

INSTRUCTION MANUAL FC-102

*This Manual Provided
Courtesy of Greg White, VA3VFO
va3vfo@rac.ca*

YAESU MUSEN CO., LTD.

C.P.O. BOX 1500
TOKYO, JAPAN

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FC-102

HEAVY DUTY ANTENNA TUNER



GENERAL DESCRIPTION

The FC-102 is a newly designed antenna tuner ideally suited for use with the FT-102 transceiver. With a power handling capability of 1.2 kW, the band-switched L-C pi-network will match a wide variety of antennas (including a single wire) to your transceiver or linear amplifier on all HF amateur bands. New design features include an in-line wattmeter with three ranges (20, 200 and 1200 watts full scale), and a "peak hold" system that enables the operator to observe peak power with ease, as well as the common rms indication.

A separate SWR meter is also built in for antenna tuning indication without the need to switch meter functions. The FC-102 includes internal relays to provide low-loss push button selection of two different antennas (and two transmitters), while the optional FAS-1-4R Remote Antenna Selector may be mounted either inside the FC-102 or right at the antennas, to allow selection of four additional antennas. When remotely installed, the FAS-1-4R is connected by a control line to the FC-102, eliminating the need for costly multiple feedlines.

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SPECIFICATIONS

Frequency Range:

Band	Operating Range
1.8L	1.8–2.0 MHz
1.8H	1.9–2.4 MHz
3.5	3.5–4.0 MHz
7	7.0–7.5 MHz
10	10.0–10.5 MHz
14	14.0–14.5 MHz
18	18.0–18.5 MHz
21	21.0–21.5 MHz
24.5	24.5–25.0 MHz
28	28.0–30.0 MHz
THRU	any HF frequency

Maximum Power:

1.2 kW at 50 ohms

Power Meter Ranges:

20 W, 200 W, 1200 W full scale

SWR Matching Range:

1:1–5:1

Insertion Loss:

less than 0.5 dB

Dimensions (WHD):

240 x 129 x 309 mm

Input Impedance:

50 ohms

Weight:

5.0 kg.

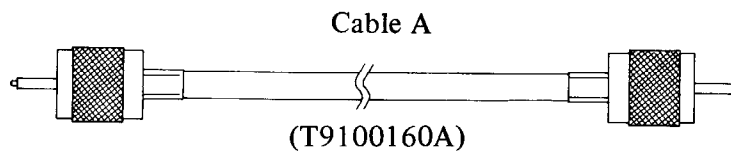
Antenna Impedance Matching Range:

10–250 ohms (3.5–28 MHz)

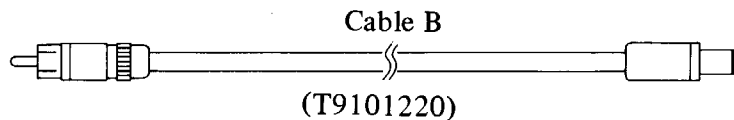
16–150 ohms (1.8 MHz)

ACCESSORIES

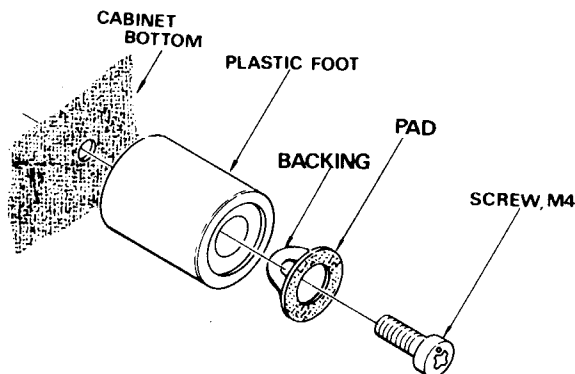
Connection Cable A



Connection Cable B

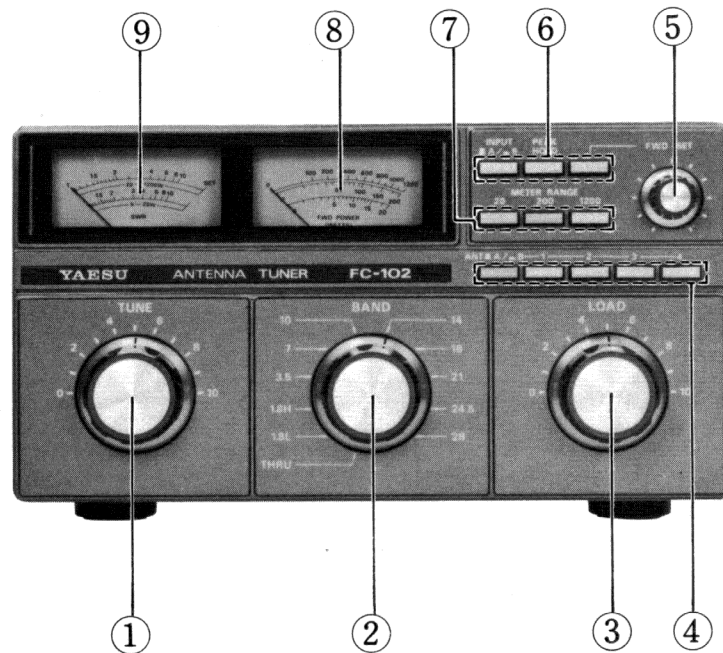


Foot 30A (R3054620)



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va3vfo@rac.ca*

FRONT PANEL CONTROLS AND SWITCHES



(1) TUNE

This control matches the impedance of the FC-102 and antenna system to that of the transmitter or linear amplifier. Its setting is affected by the BAND selector, LOAD control and antenna in use.

(2) BAND

This selector allows the amount of inductance that the FC-102 adds to the antenna system to be adjusted. Selector positions are marked with the band of operation, except for the THRU position, which allows bypassing of the tuner circuit (Power Meter and SWR Function are not disabled).

