THE FC-301 ANTENNA COUPLER

The FC-301 antenna coupler is designed for low and medium power applications in the HF amateur bands from 160 through 10 meters. It is designed to minimize the adverse effects of high SWR on a coaxial line or wire antenna which may result in difficulty in tuning a transmitter designed to work into a resistive 50 ohm load.

The FC-301 comes equipped with three UHF-type female coax receptacles, and a threaded terminal to accept a single-wire antenna.

The front panel controls include a bandswitch for selecting proper impedance values for matching, TUNE and LOAD controls for adjustment of the capacitive coupling, and a POWER & SWR switch for setting the meter sensitivity for the power being used. The ANT SELECT switch chooses among any of four antennas to be matched, and if it is desired to feed an antenna directly through the coupler to the transmitter without any matching done by the coupler, a position of the BAND switch will accomplish this.

High-quality low-loss components are used throughout the FC-301 antenna coupler, and the matching function it performs means your transmitter will always "see" the resistive termination it was designed for. The inherent selectivity of the FC-301 matching circuitry helps attenuate harmonics, too, thus reducing harmonic-related TVI or out-of-band emission.

FC-301 SPECIFICATIONS

FREQUENCY COVERAGE	160mL	1.8-2.0 MHz
	160mH	1.9-2.4 MHz
	80m	3.5 -4.0 MHz
	40m	7.0-7.5 MHz
	20m	14.0-14.5 MHz
	15m	21.0-21.5 MHz
	10m	28.0-29.7 MHz
Input impedance	50-75 ohms	
Max. variation in load impedance	50 ohm in: 10-250 ohms 75 ohm in: 18-300 ohms	
Maximum transmitter power	500 W PEP @ 50 ohms	
Power meter calibration scales	25 W, 250 W, 500 W	
Insertion loss	0.5 dB max.	
Rear panel antenna connections	3 coaxial "UHF" type 1 single wire terminal	
Dimensions	212 (L)x125(H)x295(D) mm.	
Weight	4.6 kg.	
SWR calibration	To 4:1 SWR	

TUNE

The TUNE control is a dual capacitor to provide capacitive adjustment of the coupling between the transmitter and the impedance established by the BAND switch and the LOAD control. The TUNE and LOAD controls are adjusted for minimum SWR.

BAND switch

The BAND switch selects the inductance required to accomplish matching on the band in question. The operator should select the BAND switch position which best covers the portion of the band being used. The DIRECT position of the BAND switch connects the transmitter directly to the antenna, bypassing the FC-301 matching circuitry, but permitting measurement of the SWR on the line at that point.

SWR SET

This control is used to calibrate the SWR METER: the SWR may be read accurately by adjusting the SWR SET control for full deflection of the FWD POWER meter with the POWER & SWR switch in the SWR SET position.

LOAD

The LOAD control is connected to a variable capacitor which adjusts the coupling between the antenna feedline and the impedance presented by the BAND switch inductor and the TUNE control.

ANT SELECT

This switch selects the antenna to be matched. The operator has the choice of one of three coax-fed antennas or a single wire antenna.

