



CHARACTERISTIC	SPECIFICATION
Design specifications	
ARINC	1-ATR short case.
Environmental category	MIL-T-5422E.
TSO	FAA TSO C31b.
FCC rules and regulations	
Physical specifications	
Size (inches)	Length: 14-3/8 max. Width: 10-25/64 max. Height: 7-11/16 max.
Weight	19.7 lb (490T-1). 19.4 lb (490T-1A).
Environmental specifications	
Ambient temperature	
Operating	-55 to 55 °C (-67 to 131 °F), 71 °C (160 °F) for 30 minutes (MIL-E-5400F, class 1A).
Nonoperating	-62 to 85 °C (-79.6 to 185 °F).
Ventilation	No forced air cooling.
Humidity	MIL-T-5422E.
Shock	MIL-E-5400F tested per MIL-T-5422E.
Altitude	Sea level to 30,000 ft operating (MIL-E-5400F, class 1A)
Sand and dust	MIL-T-5422E.
Vibration	5 to 500 Hz MIL-E-5400F (curve IV with vibration isolators and 1 g solid mount).
Fungus	MIL-T-5422E.

Equipment Specifications (Sheet 1 of 3)
Figure 11



CHARACTERISTIC	SPECIFICATION
<p>Electrical specification</p> <p>Power requirement</p> <p>Ac input</p> <p>Rf input capability Rf tune power</p> <p>Transceiver compatibility</p> <p>Rf interference</p>	<p>107.5 to 119.5 vac power factor 98 percent (Category B, MIL-STD-704), 380 to 420 Hz, single-phase, 100 watts peak maximum, 50 watts keyed during operate, 35 watts unkeyed, and 20 watts in standby.</p> <p>630 watts pep (max), 200 watts (average max). 40 watts to initiate tune cycle 70 to 150 watts to meet specified performance.</p> <p>Completely compatible with 618T-()/618T-()B and 618S HF Transceivers.</p> <p>The coupler properly installed as a system shall meet the requirements of MIL-I-6181D with the following exceptions:</p> <ul style="list-style-type: none">a. The power line interference of the fundamental and its harmonics caused by the coupler and conducted outside the system shall be not greater than 30 db above the limits established in MIL-I-6181D during the transmit mode.b. The power line interference of broadband and pulsed CW-conducted interference caused by the coupler and conducted outside the system shall be not greater than 20 db above the limits established in MIL-I-6181D during the transmit mode.c. The control line interference of the fundamental and its harmonics caused by the coupler and conducted outside the system shall be not greater than 50 db above the limits established in MIL-I-6181D during the transmit mode.d. Pulsed CW-radiated interference caused by the coupler shall be not greater than 45 db above the limits established in MIL-I-6181D during the transmit mode.

Equipment Specifications (Sheet 2 of 3)
Figure 11



CHARACTERISTIC	SPECIFICATION
Efficiency	<p>e. The CW rf-radiated interference caused by the coupler shall be not greater than 55 db above the limits of MIL-I-6181D for the fundamental during the transmit mode and shall be not greater than 30 db above the limits of MIL-I-6181D for the harmonics.</p> <p>f. Broadband radiated interference caused by the coupler shall be not greater than 25 db above the limits of MIL-I-6181D during the transmit mode.</p> <p>Efficiency can be approximated from the following equation:</p> $\text{Eff} = 90 \frac{200\%}{200 + Q_a}$ <p>where $Q_a = \frac{X_a}{R_a}$ is the series antenna Q</p> <p>X_a = antenna input reactance; capacitive and equal to or less than 430 ohms</p> <p>R_a = antenna input resistance</p>
Frequency range	2 to 30 MHz.
Input impedance	50 ohms.
Output impedance	Match long wire antennas (25 to 100 ft), general whip antenna, and shorter antennas with the aid of external coils.
Number of channels	Continuous tuning.
Tuning accuracy	1.3:1 vswr maximum for all operating conditions when tune power is 70 to 200 watts.
Modulation	Operation is satisfactory with all types of modulation.
Duty cycle	Continuous.
Protective devices	A time delay faults the system if tuning is not complete within 8 to 10 seconds.
Tuning time	3.0 seconds, typical; 4.0 seconds, maximum at standard conditions; 5.0 seconds, maximum at low temperature, low line voltage; and 6.0 seconds maximum with the 437R-1.



