| <b>Miscellaneous</b>       |                                                                                                                              |                                   |                |      |                          |
|                            |                                                                                                                              | 8 Pin DIL IC Socket               | C 3451-9       | 2    | Socket for U200,<br>U204 |
|                            |                                                                                                                              | 16 Pin DIL IC Socket              | C 4508-5       | 2    | Socket for U201,<br>U202 |
|                            |                                                                                                                              | 14 Pin SIP Socket                 | C 5981-3       | 2    | Sockets for U203         |
|                            |                                                                                                                              | 14 Pin DIL IC Socket              | C 3450-0       | 1    | PRG Socket               |
|                            | TC200                                                                                                                        | 30pF PC MNT Trimmer               | C 5058-0       | 1    |                          |
|                            | Y200                                                                                                                         | 4.5 MHz Crystal                   | C 5949-0       | 1    |                          |
|                            | SW200, SW202,<br>SW203, SW204,<br>SW205                                                                                      | 5 Station DPDT Pushbutton Switch  | C 5957-3       | 1    |                          |
|                            | SW201                                                                                                                        | 1 Station DPDT Pushbutton 6.3 Lug | C 5958-1       | 1    |                          |
|                            |                                                                                                                              | 0.0 ohm .25W Jumper               | C 5868-2       | 26   |                          |

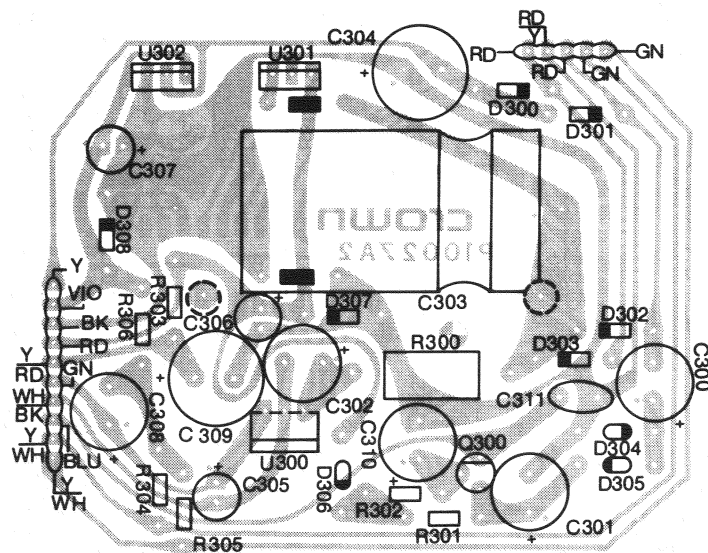


Fig. 6.13 Power Supply Component Board Layout; #Q42500-1  
(for serial numbers 3791 and above)

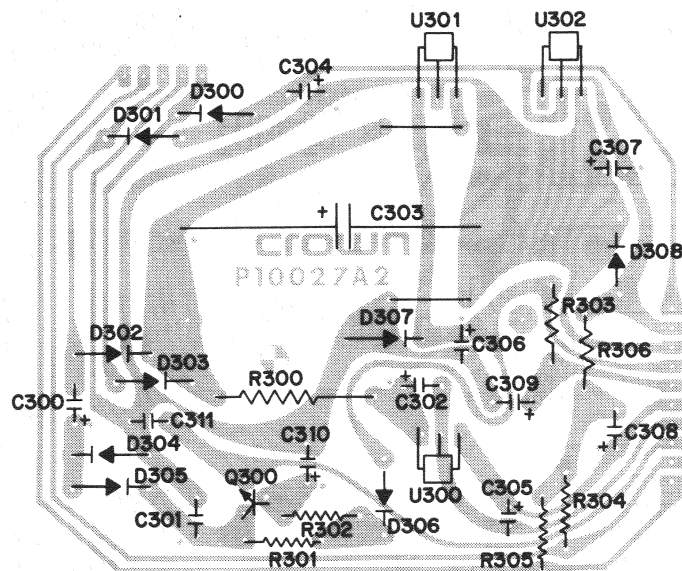


Fig. 6.14 Power Supply Foil Board Layout; #Q42500-1  
(for serial numbers 3791 and above)

Parts List: Power Supply Module; #Q42500-1 (for serial numbers 3791 and above)

| Index No.                                | Schematic Designation | Description      | Crown Part No. | Qty. | Other Information |
|------------------------------------------|-----------------------|------------------|----------------|------|-------------------|
| <b>Resistors</b>                         |                       |                  |                |      |                   |
| R300                                     |                       | 47 ohm .25W 5%   | C 1073-3       | 1    |                   |
| R301                                     |                       | 20K ohm .25W 5%  | C 5046-5       | 1    |                   |
| R302                                     |                       | 33K ohm .25W 5%  | C 4346-0       | 1    |                   |
| R303                                     |                       | 22 ohm .25W 5%   | C 4479-9       | 1    |                   |
| R304, R305                               |                       | 47 ohm .25W 5%   | C 1011-3       | 2    |                   |
| R306                                     |                       | 100 ohm .25W 5%  | C 2872-7       | 1    |                   |
| <b>Capacitors</b>                        |                       |                  |                |      |                   |
| C300, C301,<br>C302, C308,<br>C310       |                       | 47mF             | C 5219-8       | 5    |                   |
| C303                                     |                       | 2200 mF          | C 5202-4       | 1    |                   |
| C304, C309                               |                       | 470 mF           | C 4477-3       | 2    |                   |
| C305, C306,<br>C307                      |                       | 4.7 mF           | C 4253-8       | 3    |                   |
| C311                                     |                       | .02 mF           | C 5230-5       | 1    |                   |
| <b>Diodes</b>                            |                       |                  |                |      |                   |
| D300, D301,<br>D302, D303,<br>D307, D308 |                       | IN4004           | C 2851-1       | 6    |                   |
| D304, D305                               |                       | IN4148           | C 3181-2       | 2    |                   |
| D306                                     |                       | 1N966B 16V Zener | C 3533-4       | 1    |                   |
| <b>Transistors</b>                       |                       |                  |                |      |                   |
| Q300                                     |                       | SEL 2N3859A      | D 2961-7       | 1    |                   |
| <b>Integrated Circuits</b>               |                       |                  |                |      |                   |
| U300                                     |                       | MC7805CT +5V     | C 5094-5       | 1    |                   |
| U301                                     |                       | MC7815CT +15V    | C 5095-2       | 1    |                   |
| U302                                     |                       | MC7915CT -15V    | C 5096-0       | 1    |                   |
| <b>Miscellaneous</b>                     |                       |                  |                |      |                   |
|                                          |                       | 0.0 ohm Jumper   | C 5868-2       | 2    |                   |

Parts List: Memory/Display Board; #M42843-9 (for serial numbers 3791 and above)

| Index No.            | Schematic Designation                                       | Description                | Crown Part No. | Qty. | Other Information |
|----------------------|-------------------------------------------------------------|----------------------------|----------------|------|-------------------|
| <b>Resistors</b>     |                                                             |                            |                |      |                   |
|                      | R400                                                        | 150 ohm .25W 5%            | C 3799-1       | 1    |                   |
| <b>Diodes</b>        |                                                             |                            |                |      |                   |
|                      | LED 400                                                     | Amber Rectangular LED      | C 5989-6       | 1    |                   |
|                      | LED401,<br>LED402,<br>LED403<br>LED404<br>LED405,<br>LED406 | Green Rectangular LED      | C 5956-5       | 6    |                   |
| <b>Miscellaneous</b> |                                                             |                            |                |      |                   |
|                      |                                                             | TACTILE SWSPR Contact      | C 5953-2       | 9    |                   |
|                      |                                                             | TACTILE SWBTN Contact      | C 5954-0       | 9    |                   |
|                      |                                                             | Housing Activator, Pushbar | D 5752J6       | 9    |                   |
|                      |                                                             | Display Fluorescent        | C 5939-1       | 1    |                   |