POWER &SWR switch

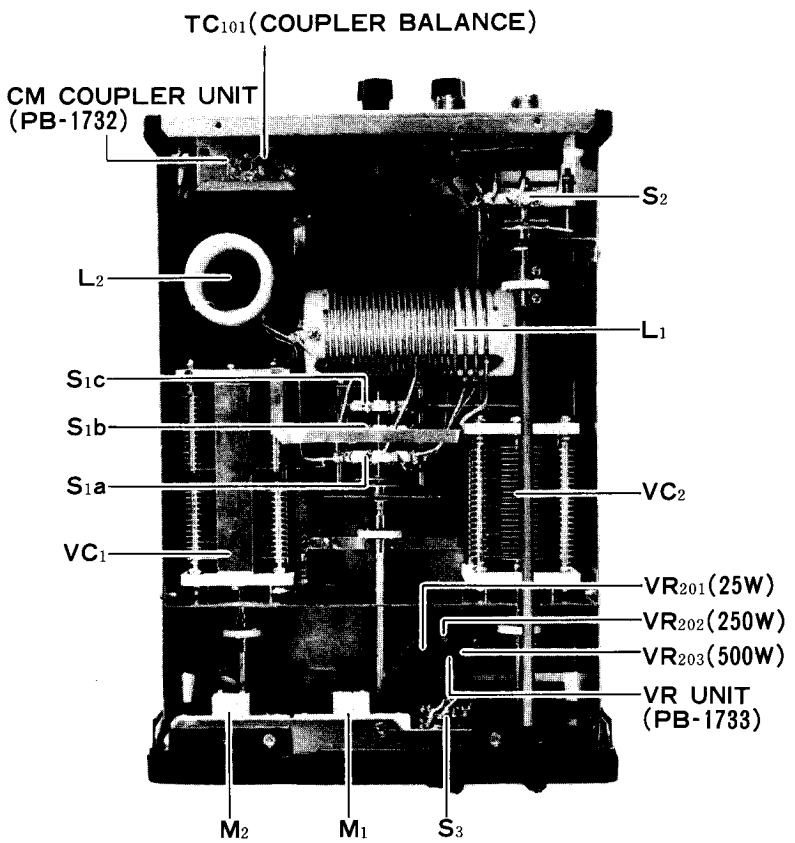
This switch is used to select the proper sensitivity of the FWD POWER meter for the power being used, and to provide calibration for the measurement of SWR.

FWD POWER meter

The FWD POWER meter reads the output power on three scales of 25 watts, 250 watts, and 500 watts maximum.

SWR meter

When calibrated, this meter provides accurate measurement of SWR for purposes of adjusting the LOAD and TUNE controls for the best match.



REAR PANEL CONNECTIONS

ANT 1, ANT 2, ANT 3

These three female UHF-type connectors will accept the coaxial feedline from the antenna. As well, a dummy load such as the YAESU YP-150 may be attached to one of these connectors for tuning or test purposes.

WIRE

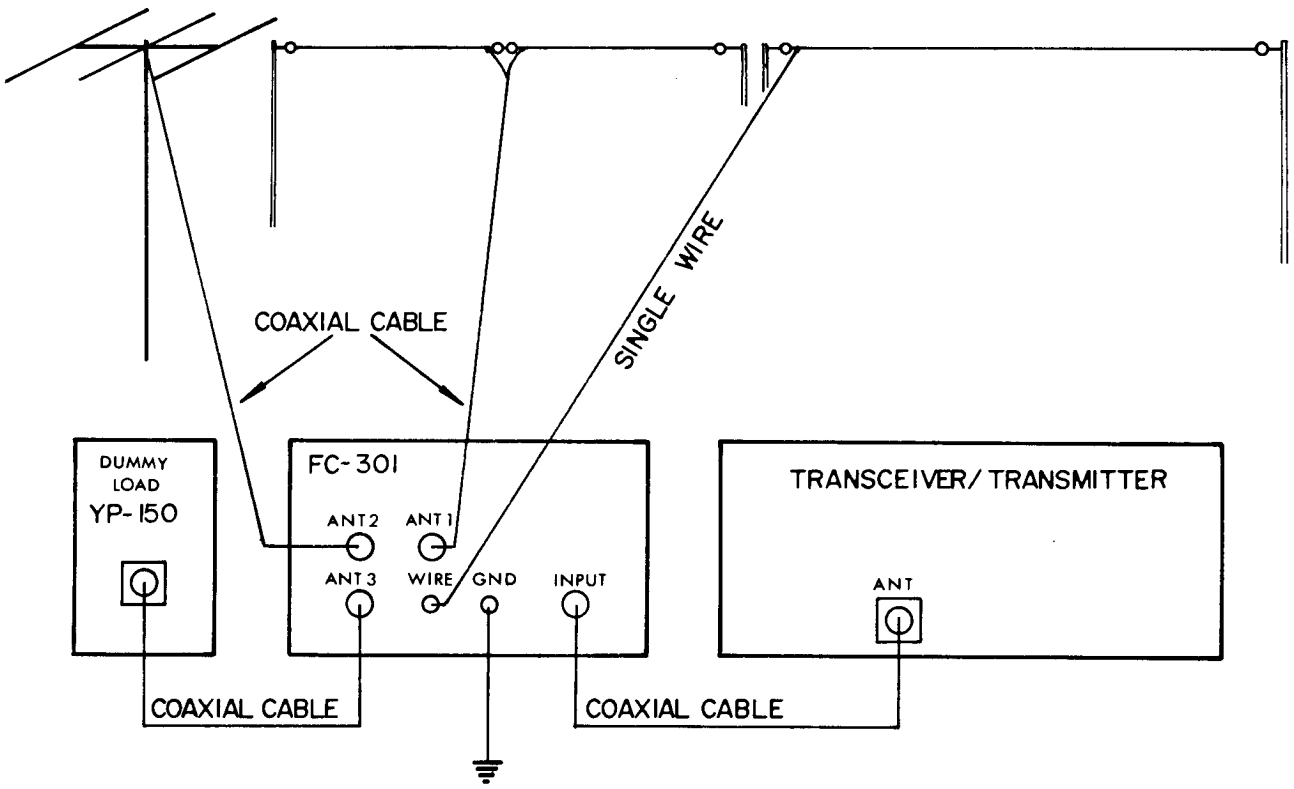
This threaded terminal accepts a single-wire antenna such as the "Windom" type.

