

7.0 SPECIFICATIONS

Input	120 VAC±20%, 50-60 HZ
Output	10 amp relay contact
Size	10"Wx 12" H x 5" D
Mounting	Any flat surface
Weight	Approximately 15 lbs
Temperature	-55 C to +55 C
Frequency	Within VHF range as specified by customer
Warranty	1 year from date of purchase
Antenna	VHF whip or remote antenna as required

8.0 REPLACEMENT PARTS LIST

Base Assembly	1	Control Industries No. 11-0133
Receiver Board	1	Control Industries No. 11-0155
Decoder Board	1	Control Industries No. 11-0366
Timer Board	1	Control Industries No. 11-0377
Power Supply Board	1	Control Industries No. 11-0088
Power Relay Board	1	Control Industries No. 11-0095
Fuse	1	LittleFuse MDL 3
Fuse	1	LittleFuse MDL 1

RECEIVER CONTROLLER

MODEL RC 1T2A (S/N 8000 and Above)

FIELD SERVICE INSTRUCTIONS

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Control Industries Inc.
409 Lafayette Ave.
Urbana, Ohio 43078
TEL 937-653-7694
FAX 937-653-8018

**HANDBOOK OF OPERATING AND MAINTENANCE
INSTRUCTIONS
RECEIVER CONTROLLER RC-1T2A**

1.0 GENERAL:

The model RC-1T2A controller has been specifically designed to provide remote control of airport lighting systems which require only one control function. This control system will allow the approaching pilot to turn the runway lights on at his discretion. The RC-1T2A is enclosed in a weather-proof water-tight housing and is conservatively designed for continuous outdoor unattended operation.

The RC-1T2A receiver controller complies with FCC rules and regulations Part 15.

2.0 ELECTRICAL:

The receiver is of combination field-effect transistor and integrated-circuit design. The sensitivity is adjustable from 1 microvolt to 30 microvolts as desired by the user, permitting a control range of 1 to 20 miles. Receivers are shipped normally adjusted to a sensitivity of 10 microvolts. The unit is designed to operate from 120 volt $\pm 20\%$ 50-60 HZ single phase power.

3.0 THEORY OF OPERATION:

The system is activated upon receiving a series of pulses of R.F. energy where each succeeding pulse follows the preceding pulse by not more than one second.

After receipt of five pulses the relay closes.

The solid state timer will continue to operate for 15 minutes after which it will cause the system to revert to the original "off" condition. The timer is reset by the receipt of five pulses at anytime, reinitiating the 15 minute "run" cycle. The operating time may be selected in 15 minute increments from 15 minutes to 1 hour by setting switches on the Timer Board.

During testing, the 15 minute operating period may be terminated by pressing the Timeout Switch on the base assembly.

In the event of power failure, the system will resume operation in the last commanded mode

The solid state receiver-controller is composed of five printed circuit cards which include the regulated power supply and test oscillator. The following describes the theory of operation for each of the receiver-controller basic elements.

Reference: Functional Diagram Figure A.

6.0 INSTALLATION:

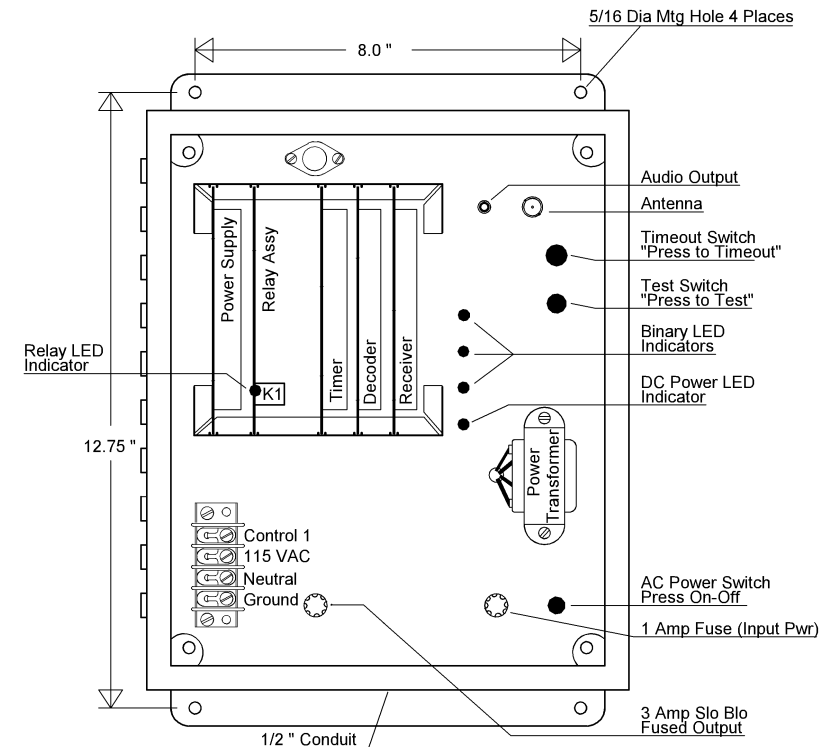
The receiver-controller RC-1T2A is designed for all-weather outdoor unattended operation. The weather-tight case will repel the elements and no shelter is required.

Control and power lines should enter by means of the 1/2 inch conduit entry in the bottom of the unit. A maximum of five conductors is required to complete the installation.

The terminal block is clearly marked with neutral and 115V AC terminations. Attention to correct connection of the neutral is important. Failure to observe these instructions may damage the equipment and may result in the undesirable switching of the neutral instead of the "hot" side of the line.

For outdoor installation the antenna is attached directly to the antenna mounting supplied on the top surface of the enclosure. For indoor installation, a remote ground-plane VHF antenna is supplied.