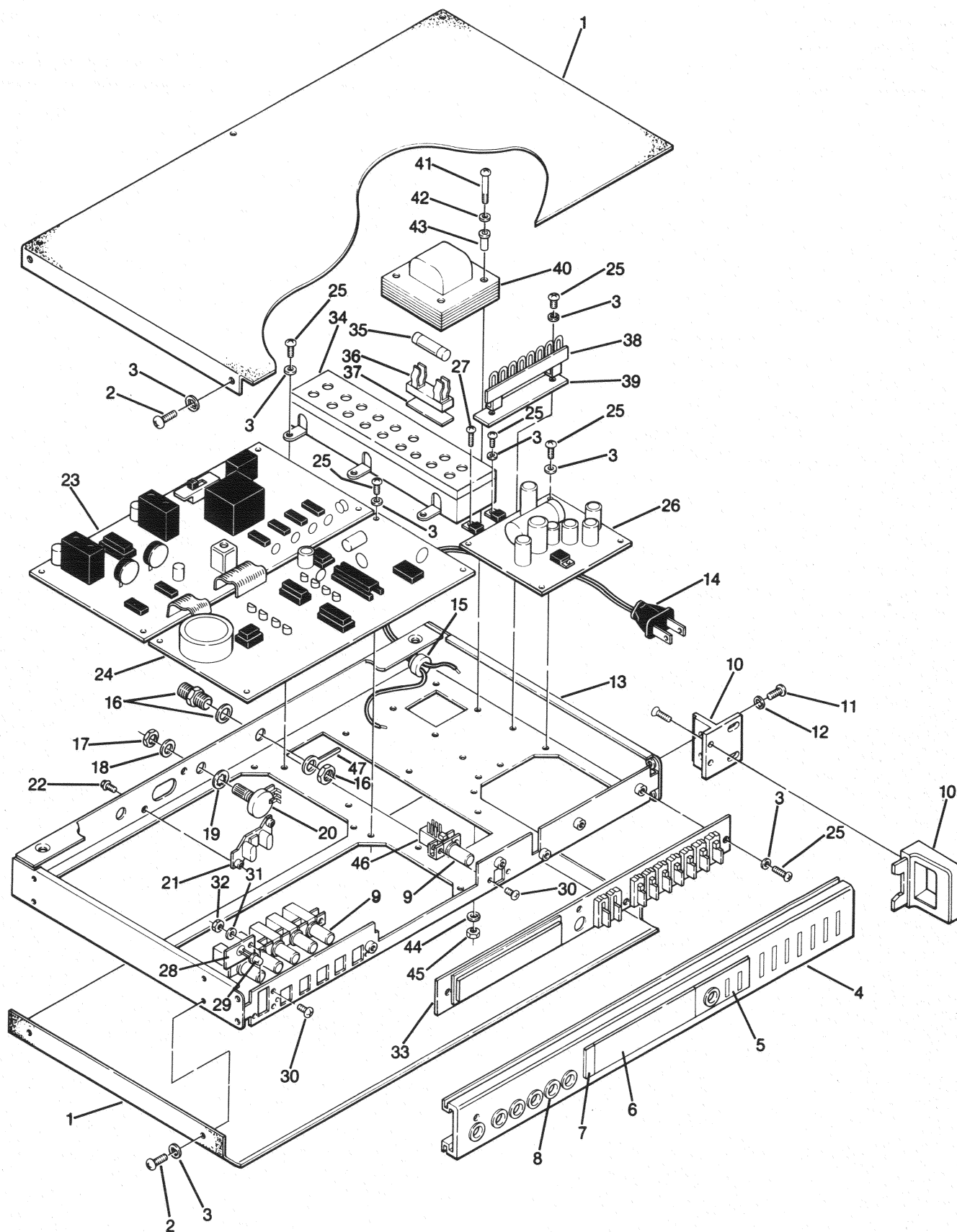


Fig. 6.15 Exploded View Drawing

Parts List: Exploded View Drawing

| Index No. | Schematic Designation | Description            | Crown Part No. | Qty. | Other Information |
|-----------|-----------------------|------------------------|----------------|------|-------------------|
| 1         |                       | Cover, Top & Bottom    | F10089K1       | 2    |                   |
| 2         |                       | Screw 6-32x.25" Black  | C 4758-6       | 14   |                   |
| 3         |                       | Lockwasher #6          | C 1823-1       | 23   |                   |
| 4         |                       | Front Panel, Silver    | F10090-3       | 1    |                   |
|           |                       | Front Panel, Black     | F10419-4       | 1    |                   |
| 5         |                       | Tuning Bezel, Silver   | F10091-1       | 1    |                   |
|           |                       | Tuning Bezel, Black    | F10416-0       | 1    |                   |
| 6         |                       | Display Lens           | D 5753-5       | 1    |                   |
| 7         |                       | End Bezel, Silver      | D 5751J8       | 1    |                   |
|           |                       | End Bezel, Black       | D 6078J5       | 1    |                   |
| 8         |                       | Switch Collars, Silver | D 4108-3       | 7    |                   |
|           |                       | Switch Collars, Black  | F10413-7       | 7    |                   |
| 9         |                       | Pushbuttons, Silver    | D 5682A4       | 7    |                   |
|           |                       | Pushbuttons, Black     | D 6013-3       | 7    |                   |
| 10        |                       | Handles, Silver        | M20242J9       | 2    |                   |
|           |                       | Handles, Black         | M20250J2       | 2    |                   |
|           |                       | End Caps, Silver       | M20349J2       | 2    |                   |
|           |                       | End Caps, Black        | M20352J6       | 2    |                   |
| 11        |                       | Screw 10-32x.5" Black  | C 5944-1       | 4    |                   |
| 12        |                       | Starwasher #10         | C 2279-5       | 4    |                   |
| 13        |                       | Chassis                | M20256J9       | 1    |                   |
| 14        |                       | AC Cord                | C 5020-0       | 1    |                   |
| 15        |                       | Strain Relief          | C 4896-4       | 1    |                   |
| 16        |                       | RF Input, Female       | C 5207-3       | 1    |                   |
| 17        |                       | Bright Nut             | C 1288-7       | 2    |                   |
| 18        |                       | Bright Washer          | C 1289-6       | 2    |                   |
| 19        |                       | Lockwasher             | C 2188-8       | 2    |                   |
| 20        |                       | Level Control          | D 5769-1       | 2    |                   |
| 21        |                       | Output Jack            | C 4933-5       | 1    |                   |
| 22        |                       | Screw, Self-Starting   | C 4895-6       | 2    |                   |
| 23        |                       | Main Board *           |                |      |                   |
| 24        |                       | Control Board *        |                |      |                   |
| 25        |                       | Screw 6-32x.25"        | C 1954-4       | 23   |                   |
| 26        |                       | Power Supply Board *   |                |      |                   |
| 27        |                       | Screw Nylon 6-32x.38"  | C 2620-0       | 1    |                   |
| 28        |                       | Power LED Board        | P10009-2       | 1    |                   |
| 29        |                       | Power LED              | C 4342-9       | 1    |                   |
| 30        |                       | Screw 4-40x.25"        | C 1827-2       | 1    |                   |
| 31        |                       | Starwasher             | C 1824-9       | 1    |                   |
| 32        |                       | Nut 4-40               | C 1938-7       | 1    |                   |
| 33        |                       | Display Board *        |                |      |                   |
| 34        |                       | Front End Module       | Q42497-0       | 1    |                   |

\* Check parts lists for correct replacement circuit boards within specified serial number groups.

Parts List: Exploded View Drawing Contd

| Index No. | Schematic Designation | Description       | Crown Part No. | Qty. | Other Information |
|-----------|-----------------------|-------------------|----------------|------|-------------------|
| 35        |                       | Fuse 1/8 Amp      | C 1758-9       | 1    |                   |
| 36        |                       | Fuse Block        | C 3776-9       | 1    |                   |
| 37        |                       | 1" Foam Tape      | S 1152-8       | 1    |                   |
| 38        |                       | Terminal Strip    | D 3503-6       | 1    |                   |
| 39        |                       | Insulator         | D 3600-0       | 1    |                   |
| 40        |                       | Power Transformer | D 5901-0       | 1    |                   |
| 41        |                       | Screw 8-32x.75"   | C 4330-4       | 4    |                   |
| 42        |                       | Flat Washer #8    | C 2101-1       | 4    |                   |
| 43        |                       | Shoulder Washer   | C 4251-2       | 4    |                   |
| 44        |                       | Lockwasher #8     | C 1951-0       | 4    |                   |
| 45        |                       | Nut 8-32          | C 1986-6       | 4    |                   |
| 46        |                       | Switch DPDT       | C 5958-1       | 1    |                   |
| 47        |                       | Solder Lug        | C 2828-8       | 1    |                   |





## SECTION 7 MAINTENANCE

### 7.1 Introduction

Section 7 contains technical information required to effectively and efficiently service and repair the Crown FM TWO. Included are disassembly and reassembly procedures, required test equipment lists, checkout procedures and basic troubleshooting tips

**This information is intended for use by an experienced technician only!**

Use this information in conjunction with the schematic/board layout diagrams, parts lists and exploded view drawings (the latter located in Section 6 of this manual).

### 7.2 Required Test Equipment

Due to the complex circuitry utilized in the FM TWO, special alignment procedures and the correct test

equipment are necessary to insure original factory specifications are achieved.

**Note:** Front end module alignment requires a full band (88.1 to 108 MHz) sweep generator with markers at 90.1, 98.1 and 106.1 MHz. Due to this requirement, along with other RF considerations, this procedure does not include Front End module alignment. Refer all servicing on the Front End module to the Crown Service Department.

The following table lists standard test bench equipment required by this procedure. The "Requirements" column provides information to allow intelligent selection of equipment model substitutes, if necessary.

| EQUIPMENT                        | REQUIREMENTS                                          | APPLICATIONS                                                 | MODEL                                |
|----------------------------------|-------------------------------------------------------|--------------------------------------------------------------|--------------------------------------|
| RF Generators - Two Required     | 88 to 108 MHz output<br>FM mono and Stereo modulation | Used to generate various FM signals                          | Sound Technology 1020A or equivalent |
| AC Voltmeter                     | 100 mV to 10 V range                                  | Measure audio output levels and signal-to-noise ratios       | HP 400F or equivalent                |
| Digital Volt Meter               | —                                                     | Resistance and Voltage checks                                | Fluke 8020 or equivalent             |
| Frequency Counter                | Capable of measurements to 108 MHz                    | Monitor frequency output of RF Generator                     | Fluke 1912 or equivalent             |
| Antenna Impedance Matching Box   | Two 50 ohm inputs with 75 ohm output                  | Summing of two RF generators with a single 75 ohm output     | See Fig. 7.1                         |
| Oscilloscope                     | 15 MHz                                                | Used for monitoring signals and signal tracing               | Tekequipment D54A or equivalent      |
| THD Analyzer                     | 1% full scale measurement                             | Measure total harmonic distortion of audio output            | Sound Technology 1700 or equivalent  |
| Band-pass Filter Switch selected | 200 Hz to 15 kHz                                      | Used to bandpass limit audio output                          | —                                    |
| One kHz Notch Filter             | —                                                     | Used in IHF usable sensitivity, DBQ and 30 dB quieting tests | —                                    |
| Audio Generator                  | 20 Hz to 20 kHz sine wave output                      | Used to modulate FM generator for frequency response tests   | —                                    |