GND

This terminal should be connected to a good earth ground so as to provide a DC path to ground for stray currents, and to reduce "RF in the shack" and ground loops, etc., that may make antenna matching difficult. This is particulary important in the case of certain types of single-wire antennas.

INPUT

The INPUT connector is another female UHF receptacle for connection between the FC-301 and the RF output connector of the transmitter or transceiver.



ANTENNA MATCHING PROCEDURE

IT IS STRONGLY RECOMMENDED THAT THE FOLLOWING SECTION BE READ IN ITS ENTIRETY BEFORE ANY MATCHING OF ANTENNAS IS ATTEMPTED. WHILE A STRAIGHTFORWARD PROCEDURE, ANTENNA MATCHING WITH A COUPLER SUCH AS THE FC-301 INVOLVES A LOGICAL PROGRESSION OF STEPS, AND FAMILIARITY WITH THE TOTALITY OF THE FOLLOWING SECTION WILL CLARIFY THE PROCEDURE IMMENSELY.

To summarize the procedure that is followed in using the FC-301 antenna coupler to match a feedline to the transmitter, the following process takes place:

1) The proper inductance is chosen using the Band switch.
2) The LOAD and TUNE controls are adjusted to secure a minimum SWR. Thses 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, one should try moving 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.

	BAND	TUNE	LOAD
1.8MHz	160L	3.5	6.0
1.9MHz	160L	4.5	6.5
1.8MHz	160H	2.0	4.5
1.9MHz	160H	3.0	5.1
3.5MHz	80	5.5	7.0
4.0MHz	80	6.5	7.9
7.0MHz	40	6.2	7.8
7.5MHz	40	7.0	8.0
14.0MHz	20	6.0	8.0
14.5MHz	20	6.5	8.0
21.0MHz	15	3.5	8.5
21.5MHz	15	4.0	8.5
28.0MHz	10	4.0	9.0
29.7MHz	10	4.5	9.0

Figure 1

The reader is referred to Fig. 1, which contains the approximately correct 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 in Fig. 1 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 Fig. 1 represent useful starting points for matching unknown impedances.

The following, then, is a step-by-step procedure to follow for the matching of an antenna feedline that has not been matched previously.

1) Tune up the transmitter in the normal way into a 50-ohm dummy load (if 50 ohm coax is used between the transmitter and the FC-301) or other resistive 50 ohm termination. Reduce the gain control on the transmitter to a minimum, and place the transmitter in "standby" for the moment.