4. EQUIPMENT DESCRIPTION.

A. Mechanical.

The 490T-1/1A Antenna Coupler is contained within a full ATR short case. The basic construction is of the nonpressurized, semiportable, dustproof type without forced air cooling. The 490T-1/1A Antenna Coupler is modularized for ease of maintenance. A vertical plenum from front to back minimizes radio-frequency interference by shielding all control lines from rf circuits. The plenum is also used to mount several of the rf subassembly modules. Refer to figure 12 for module identification and to figures 13 and 14 for module location. The shunt and series capacitors, the step coil, and the series and shunt varicoils are arranged in an L-configuration and mounted across the upper front and left side of the chassis. The electronic control amplifier module and antenna coupler control module are located on the rear right side of the chassis. The discriminator module is mounted on a sheet-metal shield located on the lower left side.

B. Electrical.

490T-1/1A Antenna Coupler includes nine subassembly modules and a main chassis. The following paragraphs contain an electrical description of each module of the 490T-1/1A Antenna Coupler.

Antenna coupler control module A2 (coupler control) controls the 490T-1/1A Antenna Coupler and transceiver during the tuning operation. It automatically sequences the operation of the other modules of the coupler while maintaining compatible operation with the transceiver. All switching of this module is accomplished by silicon controlled switches, silicon transistor logic circuits, and hermetically sealed miniature relays.

Loading-phasing discriminator module A8 (discriminator) samples the forward and reflected rf power to produce dc output voltages that are proportional to phasing and loading errors. The circuits also provide dc voltage outputs proportional to forward and reflected power. These voltages control the initial tuning operation and the demand surveillance retuning function.

Variable rf stepping coil module A4 (step coil) provides 12 incremental values of inductive reactance required to tune capacitive antennas. The reactance of each coil step is slightly less than the reactance of the entire series varicoil. The sections are switched by a drum that is rotated by a motor-driven Geneva mechanism. The design of the contacts on both the stationary coil and rotary drum ensure positive connection and rapid movement. End-to-end movement is accomplished in approximately 500 milliseconds.

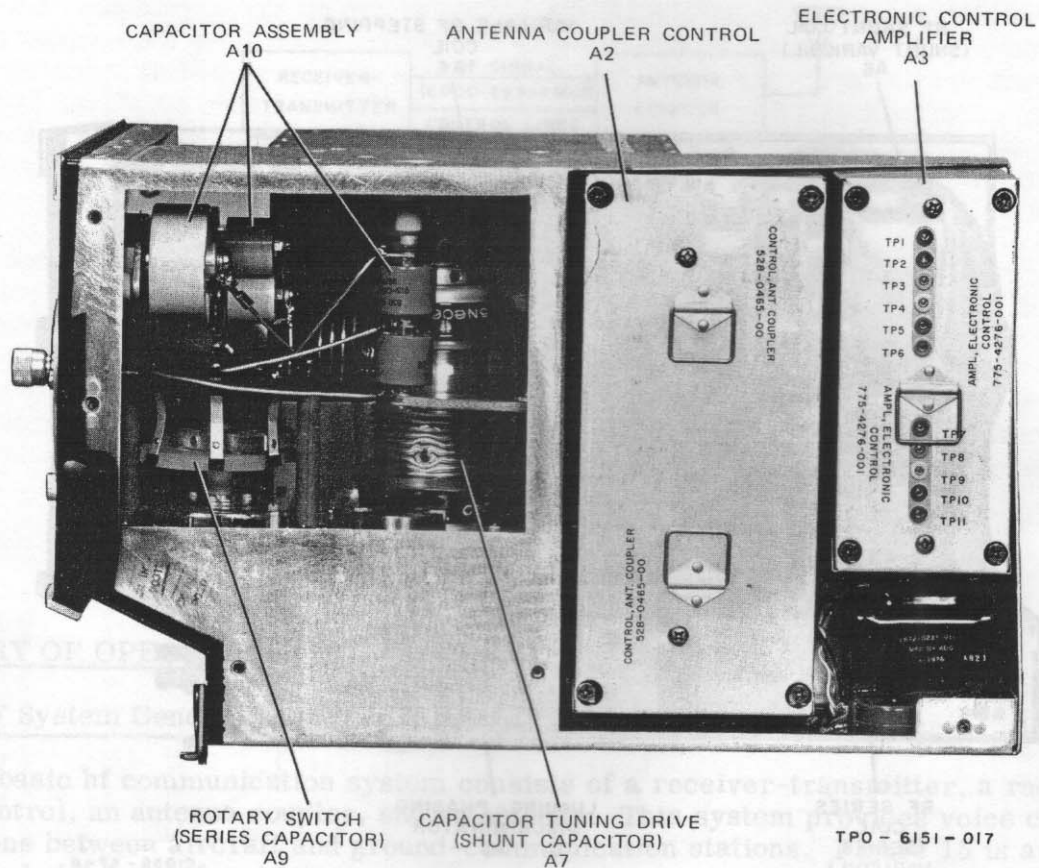
Rf series and shunt coil modules A5 and A6 include a continuously variable coil and a servo motor. The rf series coil (series varicoil) is connected in series with the step coil to provide continuously variable values of inductive reactance. The rf shunt coil (shunt varicoil) is used in final tuning to phase the antenna circuit.