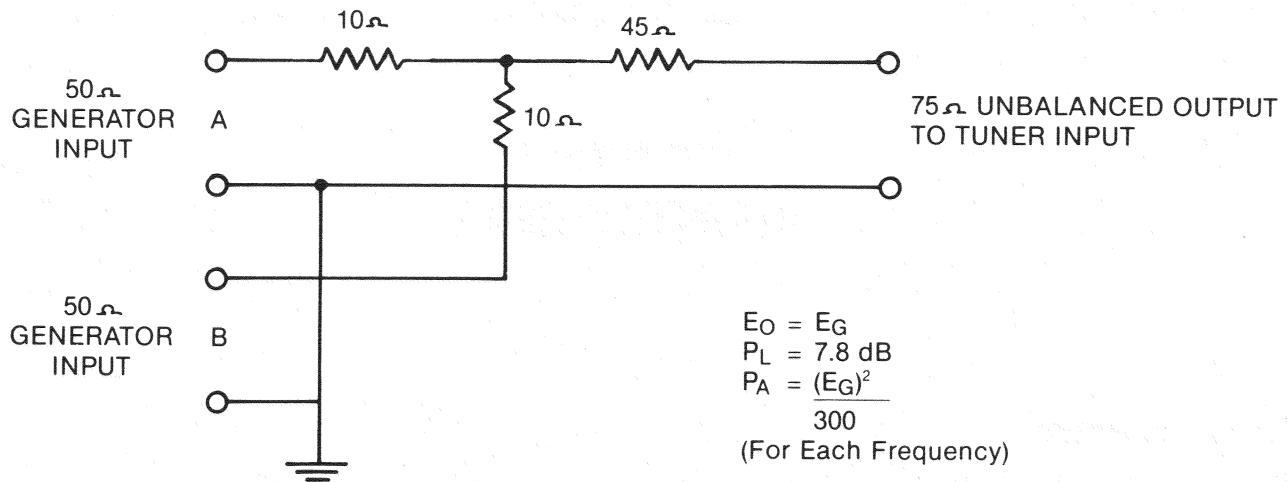


Fig. 7.1 Antenna Impedance Matching Box

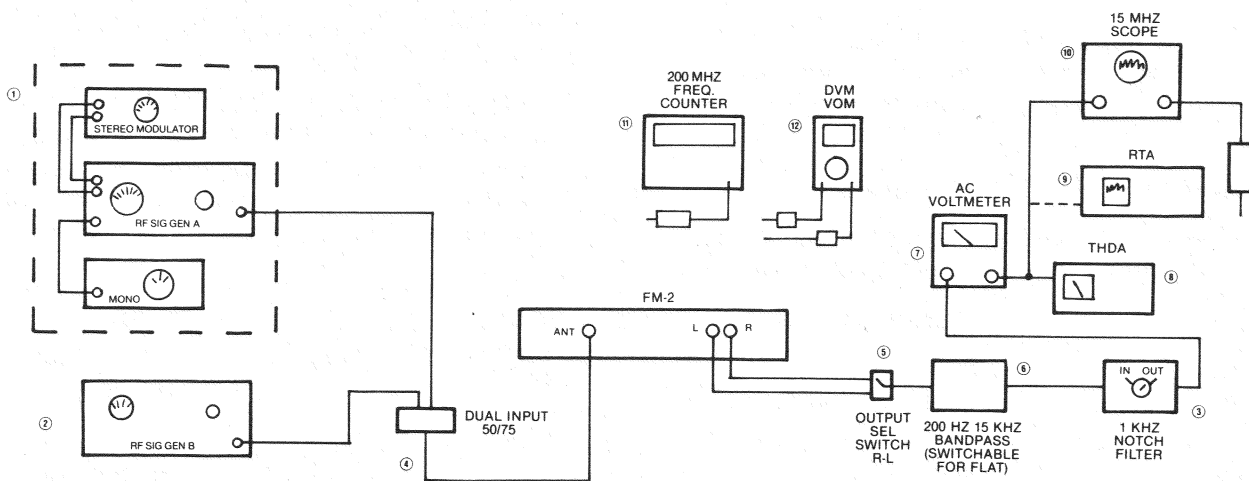


Fig. 7.2 Service Bench Setup

1. RF Signal Generator "A" 88 to 108 MHz output with stereo and mono capabilities. Output level to 1 volt. May be a single unit.
2. RF Signal Generator "B". Same as above.
3. 1 kHz Notch Filter.
4. Impedance matching box plus summation for the two RF generators.
5. Right-Left audio output selection switch.
6. 200 Hz to 15 kHz Band-pass Filter. Must be switchable for flat response.
7. AC Voltmeter.
8. Harmonic Distortion Analyzer.
9. Optional Real Time Analyzer.
10. Dual channel 15 MHz Oscilloscope.
11. Frequency Counter (200 MHz).
12. Digital Volt Meter (DVM).

## 7.3 Basic Troubleshooting

As is well known, time is an important factor in providing efficient service repair. Therefore, several time-saving troubleshooting steps are listed below. These hints may or may not already be implemented in your service work. If not, you may wish to experiment with them in order to help improve your efficiency. After all, time is money!

### A. Establishing Problems

User complaints about defective operation may not always be clear or simple. Furthermore, the trouble the user has experienced may be due to the system and not the unit itself. If possible, talk to the user about this problem. This will usually be simpler than trying to understand written complaints. A first hand account of the problem can help in:

- 1) Getting the problem to re-occur on the service bench.
- 2) Getting an understanding of the probable cause. Some troubles will be obvious upon visual inspection. When the trouble (or its symptoms) is not so obvious ask:
  - a) Exactly what was the problem; how was it noticeable?
  - b) How was the unit being used?
  - c) Has the system as a whole been carefully examined for possible external problems?
  - d) How long had the unit been operating when the problem occurred? Was it heat related?

If the user is unavailable or unable to explain the trouble the next step is a thorough visual inspection.

### B. Visual Inspection

A good visual inspection may often save hours of tedious troubleshooting. Make a habit of proceeding in an orderly manner to insure that no vital part of the following procedure is omitted. The visual inspection can be performed in 10 to 15 minutes. It is recommended both as a preventive maintenance procedure and also for its value in determining cause of malfunction.

- 1) Check that all external screws are tight and that none are missing.
- 2) Check all fuses/circuit breakers.
- 3) Check for smooth and proper operation of switches, etc.
- 4) Inspect line cord for possible damage to cap, jacket and conductors.
- 5) Remove protective covers as outlined in disassembly instruction (Section 7.4).
- 6) Check that all attaching parts for internal circuits are tight and that none are missing.
- 7) Inspect all wiring for charred insulation, or discoloration as evidence of previous overheating.
- 8) Check that all electrical connections are secure. This includes wire terminals, screw and stud type terminals, and all soldered connections.

- 9) Check for obvious destruction of internal structural parts. Distortion in any of these parts could mean that the unit has been dropped or subjected to severe shock.

## 7.4 Disassembly Procedure (for Inspection, Troubleshooting, Adjustments and Replacements)

The extent of FM TWO disassembly required will depend upon the amount of servicing required to be performed. **Do not** disassemble the unit beyond the point necessary for servicing. The FM TWO is generally easy to disassembly and service. All IC chips are located in sockets for easy replacement.

Troubleshooting for specific faulty components is recommended. Module replacement is suggested only when a problem can not be corrected by component troubleshooting.

**NOTE:** Because of the complex test equipment required to align and adjust the FM TWO, certain repairs/adjustments are not recommended for field servicing.

Always observe all Cautions and Warnings listed in this section pertaining to servicing "do's and don'ts."

Illustrations referred to in parenthesis are located in the illustrated parts found in Section 6 of this manual.

### A. Cover Removal

**Warning: Remove all AC power from the unit before removing covers!**

A visual inspection can be performed by removing the top and bottom covers:

1. The FM TWO has identical top and bottom covers. Both covers are removed in the same manner.
2. Remove the seven phillips head screws (#2) securing the cover to be removed.
3. Gently lift the cover at the rear, then pull to the rear to disengage the cover front edge from the front panel flange groove. Remove the cover.

Install covers by reversing the above procedure. Guide the cover front edge flange correctly into the front panel cover flange grooves. Align cover screw holes with threaded chassis holes.

### B. AC Line Fuse Replacement

The AC line fuse (F300) is mounted in a fuse block located inside the tuner. Remove the top cover to check or replace fuse (see Subsection "A"). Install the correct replacement fuse:

- 100/120 VAC Tuners: 1/8 Amp, slow blow type.
- 220/240 VAC Tuners: 1/16 Amp, slow blow type.

FM TWO tuners through serial #3790:

Fuse block is located on #Q42468J0 power supply module board.

FM TWO tuners with serial #**3791** and above:  
Fuse block is located adjacent to the power transformer.

#### C. Front Panel Removal

Access to the display/memory board (#33) and push button switches is obtained by removing the front panel assembly (#4):

1. Remove two phillips head screws (with internal lock-washers) (#11) from each end of the front panel assembly.
2. Gently work the front panel assembly forward and remove.

**Caution:** With the front panel removed use care not to damage pushbutton switches.

#### D. Power Supply Module Removal (Replacement)

**Note:** FM TWO tuners through serial #**3790** were manufactured with #**Q42468J0** power supply modules and #**Q42466J4** Control modules installed. Units with serial #**3791** and above have power supply module #**Q42500-1** and Control module #**Q42498-8** installed. **The modules of these two versions are not interchangeable.** If one of these modules is replaced the correct replacement module must be installed.

1. Remove the FM TWO covers as described under Subsection "A".
2. Note color coding and connecting point of wire leads soldered to component board. Using desoldering tools remove wire leads.
3. Remove the two screws (one metal; one nylon) securing the two voltage regulators to the chassis. These screws must be used with the correct regulator. The specific regulator location depends on the power supply module installed.
  - a. +15VDC regulator 7815C is secured with a metal phillips head. **Insure this screw is reinstalled on the 7815C only!**
  - b. The second regulator (7915 or 7805) is secured with an insulating nylon screw. **In-sure this screw is reinstalled on VRX only!**

**NOTE:** The mica insulator located below the insulated voltage regulator must be in good condition, positioned correctly with the correct amount of thermocompound.

4. Remove the four phillips head screws (with internal lockwashers) securing the power supply module. Remove the module.

#### E. Main Module Removal (Replacement)

**NOTE:** FM TWO tuners through serial #**3790** were manufactured with #**Q42467J2** main modules. Units with serial #**3791** and above have main module #**Q42499-6**. **These two versions are not interchangeable** due to the differences in interconnecting wire cables.