(3) LOAD

This control adjusts the capacitance of the FC-102 to match the antenna in use to the inductance selected by the BAND selector and the capacitance selected by the TUNE control. As the TUNE and LOAD settings are interdependent, both must be adjusted for minimum SWR.

(4) ANT (Push Buttons)

The ANT A/B button selects between the A and B output terminals on the back of the FC-102, for selection of two antennas. When the optional FAS-1-4R Antenna Selector Unit is in use, buttons 1 through 4 select between the four output terminals on the FAS-1-4R.

(5) FWD SET knob

This knob is used to adjust the SWR meter indication for full scale deflection before measuring the reflected power (SWR).

(6) Push Button Switches

INPUT A/B

This switch selects between the two input terminals on the rear panel.

PEAK HOLD

When this switch is depressed the FWD POWER meter will hold at peak indication for about one second. When this switch is in the out(off) position the FWD POWER meter will indicate instantaneous peak or RMS power, according to the setting of the METER switch on the rear panel.

FWD SET

Before measuring SWR, this switch is depressed and then the FWD SET knob is adjusted to obtain full scale indication on the SWR meter while transmitting. In the out (off) position, the SWR meter then indicates SWR.

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(7) METER RANGE Push Buttons

These three switches select the full scale range of the FWD POWER meter.

(8) FWD POWER Meter

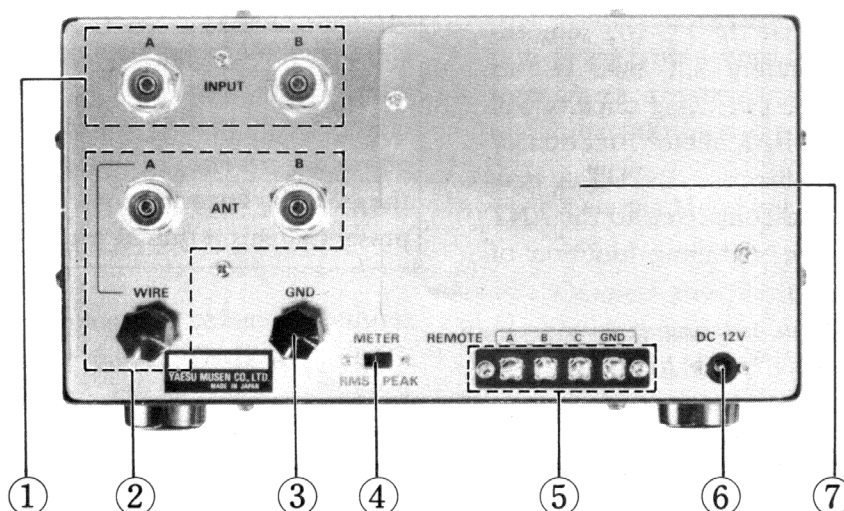
This meter indicates forward RMS power or peak power according to the setting of the METER switch on the rear panel. The three meter scales correspond to the three full scale ranges selected by the METER RANGE buttons.

(9) SWR Meter

This meter indicates reflected power for SWR measurement during transmission and tuning of the FC-102. The FWD SET button must be pressed and the FWD SET control adjusted for full scale deflection before SWR is measured. SWRs for power levels of 5–20 watts are indicated on the inner scale, and SWRs for power levels of 20–1200 watts are indicated on the outer scale.

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REAR PANEL CONNECTORS



(1) INPUT A and B

These coaxial jacks are for connection of the transmitter and/or linear amplifier. One or both of these may be used, in which case the INPUT A/B switch on the front panel is used to select which input jack will be connected to the selected antenna. Care must be used to avoid applying power to the input that is not selected by the INPUT A/B switch.

(2) ANTENNA A, B and WIRE

The A and B coaxial jacks are for connection of antennas, which can then be selected for operation by the ANT A/B switch on the front panel. The A jack is also connected to the WIRE terminal, so if a long wire antenna is connected to the WIRE terminal the A coaxial jack must not be used. The ANT A/B switch will then select the wire antenna when in the A (out) position.

(3) GND

This terminal should always be connected to a good earth ground along with the transmitter and linear amplifier. When a long wire antenna includes parallel feedline this terminal should also be connected to one side of the feedline (as well as to earth ground).

(4) METER Switch

For SSB operation, this switch is used to select either RMS or peak (PEP) indication on the FWD

POWER meter on the front panel. In either case, the PEAK HOLD switch on the front panel will cause the meter to hold at its point of maximum deflection.

(5) REMOTE Terminal Strip

Terminals A, B and C are used to provide switching control signals for the optional FAS-1-4R Antenna Selector Unit, according to the setting of the ANT selector buttons on the front panel. When the ANT A/B switch is depressed (B position), pressing button 1 will result in zero volts between terminals A, B and C; and the GND terminal on the strip. When button 2 is pressed, plus 12 volts DC will be present between terminal A and GND. When button 3 is pressed 12 volts will be present at terminal B; and when button 4 is pressed, at terminal C.

(6) DC 12V

This connector receives plus 12 volts for meter lamps and relay switching from the FT-102 transceiver.

(7) Subpanel

This panel provides for internal installation of the optional FAS-1-4R Antenna Selector, if desired.