MODULE	QTY	COLLINS PART NUMBER	MODULE DESIGNATION
490T-1 electrical equipment chassis	1	757-3421-001	A1
490T-1A electrical equipment chassis	1	757-3421-002	A1
Antenna coupler control (coupler control)	1	528-0465-00	A2
Electronic control amplifier	1 1	528-0467-00 775-4276-00	A3 A3
Variable rf stepping coil (step coil)	1	528-0524-00 777-3508-001	A4 A4
Rf series coil (series varicoil)	1	528-0525-00	A5
Rf shunt coil (shunt varicoil)	1	528-0526-00	A6
Capacitor tuning drive (shunt capacitor)	1	528-0466-00 777-4500-001	A7 A7
Loading-phasing discriminator (discriminator)	1	528-0468-00	A8
Rotary switch (series capacitor)	1	761-6205-00	A9
Capacitor assembly	1	761-6204-00	A10

Module Identification
Figure 12

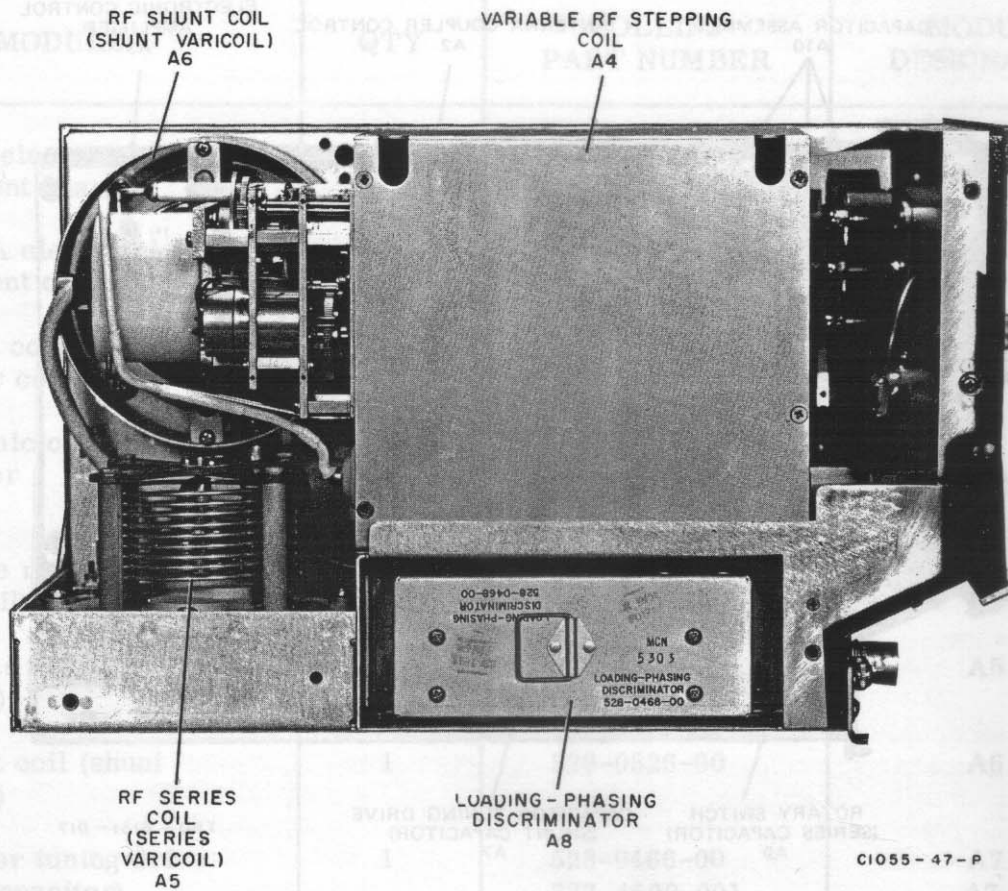
Rotary switch module A9 (series capacitor) has five fixed capacitor assemblies and a motor-driven switch. The fixed capacitors are switched in various parallel configurations to vary the series capacitance. Rotary switch (series capacitor) extends the tuning range of the 490T-1/1A to include highly inductive antennas.