**FIG K
MOUNTING PLAN, PICTORIAL
(Shown with PCB Cover Removed)**



5.3.5.2 OPERATING THEORY (TEST OSCILLATOR):

The test oscillator is composed of an FET (Q-4) and a quartz crystal operating on the third mode. The output (drain) of the FET is tuned to 3 times the crystal operating frequency. Coil L-2 is tuned to the 3rd mode frequency of the crystal. L-1 is tuned to 3 times this frequency. No direct coupling of this oscillator into the receiver exists. Stray coupling through the power supply and wiring is sufficient for the purpose. The time constant for momentary initial start up is established by R-1-C-6. Failure of the test oscillator will not disable the operation of the controller. Only testing convenience will be affected.

Transistor Q-1 is a switching transistor effectively in series with the power supply of the test oscillator. Failure of this transistor or associated circuits will cause failure of the test oscillator. The momentary timing network appears in the base circuit of Q-1

5.3.6 AUDIO OUTPUT MODULE:

An audio output module is included as an integral part of the receiver. This module is for the purpose of conditioning and sending audio tones over telephone lines to a remote location for control purposes.

5.3.6:1 AUDIO OUTPUT MODULE FUNCTIONS:

The audio module provides power amplification of the audio signal. It is present at the audio jack to a level of 1 milliwatt minimum across a 600 ohm balanced to ground resistive load. The audio signal is thus made proper for presentation to standard telephone circuits. Diode limiting is provided to prevent any possibility of excessive level which would cause cross-talk within the telephone system.

FIG A

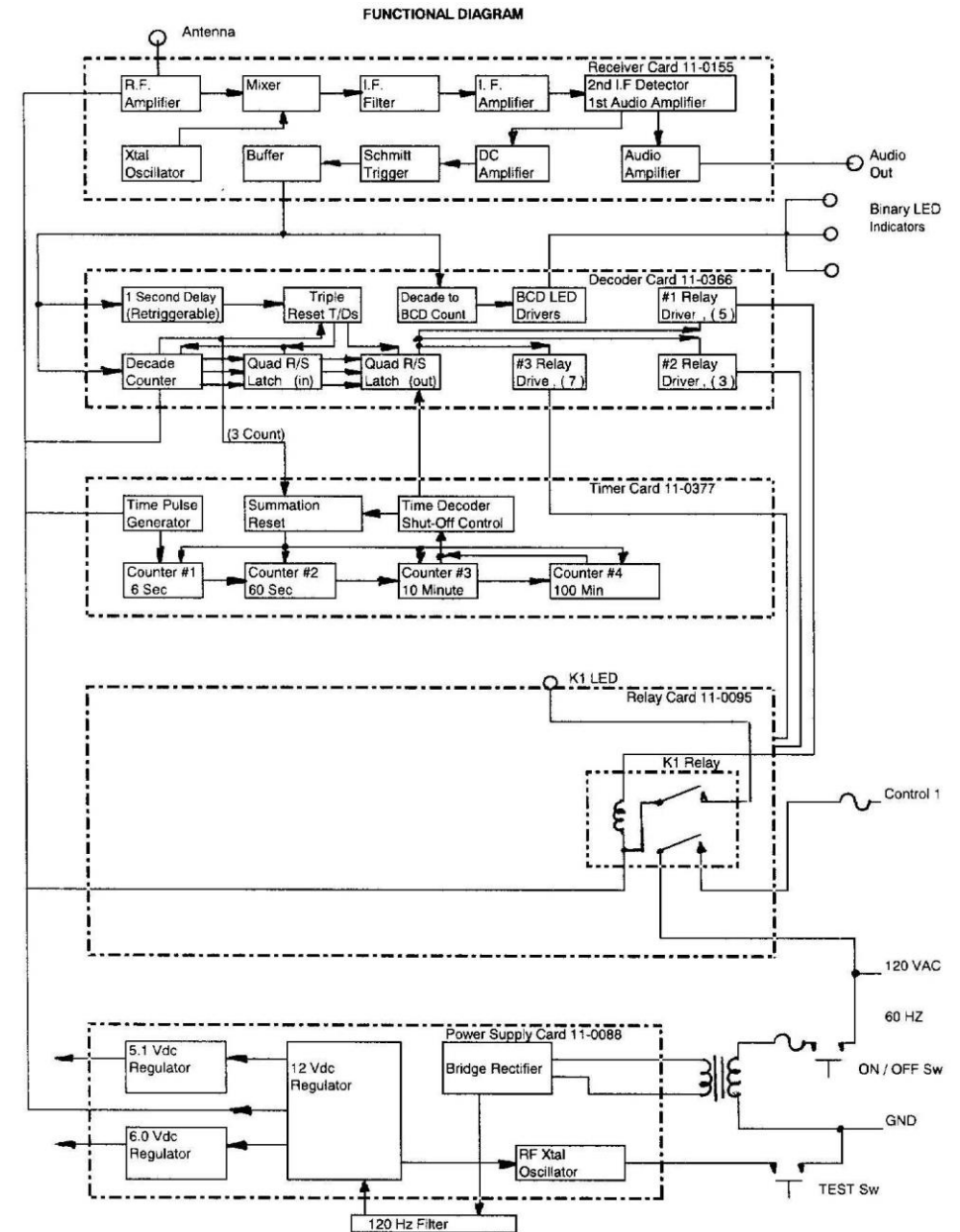
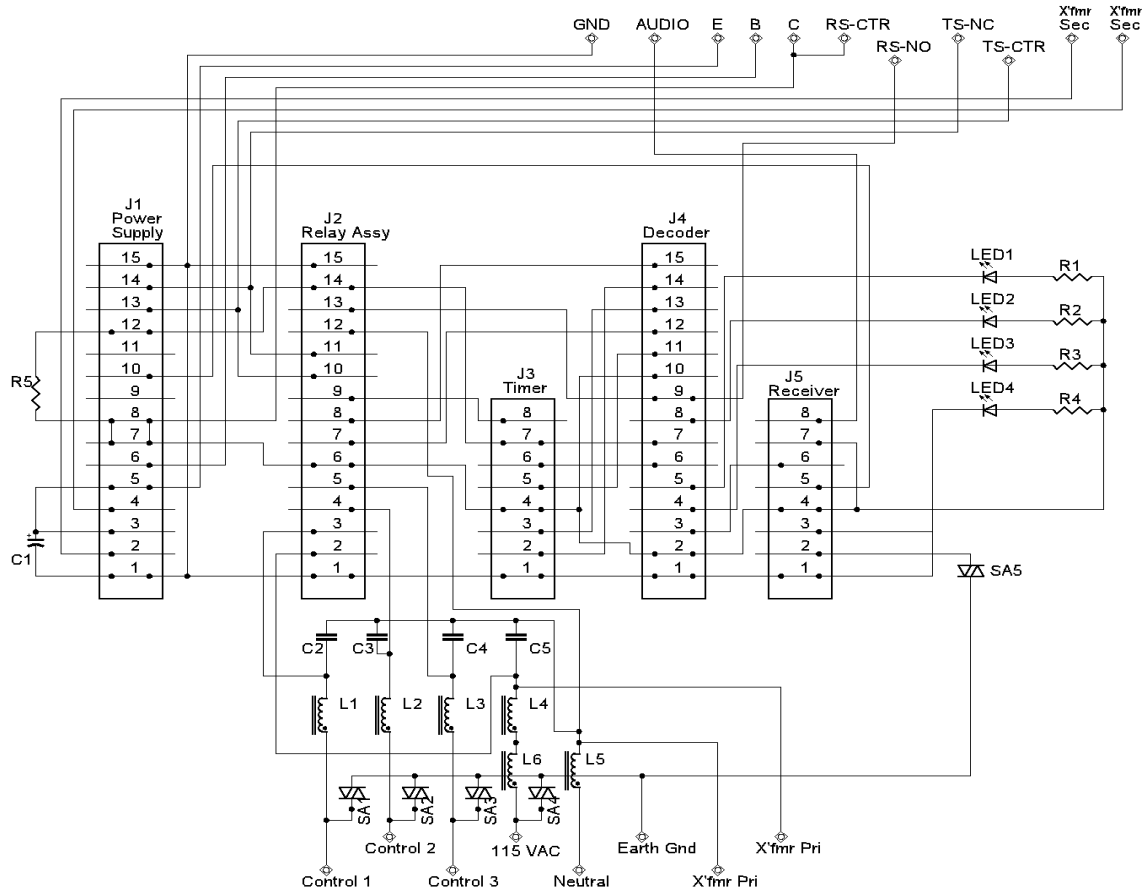