1. If the main module is to be replaced note the position of de-emphasis switch SW100:  
Open (left pos.) 50us (Europe)  
Closed (right pos.) 75us (USA)  
Place the de-emphasis switch in the required position.
2. Note the color coding of the wire leads soldered to the component board including the shielded cable from the front end module. Using desoldering tools carefully remove wire leads.
3. Remove the four phillips screws (with internal lock-washers) securing the component board. Remove the module.
4. If a replacement module is installed; perform the calibration procedure given in Section 7.5.

#### F. Control Module Removal (Replacement)

**Note:** FM TWO tuners through serial #**3790** were manufactured with #**Q42466J4** control modules which matched #**Q42468J0** power supply modules. Units with serial #**3791** and above have control module #**Q42498-8** and power supply module #**Q42500-1** installed. **The modules of these two versions are not interchangeable.** The correct replacement module must be installed.

**Program socket information:** The program socket with installed diodes determines the FM tuning range and 1st. I.F. frequency of the FM TWO.

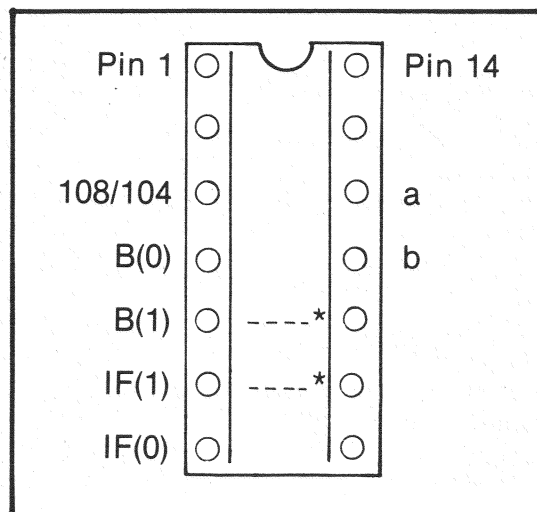


Fig. 7.3 Program Socket Layout

#### Notes:

1. Pins 1, 2, 13 and 14 have no operation.
2. Diode cathode end is to the right.
3. \*\*On #Q42498-8 control modules a&b are jumped on the pc board foil pattern.

| Operation      | Diode In:                                    | FUNCTION              |                 |
|----------------|----------------------------------------------|-----------------------|-----------------|
|                |                                              | Receiving Frequency   | Channel Spacing |
| *U.S.A.        | B(1)                                         | 87.9 to 107.9 MHz     | 200 kHz         |
| Europe         | B(0)                                         | 87.5 to 104/108.0 MHz | 50 kHz          |
| Stop @ 108     | 108/104 plus jump a&b (B0 programming only!) |                       |                 |
| IF 10.650 MHz  | IF(0)                                        | Sets IF to 10.650 MHz |                 |
| IF 10.675 MHz  | IF(0) and IF(1)                              | Sets IF to 10.675 MHz |                 |
| IF 10.7        | None                                         | Sets IF to 10.7 MHz   |                 |
| *IF 10.725 MHz | IF(1)                                        | Sets IF to 10.725 MHz |                 |

\* Indicates U.S.A. set up.

### Procedure

- Note color coding of the wire leads and flat cables soldered to Control module component board including shielded cable from Front End module. Using desoldering tools carefully remove all wire leads and flat cables from component board.  
**Note:** Tuners through serial #3790 had a remote control cable to a remote control connector on the rear panel.
- Tuners with serial #3791 and above: Remove wire lead running from power switch to Main module at the power switch.
- Tuners with serial #3790 and below: Remove twisted leads from power LED board.  
Tuners with serial #3791 and above: Remove wire lead and 300 ohm resistor from power LED board.
- Remove four small phillips head screws securing the switch brackets to the chassis.
- Remove the three phillips screws (with internal lockwashers) securing the component board to the chassis. Remove module.

### G. Memory/Display Board Removal (Replacement)

**Note:** FM TWO tuners through serial #3790 were manufactured with memory board #M52667-2 and display board M42665-6 installed. Tuners with serial #3791 and above were manufactured with a one piece memory/display board #M42843-9 installed. Select the following procedure depending upon unit serviced.

**Caution: Use care when servicing these pc boards. Pushbutton switches or the display may easily be damaged.**

### For Units Through Serial #3790:

On these tuners the memory/scan switches are mounted on two pc board.

- Access to the rear of the memory switch and display pc board can be obtained by:
  - Making a diagram of hardware orientation.
  - Removing the hardware securing both boards:
    - two with nuts and lockwashers.
    - one with double nut and lockwasher.
  - Removing spacing bracket.
- To remove either pc board:
  - Make a wiring diagram of the flat cables and wire leads.
  - Using desoldering tools carefully remove flat cables and wire leads from the control module board and power supply board.

### For Units With Serial #3791 and Above:

On these tuners all memory/scan switches and the display are mounted on one printed circuit board.

- Using desoldering tools remove the six memory board flat cables from the Control module component board.
- Remove the four phillips head screws (with internal lockwashers) securing the memory board. Far right screw does not have lockwasher.
- Carefully work the memory board with flat cables forward to clear the scan switch.
- Remove the wire lead running to the power supply from the memory.
- The components mounted on the memory/display board are now accessible for servicing including the display.

### H. Front End Module Replacement

The Front End module **should not under any circumstances be removed or adjusted** except as described in this manual - See Section 5. Refer all other servicing to the Crown Service Department.

## 7.5 Field Checkout and Alignment Procedures

### A. Crown Test and Check Out Procedures

Crown test and check out procedures reflect our basic design philosophy; we believe that reliability can be engineered into a product. As such, our checkout is designed to expose and correct a problem, before it happens. This testing begins when the unit is still a pile of parts; selection and grading of components is standard. The final test-inspection is the culmination of this vigorous program; but our concern doesn't stop here. Our products are backed by an extensive field service program and backed by a comprehensive warranty.

Because Crown is concerned with standard, repeatable measurements, our specification sheets are produced using standards set by IEEE Std #185-1975 and IHF Std #IHF-T-200, 1975. These standards are published by The Institute of Electrical and Electronic's Engineers Inc.

The following discussion examines each of the test procedures. This is an attempt to help you understand, in layman's terms, what the tests mean.

1. **THD** - The total harmonic distortion is measured at the output of the FM TWO via a Crown custom built harmonic distortion Wave analyzer. At 1000Hz; second, third and fourth harmonic contributions are measured, noted and used in calculating the total harmonic distortion.
2. **IHF Usable Sensitivity** - "Sensitivity" in this usage refers to the relative strength of input signal required to produce a standard signal to noise ratio; in this case, 30dB. With the output of the unit under test referenced to 0dB, the input signal (98.1MHz) strength is the IHF usable sensitivity spec.
3. **30dB Quieting** - This test is devoted to measuring the strength of input signal that will cause the output noise to be quieted by 30dB without simultaneous modulation. Monitoring the output via an ACVM, the input signal strength is adjusted until a 30dB difference, referenced to the amount of output noise, is measured.
4. **50dB Stereo Quieting** - Referencing the output of the FM TWO to 0dB, the strength of the input signal is adjusted until a 50dB output reference to noise ratio is noted. The resulting figure indicates the strength of input signal required to produce an output signal whose signal to noise ratio is 50dB. This figure, stated in dBf, represents the quieting of the tuner during stereo reception.
5. **Signal To Noise** - The signal to noise test reveals, under simulated conditions, the ratio of usable signal to noise measured at the output of

the FM TWO. This test indicates the quality of reception that you can expect with relatively strong input signals.

6. **Hum and Noise** - The procedure for obtaining the hum and noise specification is essentially the same procedure used in obtaining the signal to noise spec. In this procedure, however, the 200Hz high pass filter, normally connected at the output during noise measurements, is removed to allow for the measurement of power supply hum components.
7. **Stereo Separation** - Keeping the right channel information from leaking into the left channel and vice versa is desirable during the reception of a stereo broadcast. The quality of the isolation between channels is revealed in the stereo separation spec. While feeding left or right channel information into the FM TWO at its antenna terminals, the output of the opposite channel is measured at two frequencies to ensure consistency throughout the FM band.
8. **Frequency Response** - The frequency response of all FM tuners is limited due to the nature of FM transmitting equipment. FM TWO's are tested to ensure a deviation of no more than +.5dB from 30Hz to 15KHz.
9. **Capture Ratio** - Occasionally, there will be a situation during which two stations will be transmitting simultaneously at the same frequency. The ability of an FM tuner to discriminate against the weaker of the two signals is measured by its capture ratio. The figure obtained, represents the additional signal strength required of the stronger signal to suppress the weaker one by 30dB. Two r.f. signal generators are used to simulate a situation such as the one described above, thereby permitting the measurement of the tuner's capture ratio.
10. **Alternate Channel Selectivity** - Alternate channels are those channels that lie 400KHz at either side of a desired frequency. The alternate channel selectivity spec. tells how strong an alternate channel must be in order to interfere with the reception of a desired station. Two r.f. generators are used in determining this spec. One represents the desired station, while the other represents the alternate channel.
11. **R.F. IM.** - Several kinds of spurious signals plague FM reception. Most of these spurious signals in the FM TWO are so miniscule that they can be entirely disregarded. Intermodulation distortion or "cross mod." is the most measurable form of spurious response. It occurs whenever two or more undesired signals mix together within the

tuner in such a way that a new frequency is produced. If this internally generated spurious frequency happens to be the same as the tuned frequency, and if the spurious signal has enough strength, interference results. Cross mod. is tested for by intentionally beating two generators' signals together. The required generator signal strength is measured and compared to the IHF usable sensitivity, and noted as a ratio.

12. **Pushbuttons** - This check is to verify the correct operation of all the pushbuttons and displays.

13. **dBf-uV Conversion:** The following equations may be used to convert RF signal levels from dBf to uV and uV to dBf.