Right Side Module Location
Figure 13

Capacitor tuning drive module A7 (shunt capacitor) is a motor-driven vacuum capacitor. In a highly inductive antenna, if the capacitive reactance of the series capacitor is not large enough to cancel the inductive reactance, shunt capacitance is added until the antenna is capacitive and more than 50 ohms. Also, during antenna resonating procedures with series varicoil and step coil at maximum, shunt capacitance is added until resonance is achieved and magnitude of antenna impedance is less than 50 ohms. In final tuning, shunt capacitance is added when the shunt varicoil reaches maximum.

Electronic control amplifier A3 consists of servo compensation network, series and shunt varicoil amplifiers, plus a band sense determining circuit that allows band prepositioning of tuning elements. Servo compensation network allows switching of input signals and conversion of these dc input signals to 400-Hz chopped square waves prior to amplification by servo amplifiers.

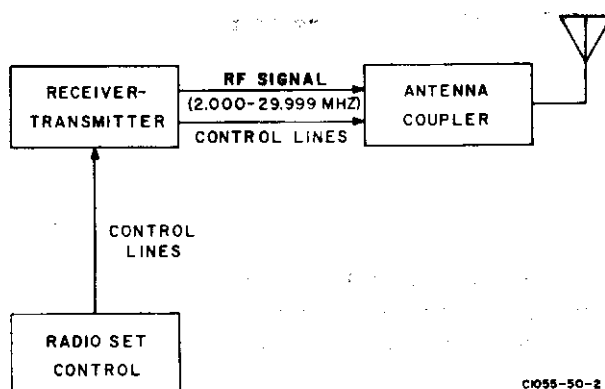


Left Side Module Location
Figure 14

The 490T-1 contains an antenna transmit-receive relay and a receiver ground relay. The antenna transmit-receive relay automatically bypasses the 490T-1 tuning elements when the hf system is in the receive mode; and the receiver ground relay protects the receiver by grounding the receiver input when the complementary transmitter of a dual installation is operating.

C. Indicators. (Refer to figure 1.)

Two indicator lamps labeled TUNE and OPR are located on the front panel of the coupler. The tune lamp lights when sufficient forward power is available and tuning is in progress. The operate lamp lights to indicate that the coupler is in the operate condition. A fault condition is indicated when both lamps are lit.



Basic HF Communication System,
Block Diagram
Figure 15

5. THEORY OF OPERATION.

A. HF System General Theory of Operation.

A basic hf communication system consists of a receiver-transmitter, a radio set control, an antenna coupler, and an antenna. This system provides voice communications between aircraft and ground-communication stations. Figure 15 is a simplified block diagram of an hf system.

The receiver-transmitter can receive and transmit in the high-frequency band (between 2.000 and 29.999 MHz). The receiver-transmitter initiates the antenna coupler tune cycle.

The radio set control furnishes frequency and mode information to the receiver-transmitter. This information is in the form of binary ground-or-open signals applied to the control wires of the radio set control. In addition, the antenna coupler derives band information from the transmitted rf signal. This band information is used to automatically tune the 490T-1/1A Antenna Coupler and match the antenna impedance with the receiver-transmitter impedance.