FIG B
INTERCONNECTING WIRING DIAGRAM
(with Lightning Suppression Components)



5.3.4 *TIMER BOARD (C.I. PART #11-0377):*

The purpose and general theory of the timer card is described in paragraph 3.3. The timer card is primarily used to perform shut down functions after 15 minutes operation. The operating time is preset at the factory at 15 minutes. Other operating periods may be selected by changing the settings of SW1 thru SW4. Only one (1) switch should be set to 'ON' at any one time. S2-ON will give 30 minutes of operation, S-3 ON will give 45 minutes, and S-4 ON will give one hour of operation.

Twelve volts enters the timer card on pin 4, and 5.1 volts D.C. enters on Pin 7. Disturbance to other parts of the receiver can occur only as the result of direct short circuits associated with these pins.

5.3.4.1 *DETAILED OPERATIONAL THEORY:*

The basic timing of this card is derived from the stable 600 millisecond time pulse generator which is always running. The timing signals are summed in a series of 4 decade counters, establishing a one minute time base in the first two counters, and counting from 1 thru 99 minutes in the last two. After receipt and decoding by the decoder card of 3 incoming pulses of R.F, the counters are reset to a count of zero, initiating the 15 minute time period. The 15 minute count is decoded by IC6, a quad 2 input AND gate, and switch SW1. This sends a reset signal to the decoder which commands the relay Off.

5.3.5 *TEST OSCILLATOR:*

An R.F. oscillator operating on the input frequency of the receiver is included to test the overall operation of the receiver. This oscillator is part of the power supply card.

5.3.5.1 *TEST OSCILLATOR FUNCTIONS:*

The test oscillator is keyed on by the red test button. Incoming pulses may be simulated by actuating this test oscillator control. Additionally the test oscillator is momentarily actuated upon application of input power for the purpose of zeroizing all logic circuits at initial start up.

The input pulses that are received from the receiver/Schmitt trigger are applied simultaneously to the clock input, pin 9, of IC-8B (Decade Counter with Binary Coded Decimal (BCD) outputs). The outputs, pins 11, 12 and 13 are presented in BCD format. They are applied thru IC-9A, B and C (one half of Hex Inverter) to drive the LED Indicators on the Chassis (see Figure K). The appropriate LED patterns for a particular count sequence are as shown on Figure J.

Proper counting sequence may be determined as follows:

(A) On the receipt of 5 pulses IC-3 pin 1 should go Hi. This Hi signal appears also at IC-4 pins 5 and 9, IC-5 pins IC-5 pins 4 and 2, IC-6 pins 1 and 3 closing Relay K-1.

In this mode the system will time out in 15 minutes and reset to initial conditions. A new 15 minute time period may be selected at any time by commanding either 5 or 3 pulses. Alternate periods of 30 minutes, 45 minutes or 1 hour may be selected from the timer board.