**Note:** uV = microvolts

For 300 ohm RF impedance:

$$\text{dBf} = 20 \text{ Log } \left( \frac{\text{uV}}{.55} \right)$$

$$\text{uV} = 10 \left( \frac{\text{dBf}}{20} \right) \times .55$$

For 75 ohm RF impedance:

$$\text{dBf} = 20 \text{ Log } \left( \frac{\text{uV}}{.55} \right) + 6$$

$$\text{uV} = 10 \frac{10 \left( \frac{\text{dBf}}{20} \right) \times .55}{2}$$

## B. Test Equipment Set Up

Fig. 7.2 illustrates the suggested test equipment set up for servicing and aligning the FM TWO. The following procedures will make reference to the equipment in this set up.

## C. Preliminary Check and Adjustments

**Note:** Use chassis ground for the following measurements.

### 1. Notes:

- TC7 and L8 are located in the front end module - the two adjustment openings are located at the front of the module (eighth compartment).
- On tuners with receiving range stop at 104 MHz, reprogram tuner for stop at 108 MHz,

see Subsection 7.4F, Control Module Removal.

With no RF signal in:

- Set tuner at 106.1 MHz. Adjust trimmer capacitor TC7 for 18.6 VDC at the output end of R252 on the control module.
  - Set tuner at 90.1 MHz. Adjust coil L8 for 4.0 to 4.3 volts at R252.
  - These adjustments are interactive. Repeat this step several times to insure correct voltage level at each frequency.
- Feed a 98.1 MHz, 1 mV (millivolt) mono FM signal modulated at 1 kHz into the 75 ohm tuner input. Adjust the 1 kHz audio output level at the output jacks for 0 dB using the two level adjusting controls on the tuner rear panel.
  - Adjusting the first IF frequency for 10.7 MHz:  
NOTE: On tuners programmed for 10.650 MHz or 10.675 MHz IF, program the IF frequency for 10.7 MHz by removing programming diode(s) from the program socket, see Subsection 7.4F, Control Module Removal.
    - Connect an oscilloscope with a 10.7 MHz marker to resistor R120 (47 ohm) on the Main module.
    - Adjust TC200 located on the control module for 10.7 MHz at R120.
    - Reprogram the tuner for selected IF frequency if required.
  - Adjusting quadrature detector U103 on the Main module:
    - Connect a DVM from pin #6 to ground and from pin #10 to ground. Record the voltage levels on these pins.
    - Adjust L102 (next to U103) until voltage at pin #6 equals voltage at pin #10.
  - The FM TWO is now ready for specification check and alignments.

## D. Tuner Specification Check and Alignment

### 1. Mono THD:

- Feed a 98.1 MHz, 1 mV (millivolt) mono FM signal modulated at 1 kHz into the 75 ohm tuner input.
- Adjust the 1 kHz output levels for 0 dB at the audio output.  
**Note:** Always make the 0 dB audio output level adjustment at the audio output jacks using the two level adjusting controls on the tuner rear panel.
- Check THD at each audio output for less than 0.05% distortion.

### 2. IHF Usable Sensitivity:

- Use a 1 kHz notch filter to reduce the output approximately 45 dB.
- Reduce generator signal level until the output equals -30 dB.

- c. Signal generator level should be less than 9.13 dBf (1.6 uV).
  - d. **Record this reading** (in uV) for use later in the RF Intermodulation test.
3. DBQ:
  - a. Switch off signal generator modulation (CW).
  - b. Measure audio output levels at the output jacks. Output levels should be approximately -40 to -50 dB down.
  - c. Record this reading for use later in the RF Intermodulation test.
4. 30 dB Quieting:
  - a. Lower the RF signal generator signal level for a -30 dB reading at the output jacks.
  - b. RF signal generator level should be less than 0.5 uV.
  - c. Remove the 1 kHz notch filter.
5. Signal-To-Noise Mono:
  - a. Set RF generator to 1 mV, mono FM modulated at 1 kHz (98.1 MHz). Adjust the 1 kHz audio level for 0 dB using the two level adjusting controls on the tuner rear.
  - b. Insure that the 200 Hz to 15 kHz bandpass filter is in the audio output.
  - c. Turn off RF generator modulation (CW) and take reading at output. The signal to noise ration should be 75 dB or greater.
6. Hum-and-Noise Mono:
 

**Note:** Test procedure is the same as Signal-To-Noise Mono, Step 5.

  - a. Remove the 200 Hz filter from the output (Bandpass equals 0 Hz to 15 kHz).
  - b. Insure the 1 kHz modulation is off (CW) and take reading at output.
  - c. The hum-to-noise ratio should be 70 dB or greater.
  - d. Insert the 200 Hz to 15 kHz bandpass filter is in the audio output.
7. Stereo THD:
  - a. Set RF signal generator to 1 mV stereo signal modulated at 1 kHz (98.1 MHz).
  - b. Connect a THD analyzer to the audio output line.
  - c. Adjust R165 (5 k ohm composit reference frequency adjustment pot) for maximum output signal at output jacks.
  - d. Adjust the 1 kHz audio output level for 0 dB at the output jacks using the two level adjusting controls on the tuner rear.
  - e. Check the THD reading. THD should be less than 0.05% distortion.
8. 50 dB Stereo Quieting:
  - a. With output referenced at 0 dB, turn off stereo modulation.
  - b. Decrease RF signal generator output level until a -50 dB reading is obtained.
  - c. RF signal generator level should be less than 36 dBf (35 uV).
9. Signal-to-Noise Stereo:
  - a. Set RF generator to 1 mV, stereo modulated at 1 kHz (98.1 MHz).
  - b. Insure that the 200 Hz to 15 kHz bandpass filter is in the audio output.
  - c. Adjust the 1 kHz stereo audio output levels for 0 dB at the audio output jacks using the two level adjusting controls on the tuner rear.
  - d. Turn off stereo modulation and take a signal-to-noise reading. Signal-to-noise should be greater than 70 dB for both channels.
  - e. Remove the 200 Hz to 15 kHz bandpass filter from the audio output.
  - f. Adjust R173 (19 kHz null pot located on the main module) for lowest audio output.
  - g. Install the 200 Hz to 15 kHz bandpass filter in the audio output.
10. Stereo Separation:
  - a. Modulate the RF signal generator left channel only at 1 kHz. Adjust the left channel tuner audio output for 0 dB at the left channel output jack.
  - b. Modulate the RF signal generator right channel only at 1 kHz. Adjust the right channel tuner audio output for 0 dB at the right channel output jack.
  - c. With the right channel modulated, take a left channel audio output reading.
  - d. With the left channel modulated, take a right channel audio output reading.  
The 1 kHz stereo separation in the above steps should be 60 dB or greater.
  - e. Adjust cross-talk level pots R180 and R181 located on the Main module for the greatest separation between channels.
  - f. Modulate the RF signal generator at 10 kHz and repeat this procedure. The 10 kHz stereo separation should be 50 dB or greater.
11. Frequency Response:
  - a. Remove the 200 Hz to 15 kHz bandpass filter from the audio output.
  - b. Set RF signal generator to 1 mV stereo signal modulated at 1 kHz (98.1 MHz).
  - c. Adjust the 1 kHz stereo audio output levels for 0 dB at the output jacks.
  - d. Modulate the RF signal generator with 30 Hz, 10 kHz and 15 kHz stereo modulation. The frequency response from 30 Hz to 15 kHz should be plus or minus 0.5 dB.
  - e. Reinstall the 200 Hz to 15 kHz bandpass filter on the audio output.
12. Capture Ratio:
 

Two RF signal generators and an impedance matching/summation box are required for this procedure.

  - a. Set RF generator #1 to 1 mV, mono signal modulated at 1 kHz (98.1 MHz). Adjust the

- 1 kHz audio output levels for 0 dB using the two level adjusting controls on the tuner rear.
- b. Set RF generator #2, with unmodulated signal (CW) at 98.1 MHz.
- c. Turn the RF level of signal generator #2 up until the output of tuner reads -1 dB.
- d. Note RF level of signal generator #2 at -1 dB output level.
- e. Increase the RF level of signal generator #2 until output of tuner reads -30 dB.
- f. Note RF level of signal generator #2 at -30 dB output level.
- g. Capture ratio calculation:

$$\text{Capture Ratio} = 10 \text{ Log } \frac{\text{Reading in Step "c"}}{\text{Reading in Step "f"}}$$

Note: Ignore minus sign.

Capture Ratio should be less than 1.5 dB.

### 13. Alternate Channel Selectivity:

- a. Set the RF output level of signal generator #2 to 10 uV at 98.1 MHz (CW).
- b. Set the RF frequency of signal generator #1 to 97.7 MHz with 1 kHz modulation.
- c. With the tuner at 98.1 MHz, increase the RF level of signal generator #1 until the audio output level reaches -30 dB.  
Note RF level of signal generator #1.
- d. Set the RF frequency of signal generator #1 to 98.5 MHz with 1 kHz modulation.
- e. With the tuner at 98.1 MHz, increase the RF level of signal generator #1 until the audio output level reaches -30 dB.  
Note RF level of signal generator #1.
- f. Alternate channel selectivity calculation:

$$\text{ACS} = \frac{A + B}{2}$$

A = Log (Reading in Step "c" x100) x20  
B = Log (Reading in Step "e" x100) x20  
Alternate channel selectivity should be greater than 75 dB.

### 14. RF Intermodulation:

- a. Set RF generator #1 to 98.9 MHz, unmodulated (CW) with 10 mV output.
- b. Set RF generator #2 to 98.1 MHz, unmodulated (CW) with 10 mV output.
- c. Tune the tuner to 97.3 MHz.
- d. Turn down the RF levels of both generators equally until the output signal from the tuner equals the dBQ reading obtained in Step 3-c.  
When this dBQ level is reached ensure that both RF generator uV output levels are equal.
- e. Note this mV RF level reading (RFI).

### f. RFIM Calculation:

$$\text{RFIM} = 20 \text{ Log } \frac{\text{RF1}}{\text{RF2}}$$

RF2 = mV reading Step 2-d  
IHF Usable Sensitivity

RF Intermodulation should be 65 dB or greater.