B. 490T-1/1A Antenna Coupler General Theory. (Refer to figure 16.)

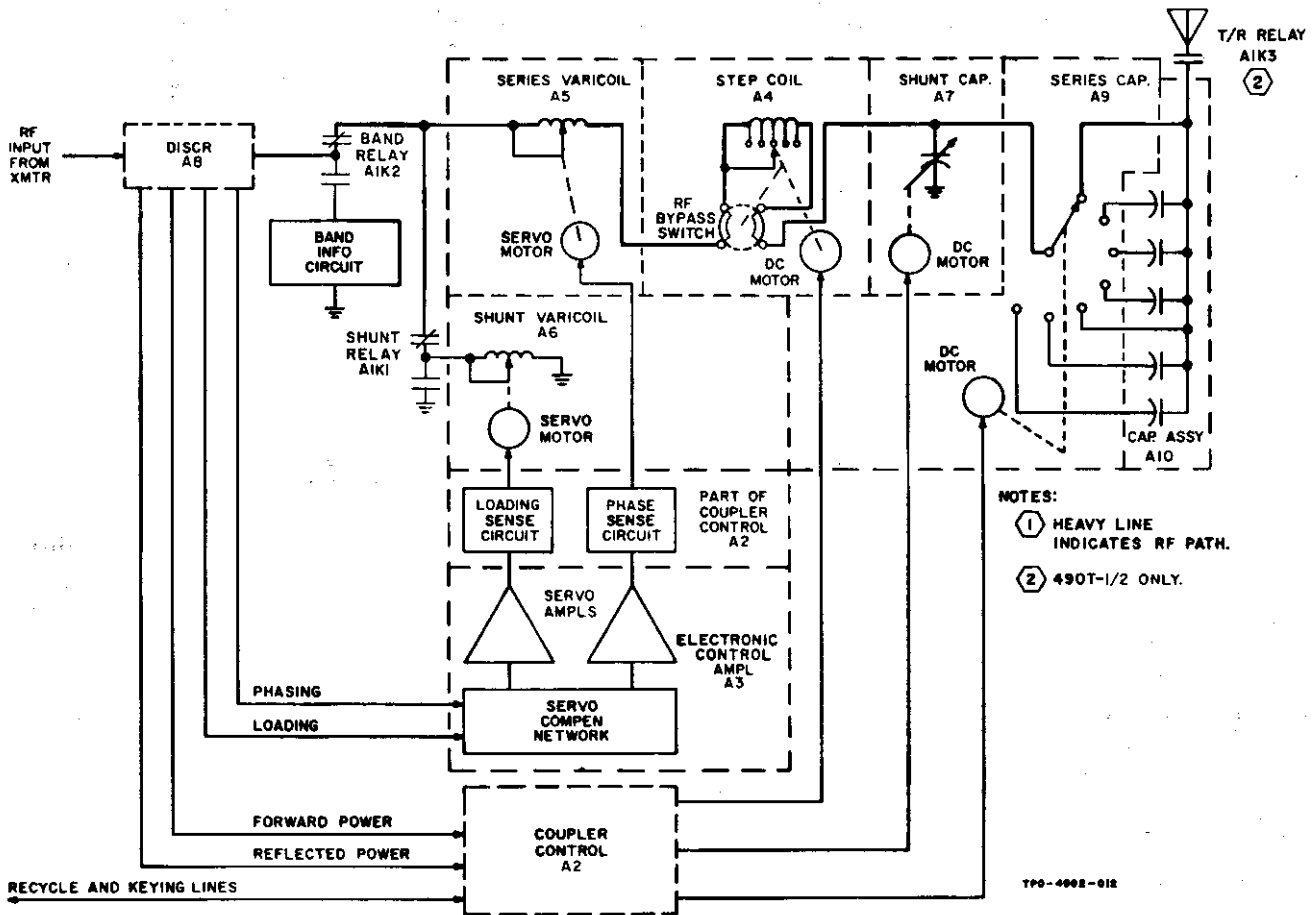
Transmitted rf signal from 2.000 through 29.999 MHz is received by the antenna coupler, and is sampled first in the discriminator. The discriminator contains sensing circuits that compare rf line current with rf line voltage to produce phasing, loading, forward power, and reflected power error information. The main rf signal either proceeds through deenergized band relay A1K2 contacts to the antenna system, or briefly, after rf power is applied and for sufficient time to determine band information through energized band relay contacts to frequency band information circuit.