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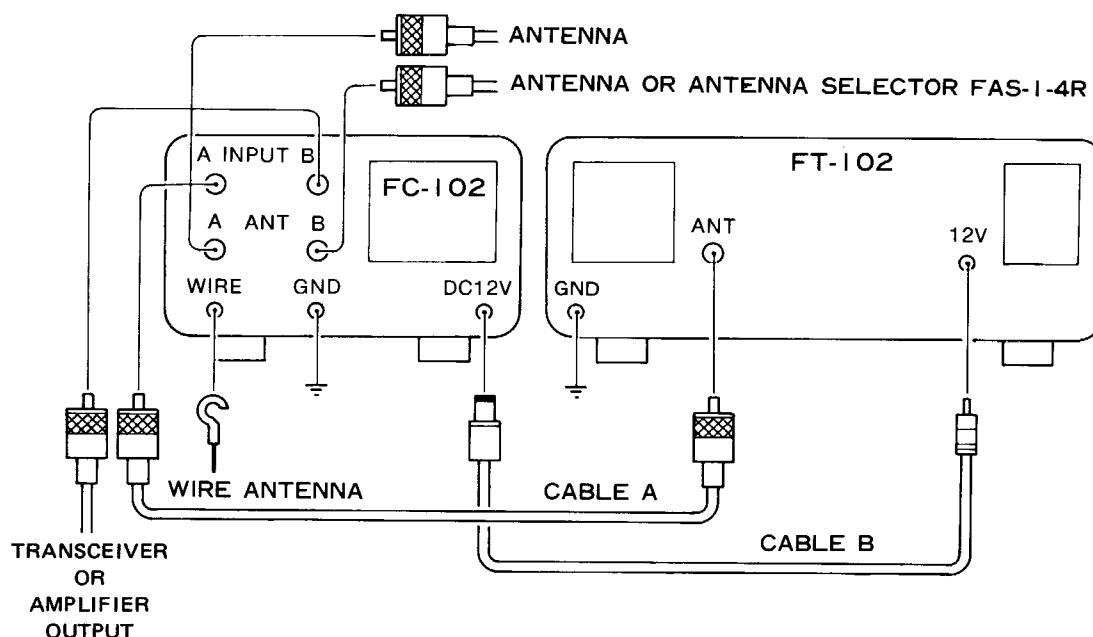
INSTALLATION

Connect the FC-102 to the FT-102 as shown in the interconnection diagram. If using the FC-102 with another transceiver, note that the FC-102 requires 12 volts DC at approximately 300 mA. If this voltage is not supplied, the switching circuits will not operate, nor will the PEAK meter function or the meter lamps light. In this case, INPUT A may still be used for an antenna connected to the ANT B jack, and the impedance matching function of the FC-102 can still be used.

CAUTION

Never make any connection to the WIRE terminal when using the ANT A terminal, as these are connected together within the FC-102. Do not allow fingers or cables to make contact with the WIRE terminal, as lethal voltage may be present at this terminal when transmitting.

INTERCONNECTIONS



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OPERATION

NOTE

THIS SECTION SHOULD BE STUDIED CAREFULLY BEFORE USING THE FC-102. FOLLOW THE PROCEDURE THAT APPLIES TO THE STATION EQUIPMENT AND PARTICULAR ANTENNA SYSTEM IN USE, AND TAKE NOTE OF THE FINAL SETTINGS OF THE LOAD AND TUNE CONTROLS FOR LATER REFERENCE.

For each of the Antenna Matching procedures which follow the same basic LOAD and TUNE adjustment method should be used. This is described below:

- 1) Before applying any power from the transmitter, set the BAND selector to the band of operation. DO NOT SWITCH THE BAND SELECTOR WHEN POWER IS APPLIED.
- 2) The LOAD and TUNE controls are adjusted to secure a minimum SWR. These two controls should be adjusted one at a time, so as to avoid confusion as to the effect of any particular adjustment. A typical procedure to follow would be to apply power, adjust the TUNE control for minimum SWR, then adjust the LOAD direction either to the right or left.

Once the LOAD control has been changed, the TUNE control should again be adjusted for minimum SWR; if this procedure improves the SWR, it should be continued by further moving the LOAD control in the same direction, but if the initial change in the LOAD control worsens the SWR, move the LOAD control in the opposite direction. It will be clear to the operator when the LOAD control is being adjusted in the right direction.

The reader is referred to the Chart, which contains the approximate positions of the BAND, LOAD, and TUNE controls for a 50 ohm load impedance, such as that presented by a dummy load. A dummy load is extremely useful for tuning up a transmitter in preparation for adjustment of matching of an antenna. If the control positions shown are utilized in conjunction with a 50 ohm dummy load, only very minor adjustments of the TUNE and LOAD controls will be necessary for a

perfect match. Of course, a 50-ohm dummy load should require no matching for a perfect match to a 50-ohm transmitter output, but this information is presented because the control positions in the Chart represent useful starting points for matching unknown impedances.

1) Antenna Matching Procedure with Dummy Load

Connect the 50 ohm dummy load to the ANT A jack, and the antenna to the ANT B jack. Set the ANT A/B switch to the ANT A (out) position. Set the BAND selector on the FC-102 to the THRU position, and tune the transmitter or linear amplifier for full operating power (into the dummy load). Now return to receive, rotate the BAND selector to the operating band of the transmitter, and press the ANT A/B button to the ANT B (in) position. Preset the LOAD and TUNE controls according to the Chart.

BAND	FREQ	TUNE	LOAD
1.8L	1.8 (MHz)	3.0	5.5
	2.0	4.0	6.0
1.8H	2.0	1.0	5.0
3.5	3.5	5.5	5.5
	4.0	6.5	6.5
7	7.0	3.5	6.5
	7.5	4.5	7.0
10	10.0	4.0	8.0
	10.5	4.5	8.0
14	14.0	7.0	8.0
	14.5	7.5	8.5
18	18.0	8.5	9.0
	18.5	8.5	9.0
21	21.0	8.0	8.5
	21.5	8.0	9.0
24.5	24.5	8.0	8.0
	25.0	8.0	8.5
28	28.0	8.0	8.5
	30.0	9.0	9.0

Finally, preset the FWD SET control to the 3 o'clock position, and the DRIVE control on the transmitter for minimum power output (the FWD set switch should be in the OFF (out) position). Listen first to make sure the frequency is clear, key the transmitter in the TUNE mode and gradually increase the DRIVE level until the SWR meter deflects to about the 1.5 marking. Now adjust the TUNE and LOAD controls on the FC-102 to obtain a simultaneous dip on the SWR meter and a peak on the FWD POWER meter. Increase the DRIVE level again for slight deflection on the SWR meter, and again adjust the TUNE and LOAD controls as above. This procedure should be repeated until the FWD POWER meter indicates the desired operating power while the SWR meter shows minimum SWR. Note that the METER SELECT switch for the range which includes the maximum power output of the transmitter or amplifier should be depressed to maintain meaningful indications.