### 15. Push Buttons:

- a. Disconnect RF generator #2.
- b. Set RF signal generator #1 to 98.1 MHz, 1 mV stereo signal modulated at 1 kHz.
- c. Set tuner to 98.1 MHz.
- d. Adjust the 1 kHz audio output level for 0 dB at the tuner output jacks.
- e. Ensure that the STEREO light is illuminated on the display.
- f. Press in the NORMAL de-emphasis button:
  - Tuner output should decrease 0.8 dB.
  - Release NORMAL button.
- g. Press in the FILTER button:
  - Tuner output should decrease approximately 6 dB.
  - Release FILTER button.
- h. Press in the STEREO/MONO button:
  - Stereo signal at output should be mono.
  - Stereo indicator should turn off.
  - Release STEREO/MONO button.
- i. Press in the DIM/BRIGHT button:
  - Display and illuminated memory LEDs should dim.
  - Release DIM/BRIGHT button.

### 16. Stereo Indicator

Switch RF generator signal from stereo to mono signal. The tuner stereo indicator lamp should go off.

### 17. Mute Check and Adjustment:

- a. Press in the MUTE button.
- b. Set RF generator to 15 uV.
- c. Adjust R119 (mute level adjustment on Main module) to mute any mono signal under 15 uV.

### 18. Signal Meter Level Adjustment:

- a. Set RF generator to 98.1 MHz, 1 mV mono FM signal modulated at 1 kHz.
- b. Set the tuner to 98.1 MHz.
- c. Adjust pot R117 (meter level adjustment on Main module) so that signal level just lights all five signal level displays:
  - Fifth signal level should go off at approximately 25 uV.
  - Last signal level should go off at approximately 1 uV.

### 19. Tune/Scan Functions:

Insure the scan up-down buttons function properly by scanning through the tuning range of the tuner.

## 20. Pre Set Buttons:

- a. Program stations into tuner memory using the six Pre Set buttons.
- b. Insure that the tuner programs and recalls all stations properly.
- c. Insure pushbuttons do not bind or push in excessively hard.
- d. Insure that the proper LED turns on with respective memory button.

## 7.6 Troubleshooting Guide

### A. No frequency display

- defective display
- +5V supply to control module defective
- broken filament wire to display module
- U203 defective
- F300 defective

### B. Display OK but no output

- U203 defective
- U108 defective
- +15V from power supply not present
- U103 defective
- U107 defective
- U105 defective
- U106 defective
- U104 defective

### C. No signal reception (just hiss)

- defective front end module
- U203 defective
- U204 defective
- +15V to front end module defective
- U100 defective
- U101 defective
- U102 defective
- Q100 defective
- bad antenna
- broken or shorted coax at antenna connector and/or from front end module to main module

### D. Up/Down & Memory buttons not operable

- switch and switch covers shorted to ground
- front panel alignment grounding switches
- switch defective
- U203 defective
- U201 defective
- U202 defective
- ribbon cable to switch board open or shorted

### E. Erratic Display

- U203 defective
- Y200 defective
- TC200 defective

- defective display
- pinched or shorted ribbon cables to memory and/or display modules
- Q205 defective
- Q208 defective

### F. Buzz in output

- C303 defective (loose)
- C307 defective
- U300 defective
- U301 defective
- U302 defective
- low line voltage

### G. Dead, no output, no power indicator

- F300 defective
- power transformer defective
- no line voltage
- K300 defective
- +5V from supply low or zero

### H. No stereo indicator

- U105 defective
- U104 defective
- Q106 defective
- L102 misaligned
- R165 misaligned
- defective display
- mono/stereo switch depressed

### I. Memory loss

- C205 defective
- D214 defective
- unplugged from AC line for more than several days

### J. Defective signal meter

- display defective
- weak signals to meter circuit
- R117 improperly adjusted
- defective D112, D113, D114

### K. No output right channel; no output left channel

- FL102 defective
- FL103 defective
- output control shorted to chassis
- open or shorted output control
- open or shorted connecting cables
- U106 defective
- U105 defective
- U108 defective

### L. Muting or scanning problems

- L102 misaligned
- mute switch defective
- U108 defective
- U104 defective
- U203 defective

## 7.7 Detailed Circuit Theory

The following explanation refers to the composite schematic diagram and the block diagram in Fig. 7.4.

The FM TWO requires a 75 ohm (unbalanced) input FM signal source to the rear panel connector. A coax cable couples the signal from the input connector to the Front End module.

### A. Front End Module

The Front End module of the FM TWO is a precision factory aligned unit. No field service should be performed on this unit with the exception of the TC7/L8 adjustments as outlined in Section 7.5, Subsection C. Return all FM TWO units with defective Front End modules to the factory for service.

The Front End module consists of three RF amplifiers, mixer, tuned buffer, local oscillator and a final buffer. The tuned buffer aids in preventing two or more signals from intermixing with each other and appearing at the wrong place on the FM band (commonly referred to as RF Intermodulation). The local oscillator not only feeds the tuned buffer/mixer stages but also feeds a Prescaler and LSI controller located on the Control module. The LSI controller generates a dc voltage which is fed to the front end module for tuning double varicaps. The varicaps are used in all tuned RF circuits in the Front End module. This provides high Q, better selectivity and less noise. There is no AGC control required.

The output of the Front End module mixer is a 10.7 MHz IF which is tuned by transformer T1. The output of T1 is fed through a coax cable to buffer Q100 on the Main module.

### B. Main Module

The Main module contains a digital IF amplifier system, dual detector stereo demultiplexer, stereo audio amplifiers and switching control.

The first IF is made up of an input buffer and four IF amplifiers with ceramic 10.7 MHz IF filters. The input impedance matching buffer consists of FETs Q100/Q101. L100 is a RF blocking inductor. Q101 amplifies and drives the first IF ceramic filter. The ceramic filters are the phase linear-type which aid in reducing total harmonic distortion. The following three IF stages (U100-U102) use uA703 operational amplifiers.

After the final ceramic filter in the first IF section, the 10.7 MHz IF signal reaches a four stages multifunction circuit U103. The main function of U103 is to act as a limiter/I.F. amplifier for the 10.7 MHz signal which will be mixed with a second local oscillator which follows. U103 also functions as a level detector and a deviation

detector for the mute circuitry. The fourth section is a quadrature detector which is not used.

The level detector output (Pin #13) feeds a level signal to adjustment trimpot R117. The center tap of R117 is fed through D112/D113 to a 5-step level detector U200 on the Control module, see Paragraph "B".

The deviation detector output (Pin #12) of U103 feeds the mute detector circuit consisting of quad comparator U104, the MUTE switch and the station detector/mute portion of the PPL controller U203 located on the Main module. The deviation level line drives U104B and U104C, and feeds the MUTE switch SW204.

U104C switches off stereo lamp driver Q106 between stations by taking the emitter low. This function is independent of the MUTE switch and the stereo signal control of Q106.

The deviation level from U103 is amplified by U104B and fed to the PPL controller U203 Pin #7 (station detector input) on the Control module, see Paragraph "C". The DC level on this line will be low between stations and high when on station.

The input mute control from U203 is applied directly to mute line driver U104A. This line is high between stations providing muting. Capacitor C149 provides an input time delay factor to U104B. C149 holds the input from U203 high through R156 compensating for fast controller chips.

The mute line controls bilateral switch packages U108A and U108B.

U104D provides a "turn-on" delay keeping the mute line low during this period. Capacitor C160 provides this delay keeping the voltage drop across R169 until charged. This eliminates any turn on popping from the tuner.

The mute line is also fed through power switch SW206 to minimize power off popping. On later units the line is returned through resistor R256 to either 15 VDC with power on, or ground with power off. On earlier units the mute line was directly grounded through the switch when power was turned off.

The input signal level necessary to overcome the mute circuit is set by U103 deviation adjustment R119. This adjustment is set for a 10-15 uV RF input signal level.

The mute feature, activated by front panel switch SW204, eliminates weak or fading signals and between station noise from the audio output. When the MUTE switch is pressed in muting is active. When the MUTE switch is in the normal or off position, between stations muting is defeated.