Power Failure mode. In the event of power failure, a network comprised of diode D1, and capacitors C7 and C8 maintains power to IC-5 so that the existing state of IC-5 at the moment of power failure is restored upon power restoration. This restores the last commanded operational mode

The decoder board has no adjustment.

FIG J
LED INDICATOR SEQUENCE PATTERN

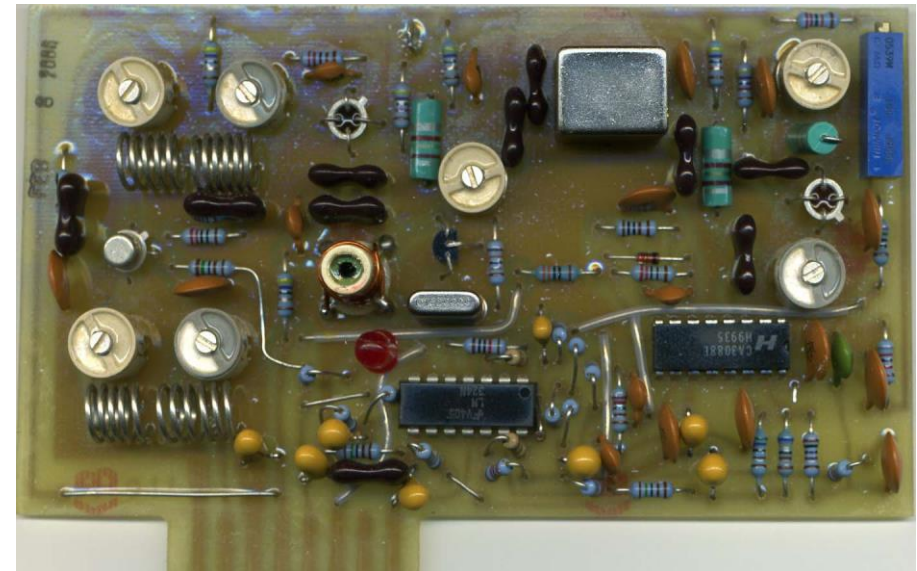
COUNT	0	1	2	3	4	5	6	7
	○	●	○	●	○	●	○	●
	○	○	●	●	○	○	●	●
	○	○	○	○	●	●	●	●
DC	●	●	●	●	●	●	●	●

3.1 RADIO FREQUENCY CARD (C.I. PART #11-0155)

The radio receiver is a single conversion superheterodyne design operating at a nominal R.F. frequency within the VHF band of 118 to 136 MHz. An IF frequency of 21.4 MHz is utilized with the bandwidth controlled by a 6 pole crystal lattice filter. This filter establishes nominal -60 db rejection at adjacent channel frequencies of ± 25 KHz or more. It also establishes an on-frequency bandwidth of nominally ± 9 KHz at the -6.0 db points. Intermediate frequency amplification is provided in part by a dual gate FET first IF amplifier. A communications type integrated circuit provides the remainder of the IF gain, AM detection, AGC and audio output. The audio output is buffered and delivered to a service jack for maintenance and test purposes. The AGC Voltage controls the overall gain of the receiver and is also used to sense the presence of a desired signal. The AGC voltage level is amplified and utilized to change the state of an integrated circuit Schmitt trigger. The Schmitt trigger is required to condition incoming R.F. pulses in terms of amplitude and rise time. It also eliminates the undesirable effects of aircraft transmitter modulation. The output binary condition of the Schmitt trigger is buffered and utilized as the input to the Decoder Card. A red LED indicator is included on the receiver card to visibly show the state of the receiver logic.

FIG C

RECEIVER CARD 11-0155



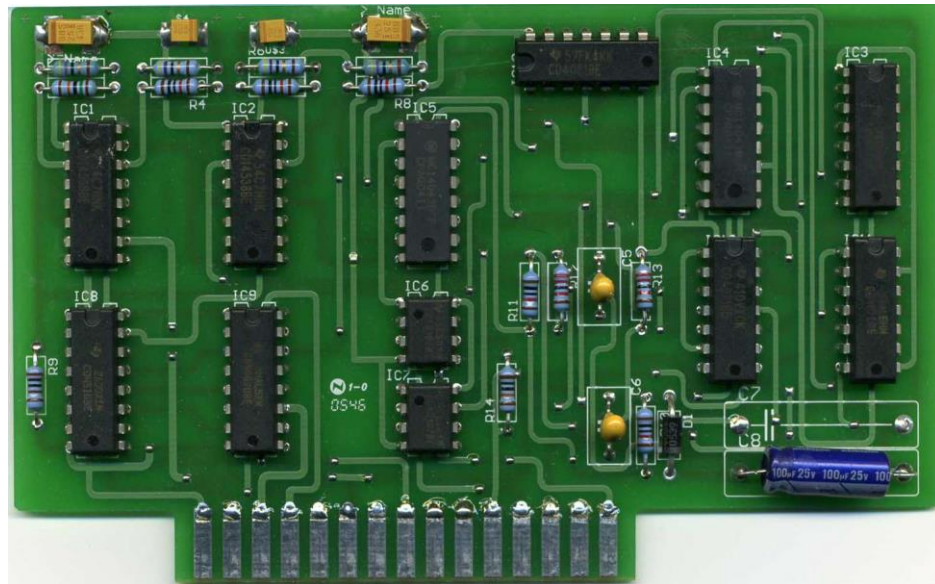
3.2 DECODER CARD (C.I. PART #11-0366):

The functional purpose of the decoder card is to sense the presence of 5 pulses, with a time period of less than one second between each ensuing pulse and affect the Relay K-1 closure. The following is the sequence of operation:

Upon receipt of the first pulse from the Schmitt trigger a one second time delay period is initiated by the re-triggerable time delay circuit. This first pulse is registered at Q1 of decade counter IC3. All subsequent pulses are registered at the corresponding output of IC3. After 5 pulses are received, the Q5 output of the counter is active, (logic Hi level). This Hi level is applied to the S1 (set input #2) of IC4, Input Quad Latch. A logic Hi level appears at the Q1 output of IC4, which in turn is connected to S0 of IC5, Output Quad Latch. This produces a logic Hi at Q0 of IC5, and the input of Output Driver IC6, commanding relay K1 to close. If for any reason the 5 pulses are not received within 1 second intervals of each other, the time delay circuit causes decade counter IC3 to reset to its original condition.