CAUTION

The BAND selector on the FC-102 must never be rotated while any power is being applied to the FC-102 from a transmitter or linear amplifier, as severe damage may result to both the FC-102 and the transmitter or amplifier. Always make sure that the equipment is in the receive mode when rotating the BAND selector

2) Antenna Matching Procedure without a Dummy Load

We recommend that a 50 ohm dummy load always be used with the FC-102, as this allows for a minimum of interference to other stations, as well as providing additional safety in preventing inadvertent overloads of the transmitter or amplifier, and a means of accurate power measurement.

When a dummy load is not available, connect the antenna to either the ANT A or ANT B jack, and set the ANT A/B switch to the corresponding position. Set the BAND selector to the operating band, and preset the

TUNE and LOAD controls to the positions shown in the Chart. Now listen to make sure that the frequency is clear, and tune the PLATE and LOAD controls on the transmitter or linear amplifier for low level power output.

Next adjust the TUNE and LOAD controls on the FC-102 to obtain a dip on the SWR meter with a corresponding peak on the FWD POWER meter. This should be done using the minimum amount of power necessary to obtain slight deflection of SWR meter when the FWD POWER switch is in the out position and the FWD POWER control is set to the 3 o'clock position. Use the 20W meter range.

Finally, increase the drive power from the transmitter, retuning its (and/or the amplifier's) PLATE and LOAD controls slightly; and then readjust the TUNE and LOAD controls on the FC-102 for the dip in SWR indication as above. Switch FWD POWER meter ranges as necessary. This procedure should be repeated until the desired output power is indicated on the FWD POWER meter, with minimum indication on the SWR meter.

3) Antenna Matching Procedure for Solid State Transmitters

When using the FC-102 with a solid state transceiver such as the FT-ONE, FT-107, or FT-707; or with a solid state linear amplifier, the FC-102 should have its TUNE and LOAD controls preset according to the Chart, and the BAND selector set to the operating band. Also press the METER RANGE switch for the 20 W range, FWD POWER switch out and FWD POWER control to the 3 o'clock position.

Using the CW mode and a key or AM mode without modulation, preset the DRIVE control to minimum. Now listen to make sure the frequency is clear, key the transmitter and advance the DRIVE until slight deflection of the SWR meter is obtained. Adjust the TUNE and LOAD controls on the FC-102 for a dip on the SWR meter and a simultaneous

peak on the FWD POWER meter. Then increase the drive and repeat the adjustment until the desired output power is obtained on the FWD POWER meter, with minimum indication on the SWR meter. Note that indication on the FWD POWER meter may not reach the desired level unless the SWR indication is sufficiently low, as most solid state transmitting circuits include protective systems that automatically reduce transmitter power when SWR is high.

NOTES ON ANTENNA MATCHING

- 1) It is very important that the maximum time limits during tune-up conditions for the transmitter are not exceeded. This is particularly important when the transmitter is being used at full power.
- 2) It should be noted that any matching performed by the FC-102 in the shack will have no effect on the losses due to SWR on the coaxial line between the FC-102 coupler and the antenna. The operator should consult one of the popular antenna handbooks to determine whether or not matching between the coaxial line and the antenna must be performed at the antenna. For example, a 100-foot length of RG8A/U coax typically has a loss (with 1:1 SWR between it and antenna) of less than 1 dB at 21 MHz. If this line is operated with a 3:1 SWR due to a low or high antenna impedance, the loss due to SWR will increase roughly 0.5 dB, an imperceptible degradation as compared to the 1:1 condition. In this case, attempts to reduce the 3:1 SWR at the antenna end would serve no useful purpose as far as reducing losses in the coax, though matching with the FC-102 would improve the impedance presented to the transmitter output circuitry. However, if a 500-foot length of the above coax were used instead of only 100 feet, somewhat more than 1 dB of loss would occur in the coax due to the 3:1 SWR, possibly justifying further matching attempts at the antenna.
- 3) When using a solid state transceiver which has protection for the output transistors against high SWR, it can be seen that the matching action of the FC-102 will ensure that a 50 ohm load is presented to the output circuitry, thus ensuring full transmitter power.

- 4) It may be useful for the operator to record in a notebook the proper TUNE and LOAD positions for a particular antenna for quick reference. Alternatively, appropriate labels may be fabricated and applied to the FC-102 front panel showing the proper positions of the TUNE and LOAD controls.

SWR MEASUREMENT

SWR is most easily measured by the FC-102 when the transmitter is operated at low level, constant (unmodulated) output, such as in the TUNE or keyed CW modes. When SWR is being measured it is important to keep the transmitter output power constant.

With the FWD SET switch depressed, adjust the FWD SET control to obtain a full scale indication at the SET marker on the SWR meter. Simply press the FWD SET switch again so that it returns to the out position, and the reflected power will be displayed as SWR on the SWR meter.

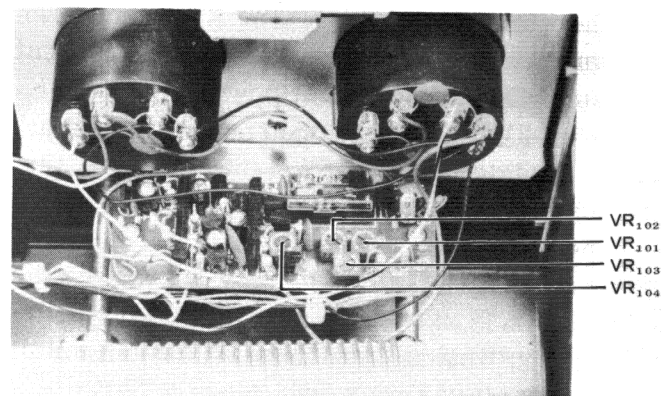
FORWARD POWER MEASUREMENT

To obtain accurate measurements of output power it is necessary to use a dummy load. Press the METER RANGE switch that corresponds with the maximum anticipated output power of the transmitter or linear amplifier. Set the METER switch on the rear panel of the FC-102 to the PEAK position, unless power is to be measured in the AM mode (in certain cases), or 12V DC is not supplied to the FC-102, in which cases the METER switch must be set to the RMS position.