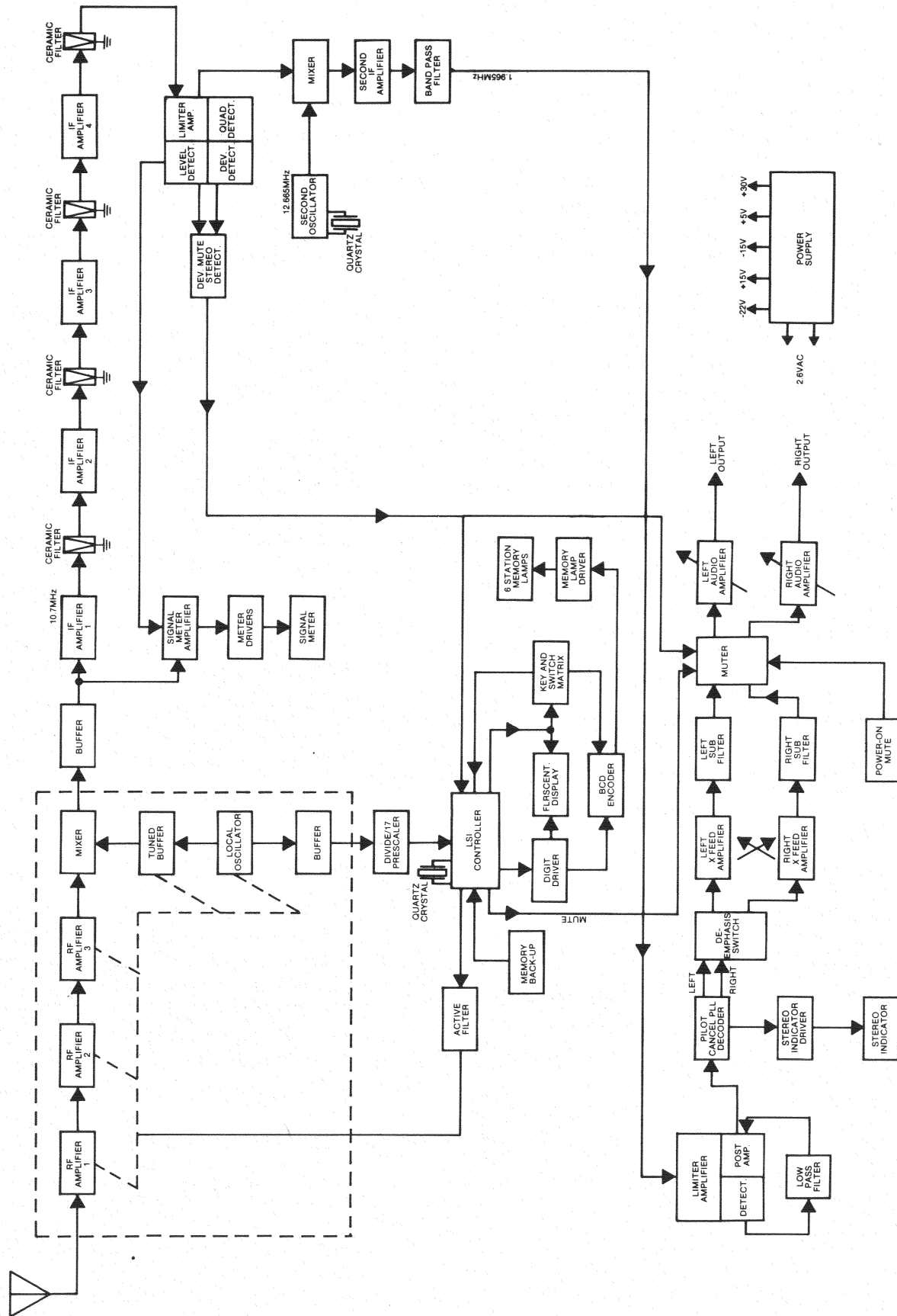


Fig. 7.4 Block Diagram

The limiter output of U103 drives second mixer Q102 through C122. A second local oscillator, crystal controlled Q104 feeds a 12.665 MHz signal to Q102. Q102 drives second IF amplifier Q103 and band-pass filter FL100. FL100 is an accurate filter which passes only the resultant 1.965 MHz signal from Q103. This second IF signal is applied to detector U107.

U107 is a pulse count digital type detector with stable characteristics, good capture ratio and AM suppression. U107 consists of a limiter amplifier, main detector and a post amplifier stage. The main detector output Pin #13 drives an external transistor amplifier Q105. Q105 amplifies the composit signal and drives an internal buffer inverter. The inverter output Pin #8 feeds low pass filter FL101. FL101 removes any 1.965 MHz signal from the composit signal. The composit signal is then fed through the internal post amplifier before it is sent to the stereo demodulator U105.

U105 is a Phase Lock Loop (PLL) MPX decoder which decodes the composit signal into left and right stereo channels. U105 also contains a stereo lamp driver circuit.

The composit input signal to Pin #2 is amplified and fed out Pin #3. The signal is coupled through C155 and fed into Pin #12 where the signal is split. One part is fed to the PLL circuit and the other to the stereo lamp driver circuit.

The 19 kHz pilot signal input to an internal stereo lamp driver is detected synchronously by the 19 kHz signal with the same phase as a pilot signal generated by the PPL. The detected signal is coupled through C153 (Pins #10 to #11) as a DC level signal proportional to the pilot signal. The DC signal is then amplified by a DC amplifier and output as a negative voltage through Pin #8 to the stereo/mono switch SW205. With SW205 switched on the negative DC signal turns signal driver Q106 on illuminating the lamp. If SW205 is open Q106 is turned off. The voltage level on the collector of Q106 controls the lamp. (-22 VDC turns lamp off; +5 VDC turns lamp on.)

Q106 is also emitter controlled by mute circuit comparator U104C.

The PPL circuit generates 76 kHz signal through the external components connected to Pin #15/#16. VCO adjust R165 sets the basic frequency for this signal. The 76 kHz signal is divided down to a 19 kHz signal. The 19 kHz signal, which is 90 degrees advanced to the pilot signal input, is input to a gain control amplifier. The output (Pin #9) of the gain control amplifier is a square wave which must be properly adjusted by R173. This signal is then fed through C167 to a pilot cancel circuit which selects either a stereo or mono audio output at Pins #5/#6. A portion of the

stereo output is mixed and fed back to Pin #1 for volume stabilization.

Some programs may be transmitted with Dolby encoded noise reduction information which requires de-emphasizing. A noise reduction de-emphasis circuit is placed after the demodulator stereo output (Pins #5/#6) for this purpose. A front panel 25us/NORMAL switch (SW100) selects the operation of this circuit. Depressing the switch selects de-emphasis. De-emphasis may be selected for either 50 us (USA) or 75us (Europe) by internal switch SW100.

The stereo audio signals are then fed to cross feed amplifiers of quad operational amplifier U106. These op amps help to separate the stereo information eliminating crosstalk problems. Identical signals in each channel are eliminated by impressing a portion of opposite channel signal on the reference input of the opposite channel op amp. Crosstalk signal level pots R180/R181 are designed to be adjusted for the greatest separation between channels.

From the cross-feed amplifiers the stereo signals are fed through low-pass filters to eliminate any unwanted frequencies. Signal levels through these filters are down -10 dB at 19 kHz and -45 dB at 38 kHz.

A front panel switch (SW203) controlled noise filter follows the low pass filters. This filter is designed to minimize the noise associated with weak FM stereo signals. With this switch on, the higher frequencies of both channels are combined through C174 to eliminate or cancel most distortion.

The stereo signals are next fed the mute control circuit U108. U108 is a quad bilateral switch with two sections used. The control inputs of U8 (Pins #5/#6) is controlled by the mute line. When the mute line is high the Q108 pair is switched on. If the mute line is taken low the Q108 pair is opened shutting the stereo audio output off. The mute control operation is described above under the description for deviation detector U103.

The final output amplifiers are U106B and U106C, the second pair of quad op amp package U106. The FM TWO rear panel LEVEL controls form part of the gain feedback network for these amplifiers. The level controls are used to obtain uniform output levels to match other components in the sound system.

On the two later versions of the Main module, transistor Q107 is used to regulate the Vcc voltage to U105 and U107.

### C. Control Module

The heart of the Control module is U203, a LSI digital tuning system controller and Phase Locked Loop (PLL) frequency synthesizer. U203 with Prescaler U204 provides full electronic control of the vari-cap tuned Front End module.

U203 provides:

- Power on clear
- Reference 4.5 MHz clock generator
- Indicator panel drivers
- Control of front end vari-caps
- Automatic up/down search (SEEK)
- Manual up/down search
- Preset station memory
- Last station memory
- Programmable IF offset

A CE (Chip Enable) input is designed to control the stand-mode of U203 (Pin #3). The Pin is tied to +5 VDC enabling the chip with power on.

Prescaler U204 receives the Front End module local oscillator on Pin #2. This RF signal is amplified and fed to a divider which is Prescaled selected (Pin #6) for divide by 16 or 17 operation from U203, Pin #4. This signal is buffered and coupled through C200 to the FM input, Pin #26 of U203.

Pin #2 of U203 is a three-state analog voltage output (E02) designed to tune the Front End module vari-caps. This level is controlled by the internal scan-select circuits of U203 to establish the receiving frequency of the tuner.

Transistors Q209 is designed to set the analog voltage to the correct values required to tune the vari-caps.

The Pin #7 SD input to U203 control the station searching operation. When this input is high the presence of a station is indicated and the operation is terminated. For a detailed description of this input signal see the mute circuit description for U104B.

The Pin #8 MUTE output of U203 mutes the tuner during station changes. This line is high with a low signal on the SD Pin #7 input. This signal is applied to mute amplifiers U104A and U104C on the Main module, see Paragraph "B".

U203 Pins #9 through #13 are outputs which enable the five digital displays of the Display module through driver transistors Q210 through Q214. The display segments for each display are turned on by the "a" to "g" output segment drivers Pins #15 through #21. segment driver Pins #15 to #17 also output the memory LED driver signals. Diodes D208 - D210 isolate U201 from the digital display. The enable outputs on Pins #9/#13 and the segment drivers are also used for the pushbutton switch frequency and IF 1 selected control. U203 Pins #22 through #25 are inputs from a seven by four input switching matrix established by the above described input/outputs. Depressing one of the scan/tune switches, one of the memory switches or setting the DIM or SCANLOCK switch completes a matrix return. Fig. 7.5 illustrates the U203 matrix network.

SCAN/TUNE Switches and SCAN/LOCK Pushbutton:  
SCAN/TUNE - UP with SCAN/LOCK Pushbutton Out  
Holding continuous scans upward.

Pressing and releasing scans one channel upward.  
SCAN/TUNE - DOWN with SCAN/LOCK Pushbutton Out  
Holding continuous scans downward.

Pressing and releasing scans one channel downward.  
SCAN/TIME - UP with SCAN/LOCK Pushbutton in  
Pressing scans upward until a station is found.

SCAN/TIME - DOWN with SCAN/LOCK Pushbutton in  
Pressing scans downward until a station is found.

|                      |          |          |        |          |        |        |        |
|----------------------|----------|----------|--------|----------|--------|--------|--------|
| SCAN<br>TUNE<br>DOWN | PRESET 4 | X        | DIODE  | 108 MHZ  | X      | B0     | PIN 25 |
| SCAN<br>TUNE<br>UP   | PRESET 3 | X        | DIODE  | DIM      | X      | B1     | PIN 24 |
| MEMORY               | PRESET 2 | PRESET 6 | DIODE  | SCAN/LOC | X      | IF 1   | PIN 23 |
| X                    | PRESET 1 | PRESET 5 | DIODE  | FM       | B2     | IF 0   | PIN 22 |
| PIN 21               | PIN 20   | PIN 19   | PIN 18 | PIN 17   | PIN 16 | PIN 15 |        |

Fig. 7.5 U203 Matrix Network

#### MEMORY Switch:

Six stations frequencies may be preset into tuner memory. Tuning data is stored into U203 RAM by pressing the MEMORY key then desired PRESET key within 5 seconds. Any stored station frequency will be cancelled and replaced during this time with the new frequency. The MEMORY key has an amber LED and the PRESET keys have green LEDs. The appropriate LED will be illuminated when that switch is active. Once a memory switch is Preset that frequency will be tuned when that switch is pressed.