In the event of AC power failure, the system will resume operation in the last commanded mode.

**FIG D
DECODER CARD 11-0366**



5.3.2.3 RECEIVER BOARD OPERATING THEORY:

The signal path through the receiver is shown in block form in Functional Diagram Figure A.

The following is a listing of the operating frequencies of the various elements of the receiver.

(a) R.F. Amplifier	VHF frequency
(b) Mixer	VHF frequency
(c) Xtal Oscillator	Input VHF frequency minus 21.4 MHz
(d) First IF Amplifier	21.4MHz
(e) Crystal lattice Filter	Center 21.4 MHz, bandwidth ± 9.0 KHz
(f) IF/Detector Chip	21.4MHz
(g) Digital logic	D.C. pulses

5.3.3 DECODER CARD (C.I. PART #11-0366):

After determination of proper operation of the Power Supply and Receiver section of the controller, and a malfunction remains, the next procedure is examination of the Decoder card. General theory of operation and purpose of this card appears in paragraph 3.2. A volt ohmmeter and an oscilloscope are required for proper servicing of the decoder card.

5.3.3.1 DETAILED OPERATIONAL THEORY:

Twelve volts D.C. should appear at Pins 2 and 10 of the base connector and 5.1 volts at pins 7. The actuating pulse appears on pin 3 arriving from the receiver/Schmitt trigger. This actuating pulse is applied to Pin 5 of IC-1, (Retriggerable One Second Timer), and to Pin 14 of IC-3, (Decade Counter). Circuit IC-1A is a time delay of one second, which is extended in one second intervals as long as it continues to receive signals before the expiration of the one second delay. Decade counter IC-3, stores the number of pulses received and initiates the transfer of commands to the control relays upon receipt of the fifth pulse, indicating true data instead of noise. Use of a suitable oscilloscope can serve to trace the presence or absence of these pulses at IC-1 and IC-3.

Receipt of 5 pulses appears Q5 of IC-3 (pin 1). As each counter output goes High, the signal is processed as explained below. A count of 5 actuates relay K-1.

5.3.2.1 SERVICING RECEIVER BOARD:

The receiver board may be tested and aligned while installed in the unit however tuning adjustments are more accessible if the receiver card is operated in a special external test jig designed for the purpose. The following test equipment is required for proper alignment of the receiver board:

- (1) A VHF signal generator AM modulated. (Hewlett Packard Model 608A or equivalent).
- (2) A high impedance volt meter (10 Mohm input impedance) capable of measuring 5.0 volts D.C.
- (3) An accurate frequency counter or other suitable means to insure the accuracy of the signal generator is required.
- (4) A standard headset or audio amplifier. Refer to Functional Diagram Figure A.

5.3.2.2 ALIGNMENT PROCEDURE: RECEIVER BOARD

- (a) Connect the VTVM between ground and the junction of resistor R-10 and R-11. This junction is also the source terminal of the first IF amplifier FET.
- (b) Adjust the sensitivity control R-11 for a reading of approximately 4.5 volts. This control is a 10 turn miniature potentiometer.
- (c) Connect the signal generator to the input of the receiver with a suitable length of 50 ohm coaxial cable. Adjust the generator to the exact operating frequency of the receiver. Increase the signal generator output until audio modulation is noted in the headset or audio amplifier connected to the audio output jack. Adjust tuning capacitors C-1, C-2, C-3, C-4, C-11, C-19, and C-21 for maximum audio in the headset. The signal generator output must be reduced as alignment progresses to insure that true tuning peaks are discernable and are not masked by AGC action. After maximizing these adjustments audio output should be obtained at approximately 5 microvolts level and above.
- (d) Connect the VTVM to test point TP-1. With no signal applied, a voltage of approximately +3.0 volts will appear. As the level of the signal generator is increased, this voltage will decrease. Precisely re-trim each of the tuning capacitors for a minimum reading on the VTVM. Keep the level of the signal generator adjusted to a level that causes a reading of 1.5 to 2.5 volts on the VTVM. This allows the most accurate adjustments to be achieved during this final tuning procedure. The red LED indicator will trip at approximately 2.0 volts on the VTVM. Below 2.0 volts it will glow. Above approximately 2.0 volts it will not glow.
- (e) Adjust the signal generator output to 10 microvolts and recheck on-channel accuracy with the counter. Adjust the sensitivity control R-11 until the logic trip point just occurs at the 10 microvolt signal input level. The logic state is indicated by a red LED indicator on the receiver card. Movement of the sensitivity control R-11 clockwise decreases sensitivity, movement counter-clockwise increases sensitivity. When adjusted as described above the LED will not glow with 5 microvolts applied from the signal generator