2) Place the BAND, LOAD, and TUNE controls in the positions indicated in Fig. 1 for the frequency at which the line is to be matched. Place the ANT SELECT switch in the position which corresponds to the rear panel connector of the antenna to be matched. Place the POWER & SWR switch in the SWR SET position, and place the SWR SET knob in the 12:00 position.

3) It is desirable to make preliminary matching adjustments with as little transmitter output power as possible. Place the transmitter in the "transmit" condition, and slowly advance the output level until deflection of the FWD POWER meter is observed. Adjust the SWR SET control to line up the meter needle of the FWD POWER meter with the SWR SET position at the far right end of the FWD POWER meter, using the minimum power necessary to accomplish this. With the needle in the SWR SET mark of the FWD POWER meter, the SWR meter will accurately read the SWR.

4) Adjust the TUNE control for minimum reading on the SWR meter. If necessary, adjust the SWR SET control and/or transmitter power to ensure proper calibration. Once the "dip" has been found using the TUNE control, move the LOAD control either to the left or right, by a small amount. Adjust the TUNE control for a "dip" again, and if the SWR improves (again, make sure that you are reasonably well calibrated) move the LOAD control slightly more in the same direction. Again "dip" the TUNE control, and continue this procedure until no further improvement is noted. If the initial direction of adjustment of the LOAD control worsened the SWR, move it an equal direction from the starting point IN THE OPPOSITE DIRECTION and follow the above procedure with successive adjustment of the TUNE and LOAD controls.

5) Once the initial procedure has been followed to yield a near-perfect match, the POWER & SWR switch may be placed in the position which most closely corresponds to the transmitter output power expected. The transmitter may then be adjusted for full power (some adjustment of the transmitter load and tune controls may be necessary during matching adjustments), and the FC-301 LOAD and TUNE controls may be adjusted to yield zero deflection of the SWR meter. When the POWER & SWR switch is not calibrated with the SWR SET controls, the SWR meter will not accurately read the SWR, but it will indicate minimum reflected power.

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.

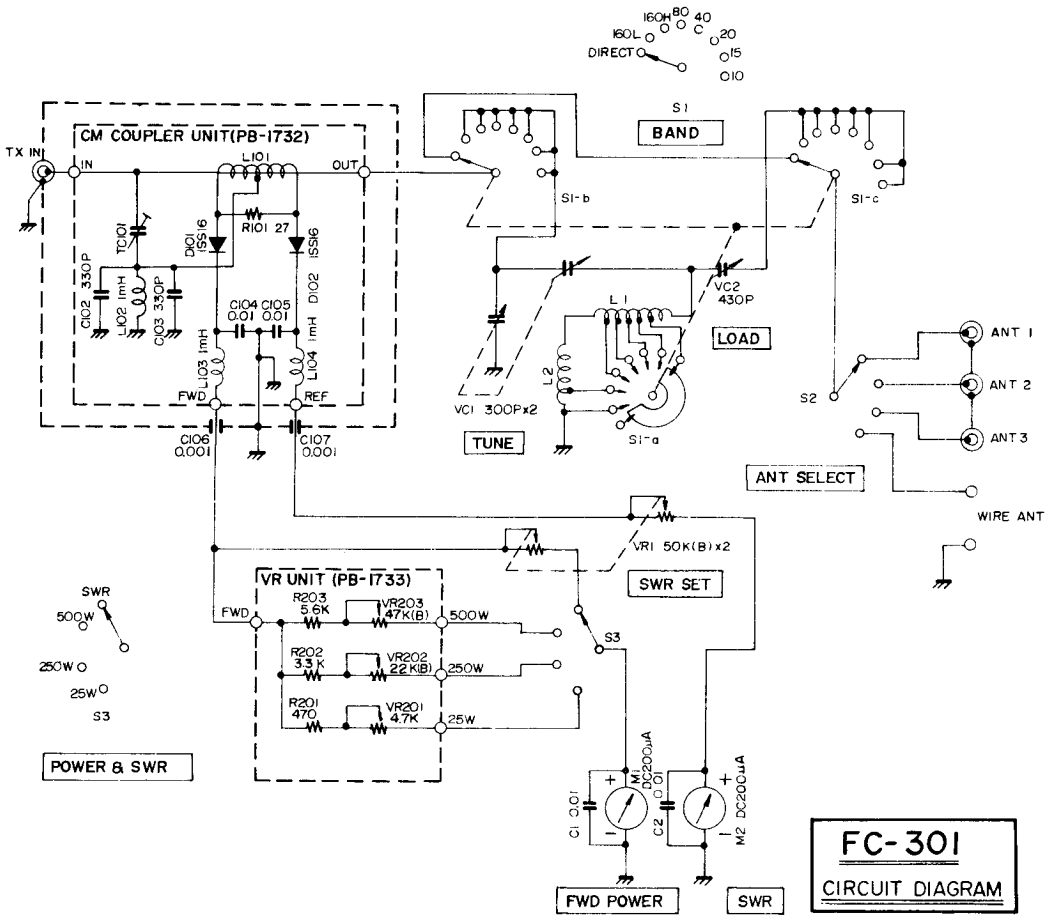
2) It should be noted that any matching performed by the FC-301 in the shack will have no effect on the losses due to SWR on the coaxial line between the FC-301 coupler and the antenna. The operator should consult one of the popular antenna handbooks to determine whether or not matching between the coaxial 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, through matching with the FC-301 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 transceiver such as the FT-301D which has protection for the output transistors against high SWR, it can be seen that the matching action of the FC-301 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-301 front panel showing the proper positions of the TUNE and LOAD controls.