The FWD POWER meter will now indicate forward power in watts for CW and FM transmissions. To obtain an indication of peak (PEP) power output when operating in an SSB mode, press the PEAK HOLD switch. The FWD POWER meter will now hold its peak indication for about one second when modulation is applied to the transmitter.

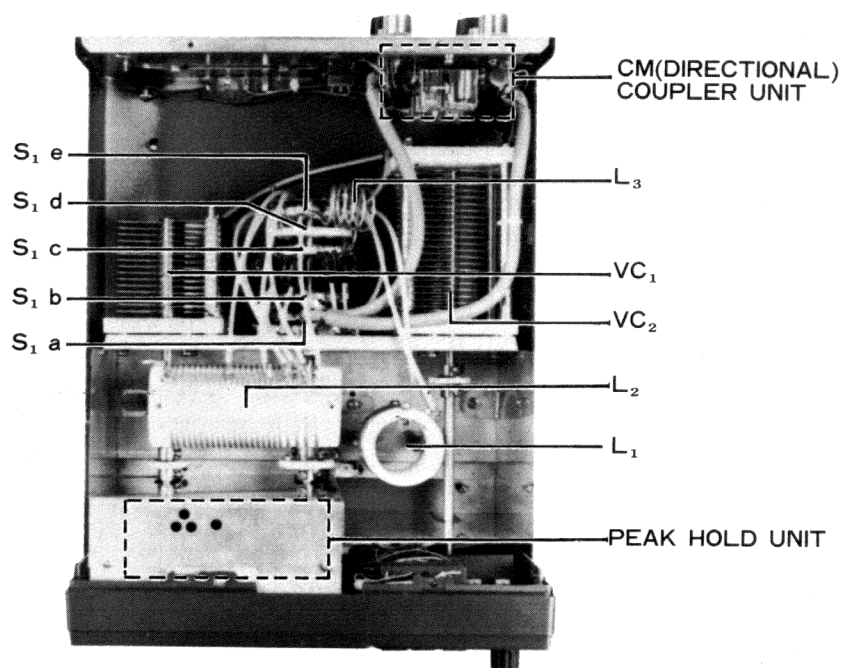
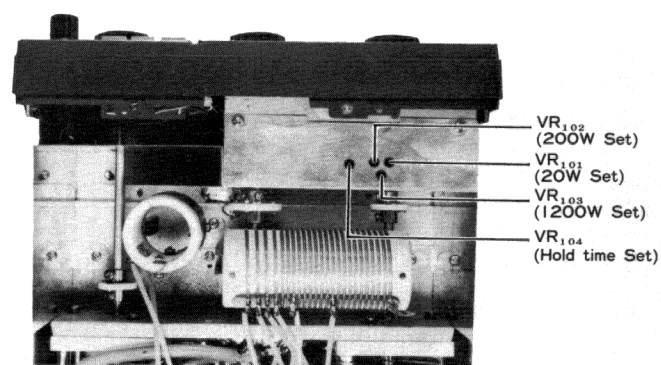
If AM modulation causes peaks in the forward power indication, the PEAK HOLD function may also be used for power measurement. However, if AM modulation causes the forward power indication to dip, the METER switch on the rear panel should be set to the

RMS position for accurate power indication. During SSB operation, forward power measurement of RMS power will be about half of the PEAK measurement, so that a 100 W signal will have meter peaks at about 50 watts when the METER switch on the rear panel is set to the RMS position. If the RMS readings are much higher than about half of the PEP level, overdrive may be causing distortion of the transmitted signal.



RECEIVE OPERATION

The FC-102 may be used to tune antennas for shortwave broadcast reception by setting the BAND selector to the amateur band nearest to the shortwave broadcast band of interest, and then adjusting the TUNE and LOAD controls for peak S-meter indication on the receiver. If the frequency of interest is far from the amateur bands it may be helpful to set the BAND selector to the THRU position, and/or to disconnect the outer contact of the coaxial feedline connector from the FC-102 (so that only the center contact makes connection). This last alternative is especially useful for reception at low frequencies.



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ALIGNMENT

The FC-102 has been carefully aligned and tested at the factory prior to shipment. With normal usage, it should not require other than the usual attention given to electronic equipment. Service or replacement of a major component may entail substantial realignment; under no circumstances, however, should realignment be attempted unless the circuit is understood, and the need for alignment is proven. Service should be performed only by experienced personnel using the proper test equipment.

Equipment required:

HF Transceiver, such as FT-102

Linear Amplifier

In-Line Wattmeter with 500 W capability,
such as Bird 43

50 ohm Dummy Load

1. Connect the test equipment as shown in the diagram. Note that, if 12V DC is not supplied to the FC-102 by the transceiver, it must be provided from a separate supply (at least 300 mA capacity). Use the INPUT A and ANT A terminals on the FC-102 for connecting the test equipment. Make sure that there are no connections to the WIRE terminal, and that hands and test equipment are kept clear of the WIRE terminal at all times, as high power is present on this terminal when transmitting.
2. Power Meter calibration
 - a. Set the BAND selector to the THRU position, and the transmit frequency to 14.2 MHz. Set the METER switch on the rear panel to the RMS position and the METER RANGE to 20W.
 - b. Adjust the transmitter for 10 watts output as indicated on the reference wattmeter, and then adjust VR₁₀₁ on the FC-102 for the same indication on the FWD POWER meter.
 - c. Repeat step b with 100 watts, adjusting VR₁₀₂ for the correct indication on the 200 W meter scale.
 - d. Again repeat step b with 250 watts, adjusting VR₁₀₃ for the correct indication on the 1200 W meter scale.
3. FWD POWER meter zeroing
 - a. With the BAND selector in the THRU position and the 50 ohm dummy load connected to the selected ANT terminal, also set the METER switch on the rear panel to the PEAK position, and the PEAK HOLD switch OFF (out).
 - b. Adjust VR₁₀₄ to the threshold point where the indication on the FWD POWER meter is just about to rise above zero (this must be done with the transceiver in the receive mode).