3.3 TIMER CARD (C.I. PART #11-0377):

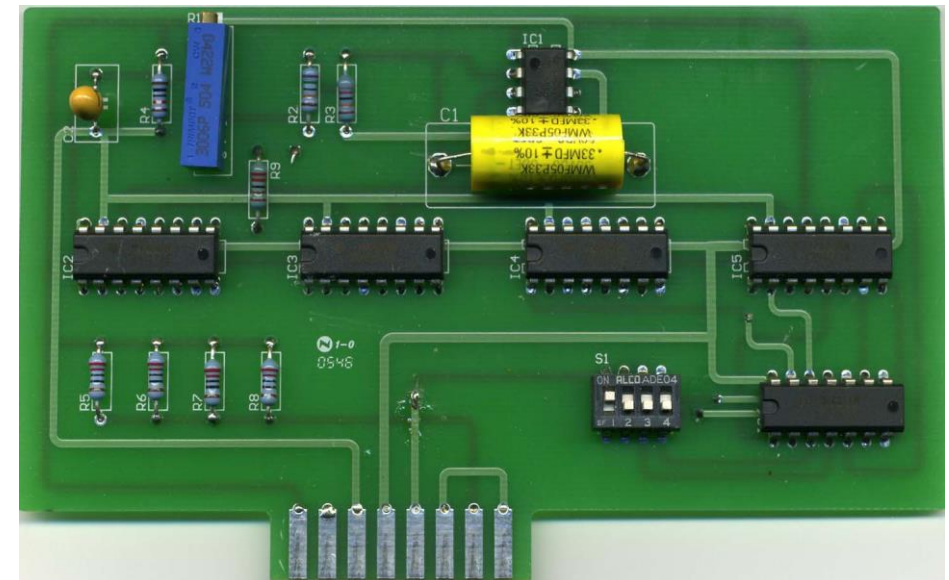
The purpose of the timer card in the RC-1T2A is to provide a 15 minute "hold-on" period for relay K-1.

The basic timing of this card is derived from the stable 600 millisecond time pulse generator which is always running. The timing signals are summed in a series of 4 decade counters, establishing a one minute time base in the first two counters, and counting from 1 thru 99 minutes in the last two. After receipt and decoding by the decoder card of 3 incoming pulses of R.F, the counters are reset to a count of zero, initiating the 15 minute time period. The 15 minute count is decoded by IC6, a quad 2 input AND gate, and switch SW1. This sends a reset signal to the decoder which commands the relay Off.

If a new control signal is received from the decoder, the decade counters will be reset to zero, initiating a new 15 minute time period. This allows the pilot to recycle the system for a full 15 minute period at any time during its activation by commanding K-1 (5 pulses). The summation reset circuitry additionally insures that all registers always start from their zero state.

Alternate time periods of 30 minutes, 45 minutes or 1 hour may be selected by changing switches SW1 through SW4.

FIG E
TIMER CARD 11-0377



3.4 POWER SUPPLY/TEST OSCILLATOR CARD (C.I. PART #11-0088):

This printed circuit board includes the rectifier and electronic regulator portions of the regulated D.C. supply and the crystal controlled test oscillator. The power transformer and dual section hum filter components of the power supply are on the chassis main-frame.

The power supply is composed of a power transformer, diode bridge rectifier, dual section hum filter, and a series pass transistor constant voltage regulator. The output voltage is regulated at 12.0 volts D.C. This regulated voltage level is further divided and clamped by Zener diodes at 6.1 volts for the receiver electronics and 5.1 volts for the solid state logic circuits. The range of control is approximately 95 volts 50-60 cycle AC to 140 volts 50-60 cycle AC. Within this excursion range the D.C. supply voltages remain constant. The test oscillator is included within the power supply card to provide a complete system test from RF input to output relay closure. The oscillator is a third mode crystal circuit activated by the red test switch button. No direct coupling of the test oscillator output is made to the receiver card. Stray coupling is sufficient for this purpose.

The test signal frequency generated is the same as that for which the receiver is designed and is provided for use by maintenance personnel to check for proper operation of the system.