The tuning ranges and IF frequency selections are diode selected using program socket D201. The FM TWO is manufactured with IF1 (10.725 MHz) and B1 (87.9 to 107.9 MHz).

| B0  | B1  | Frequency         |
|-----|-----|-------------------|
| Off | Off | 76.1 to 89.9 MHz  |
| On  | Off | 87.5 to 108.0 MHz |
| Off | On  | 87.9 to 107.9 MHz |

| IF0 | IF1 | IF Frequency |
|-----|-----|--------------|
| On  | Off | 10.650 MHz   |
| On  | On  | 10.675 MHz   |
| Off | Off | 10.700 MHz   |
| Off | On  | 10.725 MHz   |

| 108/104 | Frequency          |
|---------|--------------------|
| On      | 87.5 to 108.00 MHz |
| Off     | 87.5 to 104.00 MHz |

On = Diode in location

Off = Open location

#### DIM Switch SW200:

This switch selects display brightness.

On - brightness is reduced.

Off - brightness is normal.

A power hold-up circuit is provided for the +5 VDC line which maintains U203 station selection memory. This circuit consists of capacitor C205 and diode D214. D214 isolates the U203 +5 VDC line from normal 5 VDC line. C205 will maintain charge for approximately five days with AC power to the tuner off.

**Note:** Two 5 VDC line versions will be seen. An earlier version VDC line at the junctions of D214 and D215. The later version ties the two lines together through power switch SW206. When the POWER switch is turned off 5 VDC is removed from the normal 5 VDC line but remains supplied to U203.

The memory displays LED400 - LED406 are driven from line decoder U202. Only one LED is illuminated at a time by U202 which is driven by a BCD input from parallel shift register U201. Only three input lines are

active with Pin #12 MSB input grounded low. The high side of the LEDs is returned through R400 to the DIM SW200. Turning the DIM switch on places resistor R216 in the 5 VDC line driving the LEDs.

Switching transistors Q206 and Q207 drive the amber memory LED. These transistors are controlled from display driver output Pin #9 and mode switch matrix output Pin #20 (through D217) of controller U203.

Transistors Q208 provides the blanking drive for the first display digit. This forces the first display digit to always be "1". Q208 is driven from display driver Q210 and enabled from controller U203.

Display driver Q208 is driven from display driver Q210 and is enabled by a mode switch Pin #18 of controller U203.

Shift register U201 buffers and clocks the three data lines from the U203 display enable lines. Diodes D208 - D210 isolate U201 from the display. U201 is clocked (Pin #6) by display driver output Pin #13 of controller U203. The timing on this Pin latches the three input lines into shift register U201. Q205 buffers the clock signal and drives the clock input.

U200 is an analog signal level detector which supplies a 5-step digital output to the display 5-segment LED signal strength indicator. The five outputs of U200 drive the signal display LEDs directly.

Two versions of this circuit will be seen TL489CP or BA656.

The TL489 consists of five comparators and a reference network to detect the level of the analog input at Pin #8. The first open collector output driver Pin #2 is switched low at an input voltage of 200 mV. After each 200 mV input step the next output is switched low. The five open collector outputs are fed to driver transistors Q200 through Q204 which drive the signal display LEDs.

The BA656 consists of five 200 mV-step comparators and bar-type LED direct drivers. The input signal at Pin #8 is applied to all internal comparators. The output of each comparator will go high (from -22 VDC) in 200 mV input steps. The output resistor divider networks are selected to illuminate the signal bar LEDs in the 200 mV steps.

The POWER switch SW206 has two wiring versions: An earlier version is wired to switch 5 VDC to the Main module with the switch on. When the switch is off 5 VDC is removed and Main module mute line is grounded.

The later version is wired to switch 15 VDC and 5 VDC to the Control module normal 5 VDC line with the switch on. When the switch is off the 15 VDC line is grounded through R256 and the 5 VDC normal line is opened.

#### D. Power Supply Module

The FM TWO has two Power Supply module versions. Each module version is designed to a matching Control module.

Earlier version Q42468J0

Later version Q42500-1.

The FM TWO Power Supply is designed to plug into an "unswitched" AC Power connector of the associated audio stereo preamplifier. With AC Power continuously supplied the Power Supply module will supply DC voltages as described in the following paragraphs.

If the FM TWO is plugged into a switched AC outlet, no DC voltages will be supplied when the preamplifier is turned off. Under this condition the tuner station memory may only be maintained for five days.

The Power transformer primary may be wired for either 110 VAC or 220 VAC. The Power Supply is protected by fuse F300.

The Power Supply module also has a secondary winding which supplies 6.3 VAC to the display module filament Pins for display illumination.

**Power Supply module Q42468J0:**

In this Power Supply version relay K300 controls all transformer secondary voltages except the +5 VDC supply. The +5 VDC supply is continuous applied to the Control module 5 VDC line. If AC power is supplied, this maintains tuner station memory and picks up relay K300 when the tuner power switch SW202 is turned on.

The Power Supply employs IC voltage regulators for +15, -15 and +5 VDC. The 30 VDC supply is regulated by zener diode D306.

**Power Supply Module Q42500-1:**

In this Power Supply version all supplies operate continuous with AC power supplied. The Power Supply employs IC voltage regulators for +15, -15 and +5 VDC. The 30 VDC supply is regulated by power transistor Q300 and zener diode D306.

## 7.8 Voltage Conversion

Often Crown products are purchased in one country and later moved to another requiring an AC mains conversion. For this reason the following chart-explanation as well as a world-wide voltage map is provided.

The FM TWO power supply may be connected for any of four voltages. Converting from one to another can be accomplished with a soldering iron and a pair of wire cutters.

1. Remove the FM TWO top cover (see Section 7.5A).
2. With the top cover off locate the AC power terminal strip near the power transformer.
3. Make the appropriate change in jumpers for the required operating voltage, see Fig. 7.6.
4. Install the correct fuse in the unit (see Section 7.5B).
5. Change the AC line cord tag to read the correct voltage.

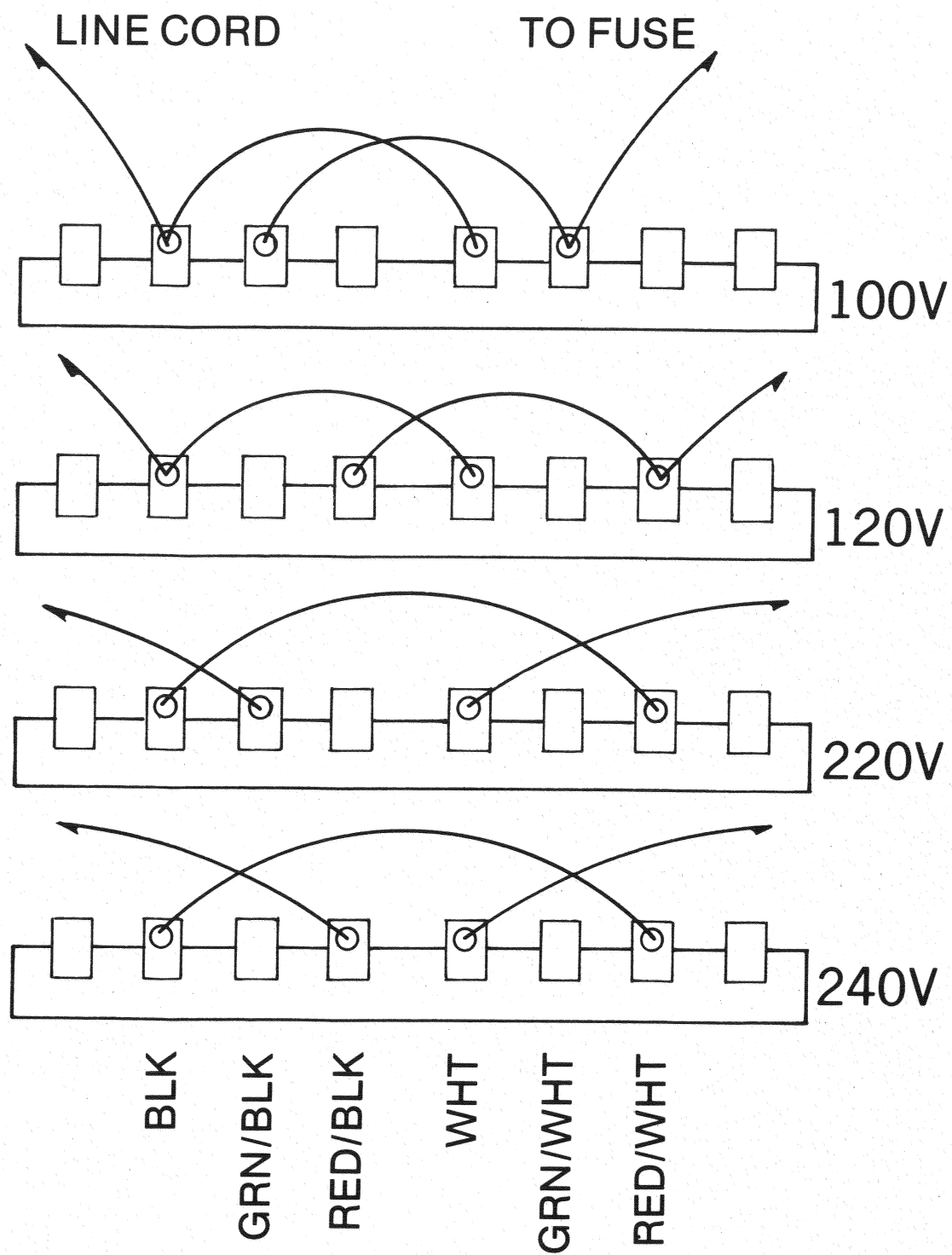


Fig. 7.6 Voltage Conversion Chart