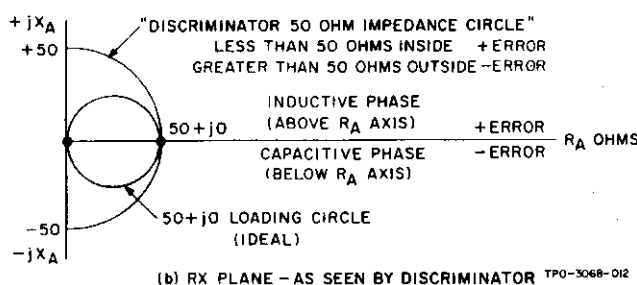
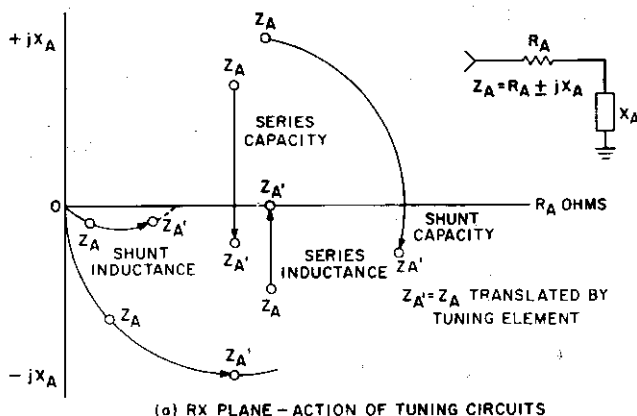
Discriminator error information appears as polarized dc error voltages at the discriminator output that are sent to activate the control circuits in the coupler control and electronic control amplifier. In the electronic control amplifier, phasing and loading error voltages are converted to 400-Hz signals and then amplified by the servo amplifiers. Servo-amplifier outputs preposition the tuning elements for correct band operation and regulate phasing and loading information to coupler control for series and shunt varicoil operation.

Coupler control inputs, forward power, reflected power, servo-amplifier outputs, recycle line, and keying lines, are sequenced by switching relays, silicon controlled switches, and transistor logic circuits to control the operation of antenna coupler.

The remaining modules comprise the tuning elements for the antenna coupler. Tuning components are the series varicoil, shunt varicoil, step coil, shunt capacitor, and series capacitor.



Antenna Coupler, Block Diagram
Figure 16



490T-1/1A, R-X Plane
Figure 17

C. Impedance Theory.

(1) R-X Impedance Plane.

Any antenna impedance ($Z_A = R_A \pm jX_A$) can be represented graphically on an R-X impedance plane. (See figure 17.) Resistive (resonant) impedances ($R_A + j0$) lie on the horizontal R_A axis. Inductive impedances ($R_A + jX_A$) are above the axis, and capacitive impedances ($R_A - jX_A$) are below the axis. Each tuning element produces a predictable translation of antenna impedance Z_A as shown. Stray reactances, which become appreciable at the higher frequencies and can act as additional network elements, will not be discussed at this time.

Series tuning elements translate Z_A upward for added inductive reactance ($+jX$) or downward for added capacitive reactance ($-jX$). Shunt tuning elements translate Z_A around on a circle which passes through both the Z_A point and the $0+j0$ origin point. Capacitive reactances produce clockwise rotation, and inductive reactances produce counterclockwise rotation.



(2) R-X Impedance Illustrated.

Normal operation is obtained when antenna impedance is within the operating curves as shown in figures 18, 19, and 20. All curves were plotted using 200 watts average and voltage limitations of 630 watts pep.