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FAS-1-4R ANTENNA SELECTOR INSTALLATION (OPTIONAL)

The FAS-1-4R Remote Antenna Selector may be installed either at the feedpoints of the antennas or inside the FC-102 Antenna Tuner, providing selection between up to four antennas.

FAS-1-4R Installation in the FC-102

1. Remove the subpanel on the rear of the FC-102 as shown in Figure 1.
2. Insert the FAS-1-4R module into the FC-102, and install the four mounting screws as shown in Figure 2.
3. Using a short coaxial jumper and the 4-conductor interconnection cable, connect the ANT B terminal on the FC-102 to the INPUT coaxial terminal on the FAS-1-4R, and connect the wire ends of the 4-conductor cable to the terminal strip on the FC-102, securing the other end of this cable into the REMOTE jack on the FAS-1-4R as shown in Figure 3. Connect the antenna feedlines to jacks 1 through 4 on the FAS-1-4R.

FAS-1-4R Interconnection at Remote Location

Connect the FAS-1-4R to the FC-102 as described in step 3 of the above procedure and shown in Figure 3, using the interconnecting coaxial cable as the feedline, and cutting or extending the 4-conductor intercon-

nection cable as necessary. Connect the antennas to jacks 1 through 4 on the FAS-1-4R using short feeder lengths of 50 ohm coaxial cable. These antenna feeders should be unbalanced (by baluns, if necessary), and as close as possible to 50 ohms at the intended operating frequencies.