PARTS LIST

Symbol Number	Parts Number	Description
		MAIN CHASSIS
		VARIABLE CAPACITOR
VC1 (Tune)	39000067	YA300PF×2
VC2 (Load)	39000068	YA430PF
		INDUCTOR
L1 (80m~10m)	55003170	#220299
L2(160m)	55003171	#220300A
		SWITCH
S1 (Band)	61000430	3-3-8
S2 (ANT Select)	61000440	1-1-4
S3 (SWR, Power)	62000025	ESR-E124R15
		METER
M1(Power)	74000310	KTC-020B
M2(SWR)	74000320	KTC-020A
		POTENTIOMETER
VR1	49800101	EWK-K8AS 15B54 50KB/50KB
		CONNECTOR
J2~J4	67000004	M-BR-06D
J5, J6	92000004	T3
		CAPACITOR
C1, C2	30820103	Ceramic Disc 50WV 0.01μF
		CM COUPLER UNIT
PB-1732	60417320	Printed Circuit Board
		DIODE
D101, 102	21090134	1SS16
		RESISTOR
R101	42124270	Carbon Composition 1/2W GK 27Ω
		CAPACITOR
C102, 103	33824331	DIPPED MICA 50WV 330PF
C104, 105	30820103	Ceramic Disc 50WV 0.01μF
C106, 107	32820102	Ceramic Feed Thru 0.001μF
		TRIMMER CAPACITOR
TC101	39000006	ECV-1ZW 10×40 10PF
		MICRO INDUCTOR
L102~104	53020001	1mH
		CM COUPLER
L101	55003172	#220301A
		CONNECTOR
	67000004	M-BR-66D
	91001339	Through Terminal A-339
	91100008	Wrapping Terminal C
	80041271	Case
	80041281	Case Cover A
	80041291	Case Cover B
	80041281	Shield Board
		VR UNIT
PB-1733	60417330	Printed Circuit Board
		RESISTOR
R201	40143471	Carbon Film 1/4W VJ470Ω
R202	40143332	〃 〃 〃 3.3KΩ
R203	40143562	〃 〃 〃 5.6KΩ
		POTENTIOMETER
VR201	49905472	SR-19R 4.7KΩ B
VR202	49905223	〃 22KΩ B
VR203	49905473	〃 47KΩ B
	91100008	Wrapping Terminal C
		ACCESSORY
		Coaxial Cable #240016 with Connector



FC-301
CIRCUIT DIAGRAM