An antenna impedance which lies within the curve of a given frequency can be tuned by the 490T-1/1A at that frequency. The curves for the 4- to 16- and 16- to 30-MHz ranges are divided into 2 parts, shown as part A and part B, with part B being an enlargement of part A around the $R_A = 0$ point, where the tuning circles are most useful. The 2- to 4-MHz curve has an additional part, part C, showing the location of tuning holes at low frequencies. Notice the similarity of the 2- to 4-MHz curves in part B. The irregular shape in the 2-MHz curve between 480 and 1060 ohms jX_A has decreased and appears between 200 and 500 ohms on the 4-MHz curve. Interpolation can be used, assuming linearity, to determine whether a particular antenna can be matched at 3 MHz. The 2- to 4-MHz curve contains a third part, part C, that outlines a series of 2- and 3-MHz holes appearing in the $R_A = 0$ to 700-ohm range. The hole completely disappears at 4 MHz. These high impedance holes are not considered realistic with respect to actual wire and whip impedances as found in most installations. A complete family of curves could be plotted for all frequencies between 2 and 30 MHz; however, interpolation can be used to determine the usability characteristics of the 490T-1/1A in a given situation. For example, assume an antenna of 4000 ohms inductive reactance with a 7000-ohm resistive component is operating at 20 MHz. After finding this point on the 16- to 30-MHz curve (marked X) estimate the location of the circle of the desired frequency and determine whether the point is inside the circle. The best way to estimate the circle is to assume linearity in dividing the R_A line between the 16- and 30-MHz crossover points into megahertz steps and draw a circle using the distance between the $R_A = 0$ point and the point of the selected frequency as the diameter.



PIN	WIRE	DESCRIPTION
F	Recycle line	Input ground causes tuning elements to move to home position.
H	Tune power ground line	Grounded by 490T-1/1A during analog tuning to maintain analog tuning and hold the transmitter in tune condition.
J	*Analog tune in progress (ATIP)	Grounded by 490T-1/1A to indicate tuning elements are tuning to the new frequency.
Š, Ľ	Key interlock 1, 2	Opened by 490T-1/1A when a fault occurs or when 490T-1/1A is homing.
K	Key line	Input ground initiates tuning to the new frequency. Also arms the coupler for demand surveillance during transmission.
C	*Operate	Grounded by 490T-1/1A to indicate it is in operate condition with a vswr below 1.3:1.
B	*Fault	Grounded by 490T-1/1A to indicate a fault or malfunction. Any failure that results in a tuning time greater than 8 to 10 seconds is considered a fault or malfunction condition.
G	Dc ground	System ground connects 490T-1 ground.
A	115 vac, 400 Hz (1)	Primary power input (hot).
D	115 vac, 400 Hz (2)	Primary power input (cold). Line may be grounded if desired.
R	+28 vdc (partially filtered)	Power output to 437R-1.
a	**Key relay ground	490T-1 tuning elements can be used during receive mode by grounding.
P	Band Y (8.0 to 30.0 MHz) (generated in 490T-1)	Output ground for 437R-1 tuning.
N	Band Z (4.0 to 8.0 MHz) (generated in 490T-1/1A)	Output ground for 437R-1 tuning.