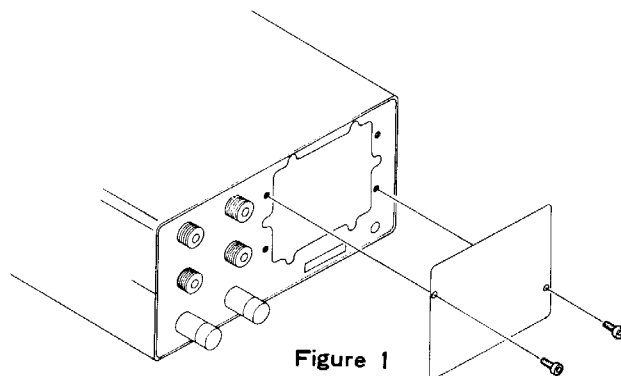


Figure 1

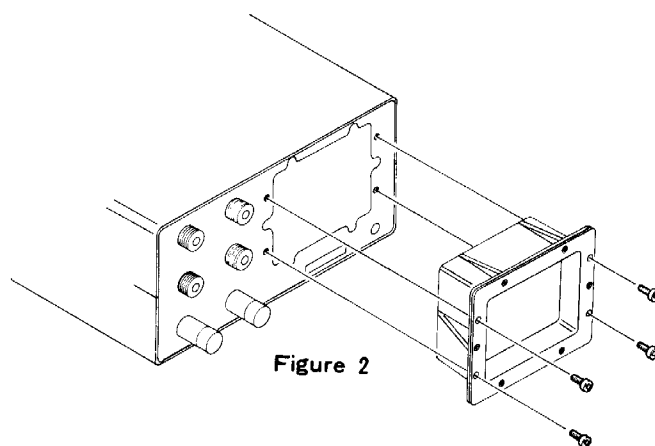


Figure 2

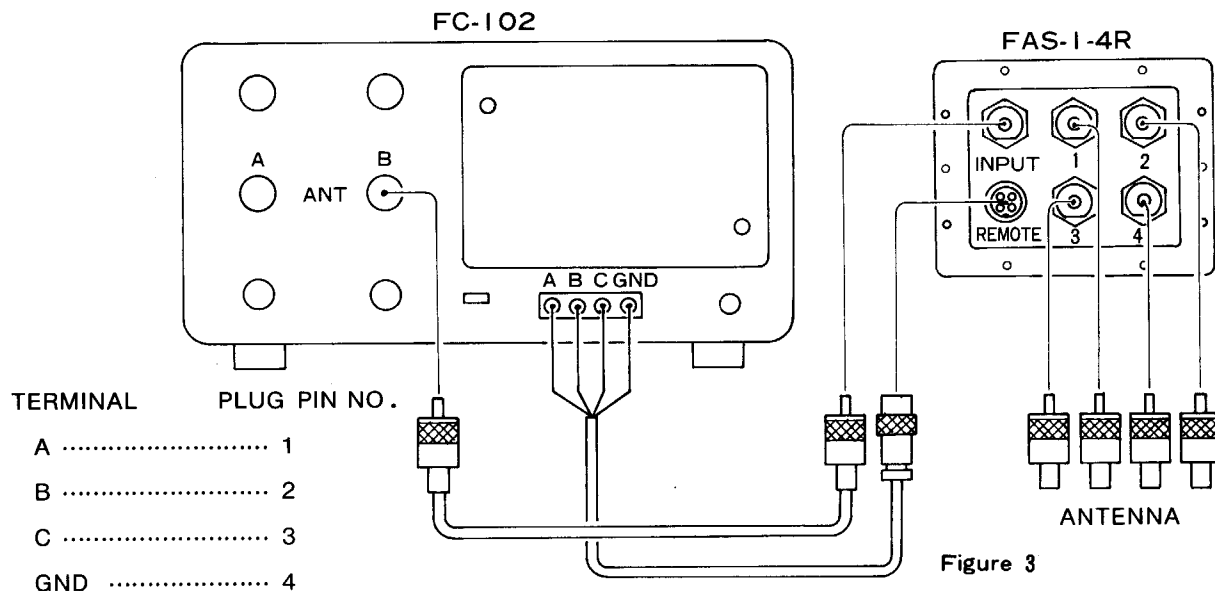
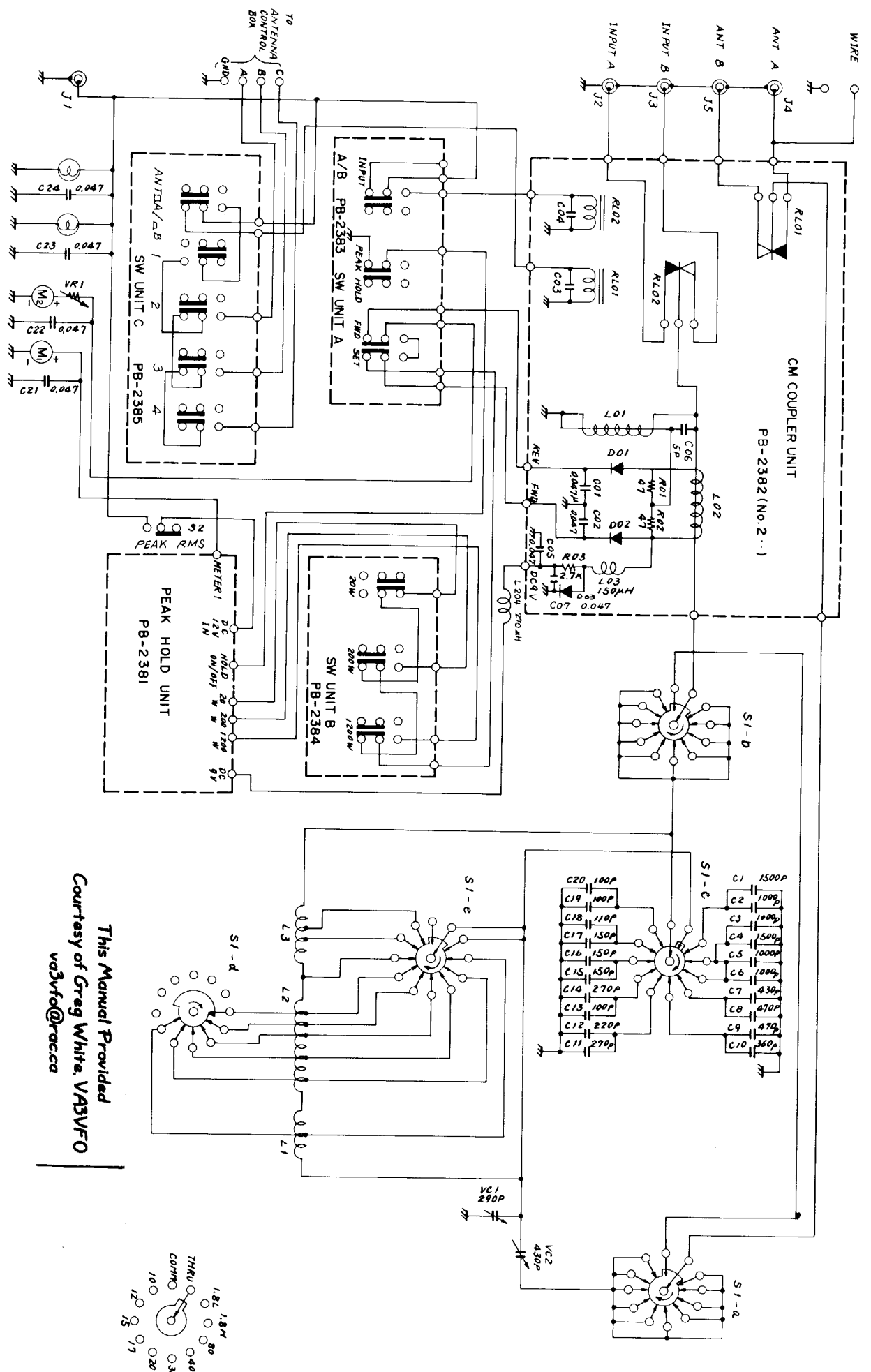
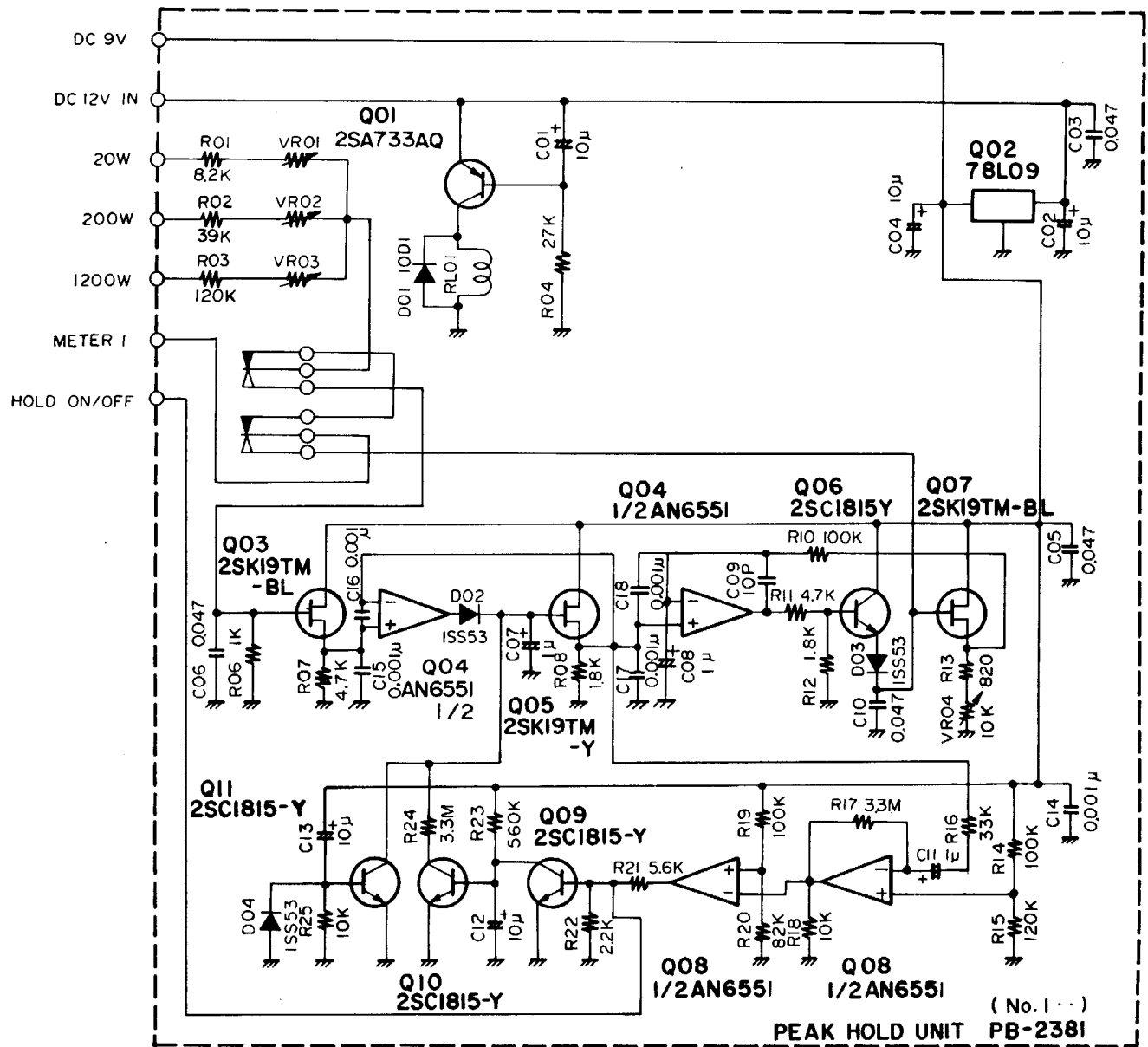