FIG F
POWER SUPPLY CARD 11-0088

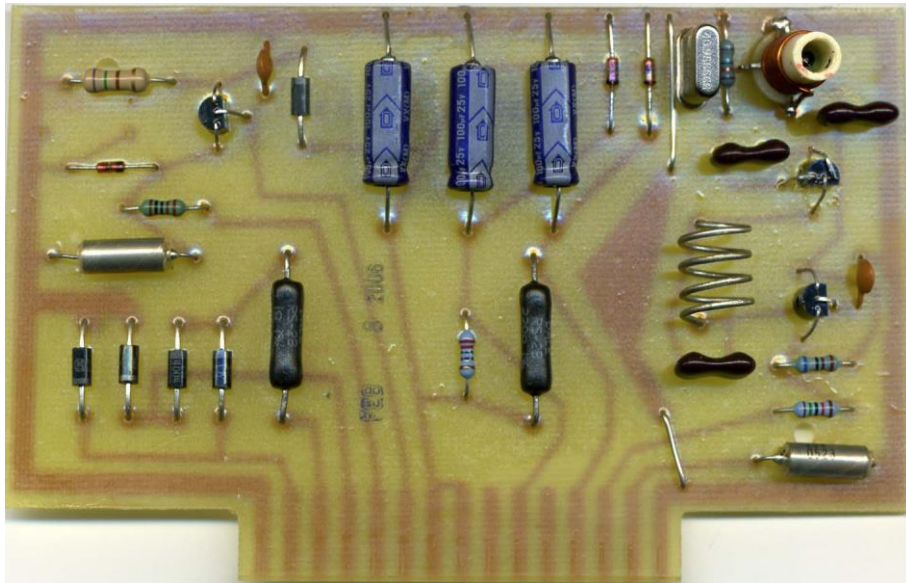
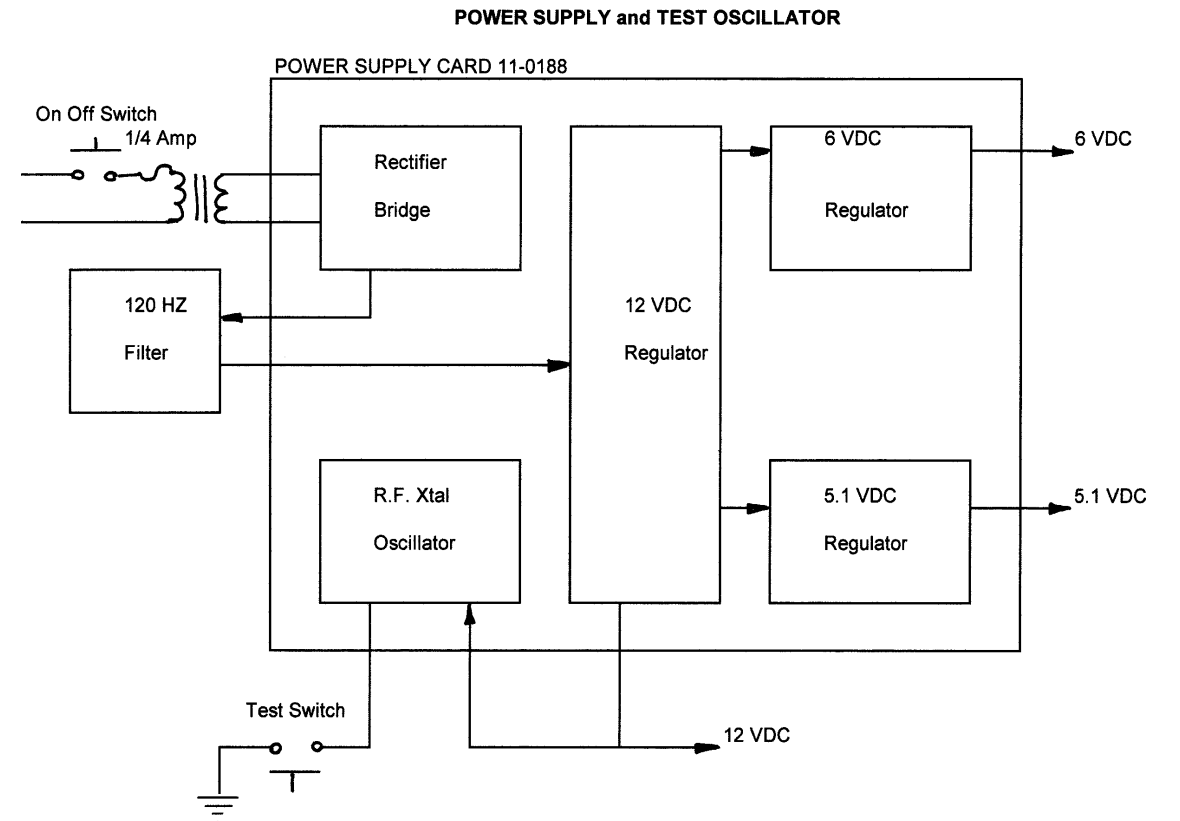


FIG H



5.3.2 RECEIVER BOARD:

The receiver board is a printed circuit card identified as C.I. part #11-0155. This board comprises the complete receiver and a Schmitt trigger driver for the logic circuitry.

An effective method of determining condition of the receiver board may be accomplished by listening to the audio at the output jack identified in Figure K. A head set or suitable audio amplifier will reveal a slight pressure of noise which gives a general indication if the receiver is operative or inoperative. Depressing the red test button should cause a loud hum to occur in the head-set and also cause the first binary indicator LED to light. Absence of either of these indications represents probable receiver board failure.

5.3 DETAILED MAINTENANCE INSTRUCTIONS:

If during the performance of check out as specified in paragraph 4.1 improper operation is noted, the following explanations and instruction procedures will simplify servicing the controller:

5.3.1 POWER SUPPLY:

It should first be determined that proper power 115V AC, 60 cycles is being applied to the input connector terminals labeled 115V AC and Neutral (Figure K). This may be determined by use of a suitable volt-ohmmeter; Simpson Model 260 or equivalent.

The power supply board (C.I. Part #11-0088) is included as one of the printed circuit cards located beneath the dust cover. All power supply electronics are located on this card except the power transformer, dual section hum filter and the series-pass regulator transistor. These latter elements are located on the chassis main-frame and mother board. An LED indicator is provided to indicate presence of 12 volts DC. This indicator is the lower-most of a series of indicators located on the right hand side of the printed circuit dust cover on the main chassis. This indicator glows at all times the receiver is turned on and D.C. is present. The location of this D.C. power indicator is depicted in Figure K.

Indication of the presence of A.C. power as measured by an appropriate A.C. voltmeter and failure of the D.C. indicator indicates a power supply failure. The following steps should be accomplished in sequence. Remove the receiver, decoder, timer and relay cards one at a time and observe the D.C. indicator. This procedure removes and isolates any possible shorts in the logic or radio boards. Recheck for proper D.C. indicator operation. If a failure remains refer to power supply schematic Figure H and perform normal check out procedures of the solid state components, capacitors and resistors. Check for shorts or opens of components, or other normal failures. The output voltage of the power transformer (T-1) should be approximately 16V AC. Replace defective components and retest.

3.5 RELAY CARD (C.I. PART # 11-0095):

The output relay K-1 and its associated components, resistor R-1 and indicator LED-1; diode D-1; and resistor R-4 and capacitor C-1 are contained on their own printed circuit card, P/N 11-0095. The relay is controlled by the relay driver on the 11-0366 Decoder Board, and its operating time by the 11-0377 Timer Board.