490T-1/1A Input Signal and Voltage Chart (Sheet 1 of 2)
Figure 102

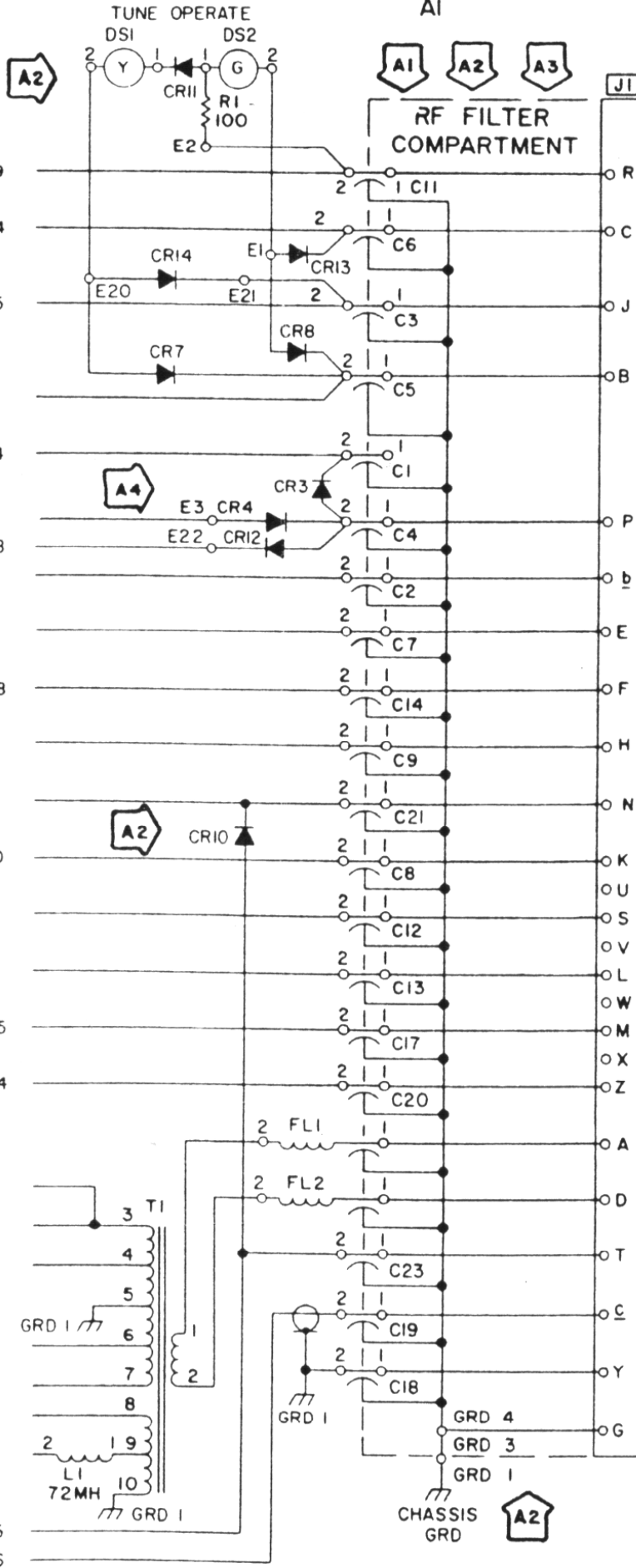


PIN	WIRE	DESCRIPTION
W	**28-volt receiver relay	Energizing circuit for receiver antenna ground relay.
X	**Receiver relay ground	Energizing circuit for receiver antenna ground relay.
b	Shunt capacitor stop	Ground supplied by 437R-1 to stop operation of the 490T-1/1A shunt capacitor.
E	Step coil limit (4 to 8 MHz)	Ground supplied by 437R-1 to limit operation of step coil.
T	Step coil limit (2 to 4 MHz)	Ground supplied by 437R-1 to limit operation of step coil.
M	Monopole limit	Prevents 437R-1 tunable coil from tuning.
Z	Run monopole	Ground potential supplied by 490T-1/1A to allow operation of 437R-1.
Y, c	Servo gain 1, 2	Allows gain of servo lead networks to be controlled externally.

*Indicator lines not used in most 618T, 618S installations.
**Applicable only to 490T-1.

490T-1/1A Input Signal and Voltage Chart (Sheet 2 of 2)
Figure 102

CHASSIS
A1



- R ○ 28V PARTIALLY FILTERED OUT
- C ○ OPERATE
- J ○ ANALOG TUNE IN PROGRESS
- B ○ FAULT
- P ○ BAND Y (8-30MHZ)
- b ○ SHUNT CAP. STOP
- E ○ STEPPED COIL LIMIT 4-8MHZ
- F ○ RECYCLE LINE
- H ○ TUNE POWER GRD LINE
- N ○ BAND Z (4-8 MHZ)
- K ○ KEY LINE
- OU ○
- S ○ KEY INTLK 1 (27.5 VDC OUT)
- V ○
- L ○ KEY INTLK 2 (27.5 VDC IN)
- W ○
- M ○ MONOPOLE LIMIT
- X ○
- Z ○ RUN MONOPOLE
- A ○ 115 VAC 400 HZ (1)
- D ○ 115 VAC 400 HZ (2) (AC GRD)
- T ○ STEP COIL LIMIT 2-4 MHZ
- C ○ SERVO GAIN 2
- Y ○ SERVO GAIN 1
- G ○ DC GRD

- NOTES:
- ① UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS AND ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS.
 - ② RF CIRCUIT PATH SHOWN AS HEAVY LINE.
 - ③ ALL DIODES ARE TYPE 1N645.
 - ④ ALL FILTER CAPACITORS ARE 1200 MICROMICROFARADS