Figure 3

REMOTE CABLE CONNECTIONS



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va3vfo@trac.ca



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 va3vfo@rac.ca

MAIN CHASSIS					TERMINAL		
Symbol No.	Part No.	Name & Description					
		CAPACITOR			T01	Q5000001	30A7 (Red)
C18	K30309024	Dipped Mica	1KWV	110 pF	T02	Q5000002	" (Black)
		(DML2 111K10)			T03	Q6000071	BP-23-4PB 4P
C13, 19, 20	K30309022	" "	"	100 pF			
		(DML2 101K10)					KNOB
C15-17	K30309023	" "	"	150 pF	R3079190	FT-20WK	(FWD SET)
		(DML2 151K10)			R3080540	FT-38WF	(TUNE, BAND, LOAD)
C12	K30309021	" "	"	220 pF	R3077910A	Push knob	
		(DML2 221K10)					
C11, 14	K30309020	" "	"	270 pF			
		(DML2 271K10)					
C10	K30309019	" "	"	360 pF			
		(DML2 361J10)					
C07	K30309018	" "	"	430 pF			
		(DML2 431J10)			PEAK-HOLD UNIT		
C08, 09	K30309003	" "	"	470 pF	Symbol No.	Part No.	Name & Description
		(DML2 471J10)			PB-2381	F0002381	Printed Circuit Board
C02, 03 05, 06	K30309017	" "	"	1000 pF		C0023810	P.C.B with Components
		(DML2 102J10)					
C01, 04	K30309015	" "	"	1500 pF			IC
		(DML2 152J10)			Q1004, 108	G1090248	AN6551
	K30309016	" "	"	2000 pF	Q102	G1090118	NJM78L09A
		(DML2 202J10)					
C21-24	K13170473	Ceramic Disc	50WV	0.047 μ F			TRANSISTOR
		(DB207YF473Z5L5)			Q101	G3107331Q	2SA733A-Q
					Q106, 109-111	G3318150Y	2SC1815Y
		POTENTIOMETER					
VR01	J60800092	K1611008VE-100KB					FET
					Q103, 107	G3090036	2SK19TM-BL
					Q105	G3090034	2SK19TM-Y
		VARIABLE CAPACITOR					
VC01	K90000039	YP-290-12	1.5KV	290 pF			
VC02	K90000040	YP-430-12	"	430 pF			
							DIODE
		INDUCTOR			D102-104	G2090027	Si 1SS53
L01 (160m)	L0021247A				D101	G2090001	" 10D1
L02 (80m-17m)	L0021217						
L03 (15m-10m)	L0021218A						RESISTOR
					R113	J02245821	Carbon film 1/4W SJ 820 Ω
					R106	J02245102	" " " " 1k Ω
					R108, 112	J02245182	" " " " 1.8k Ω
					R122	J02245222	" " " " 2.2k Ω
		METER			R107, 111	J02245472	" " " " 4.7k Ω
M01	M0290034	Power			R121	J02245562	" " " " 5.6k Ω
M02	M0290035	SWR			R101	J02245822	" " " " 8.2k Ω
					R118, 125	J02245103	" " " " 10k Ω
					R126	J02245273	" " " " 27k Ω
		SWITCH			R116	J02245333	" " " " 33k Ω
S01 (Band)	N0050063				R120	J02245823	" " " " 82k Ω
S02 (Side)	N6090020	OS-22-09S			R104,110,114 119	J02245104	" " " " 100k Ω
		CONNECTOR			R103, 115	J02245124	" " " " 120k Ω
J01	P0090093	X-G-9242			R123	J02245564	" " " " 560k Ω
J02-05	P1090194	FM-MR-M2			R117, 124	J02245335	" " " " 3.3M Ω

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va3vfo@rac.ca*