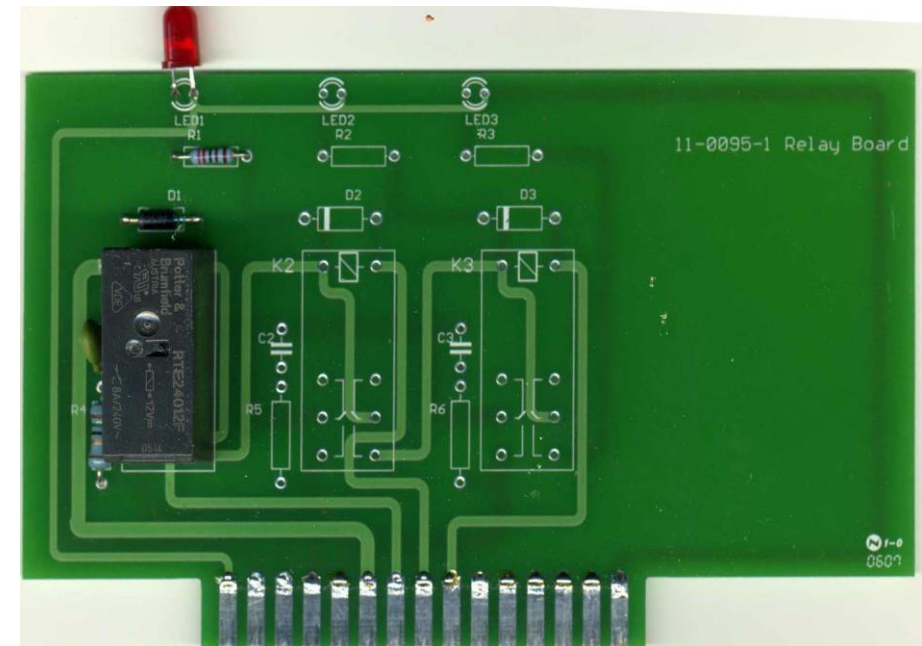
Diode D-1 is connected inversely across the relay coil to suppress the inductive transient when the relay is turned off.

Resistor R-1 and indicator LED-1 show that the relay has been activated when the LED is illuminated. The LED will be visible when the printed circuit board cover is in place.

Resistor R-4 and capacitor C-1 form an arc suppression network to reduce transient noise when the relay deactivates the load relay. This arc suppression also increases relay life.

In case the load relay connected to relay K-1 has a very high coil impedance, keeping the load energized after K-1 is shut off, the arc suppression network may be disabled by removing capacitor C-1.

Fig G
Plug-in Relay Assembly 11-0095



4.0 TROUBLE ANALYSIS:

A malfunction chart including several possible failure modes is supplied to assist the technician in analyzing the probable cause. The receiver-controller is warranted for one year from date of purchase. Failures not caused by improper installation or abnormal treatment will be corrected by the manufacturer free of charge within the warranty period.

4.1 TROUBLE ANALYSIS CHART:

The following tabulations will provide guidance for recognizing possible trouble and correction.

MALFUNCTION	POSSIBLE CAUSE	TEST AND REMEDY
AC voltage present but no DC LED indication	Open 1.0 A. Fuse	Test & Replace
	Bad AC Switch	Test & Replace
	Defect in power supply. electronic board, power transformer or series regulator transistors	Return receiver to manufacturer for service.
DC O.K., no binary LED indication, no audio indication	Defect in receiver card part number 11-0155	Replace card; retest. Send defective card to manufacturer for repair or replacement if in warranty.
DC O.K., no binary count. Audio O.K	Defect in decoder card part number 11-0366	Replace card; retest. Send defective card to manufacturer for repair.
DC O.K. Binary count O.K. Relay closures normal — No output voltage the control line	Open 3A SLO BLO Fuse	Test & Replace fuse with same type only
Failure to reset binary indicators after last pulse	Defective Decoder card, part number 11-0366	Use replacement card and retest.
Fails to turn off after 15 minutes	Defective Timer Card, part number 11-0377	Use replacement card and retest. Return defective card to manufacturer for repair or replacement if in warranty.
	Defective Relay K-1	Replace Relay Card with manufacturer's part number 11-0095
DC O.K., Binary indications normal - output indicator LED not lighted.	Defective Relay K-1	Replace Relay Card P/N 11-0095 and retest.

5.0 MAINTENANCE:

The Model RC-1T2A is designed to require a minimum of maintenance under all ranges of service conditions. There are no moving parts except the output contactor relays. With proper installation, no abuse or tampering, the unit should deliver at least 10,000 hours of trouble free operation.

5.1 MAINTENANCE CONCEPT:

The unit may be maintained readily by technician level personnel. **The printed circuit boards are not readily repairable in the field. Return defective printed circuit boards to Control Industries for repair / replacement by the manufacturer.** A stock of one each substitute cards should be retained to verify a suspected defective card by simple substitution procedures. All other elements of the receiver-controller may readily be checked utilizing normal electrical test procedures involving no special testing equipment other than a standard volt-ohmmeter. A standard headset may be used to monitor the receiver at the audio jack.

5.2 OPERATING CHECKOUT:

The service technician may determine proper operation of the receiver-controller by completing the following checklist:

- (1) Check the presence of primary line voltage as measured between input terminals marked 115VAC and neutral.
- (2) Press AC power switch and observe red DC power indicating LED inside the controller housing. Illumination of this DC indicator implies proper power supply operation.
- (3) Depress red test button five consecutive times with not more than 1 second between pulses. This action should cause the binary indicators to follow the pattern described in Figure J and result in closure of Relay K-1 and illumination of the red LED indicator adjacent to relay K-1 on the Relay Card.
- (4) After elapse of one additional second all binary indicators should extinguish.
- (5)
- (6) Depress the AC power switch, turning the system off.
- (7) After several seconds, depress the AC power switch restoring power. Observe that the system returns to the last active operating mode.

The above procedures accomplish a complete operating check of all elements and functions of the Receiver-Controller RC-1T2A.