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LASL RADIO COMMAND SYSTEM
TYPE SY-199

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1.1 DEVELOPMENT BACKGROUND

There has always been a need to provide extremely remote experimenter stations with timing signals necessary to control data acquisition instrumentation. This need cannot normally be economically satisfied by using typical hardwire links. The use of a radio command link has provided one economical solution to the problem.

In the past, a Radio Tone Receiver, Type RC-8, accepted rf commands from a remote frequency modulated transmitter. The commands consisted of tone pairs of which one tone was common to all commands. The tones were received by the RC-8 and converted to sequenced relay closures for control of the user's instrumentation.

The RC-8 equipment had several deficiencies and exhibited some idiosynchrosies that limited its usefulness. The selectivity characteristic was such that some frequencies on the outside fringe area of the band were attenuated insufficiently; hence, the equipment could occasionally be spuriously energized. The library of 12 commands was occasionally inadequate for large scale experiments. In addition, the RC-8 was totally battery powered; consequently, restricting its operational life.

The need for expanded command signaling capability, AC/DC operation with a longer lasting battery complex, for improved frequency selectivity in the band outside the desired range, and for other considerations led to the development of the new LASL Radio Command System, Type SY-199. During the development phase, consideration was given to (1) making the new system compatible with the old, (2) ameliorating the phase-in/phase-out problems, (3) increasing the battery life of the receivers to extend its operating life in the field, (4) expanding the library of commands from 12 to 40 to enable servicing of more experimenters,

and (5) maintaining the cost at a minimum consistent with the increased flexibility. Additional features include monitoring of the transmissions, recording the execution of the commands at the remote station, and employing nickel-cadmium batteries to reduce the size and weight of the battery pack.

During the initial design phase of the system, an interface problem between the Radio Tone Generator and the Timing and Control System existed. The problem was solved by connecting the ground for the tone generator to the Timing and Control System ground. Thus, when a command signal, in the form of a relay contact closure, is initiated the ground loop is closed.

1.2 DESCRIPTION AND PURPOSE

The SY-199 radio command system is comprised of (1) a Tone Generator, Type SG-116, located in the CP, (2) an RF Command Monitor and Manual Tone Keyer, Type CD-68, located in the CP, (3) an RF Transmitter, Type TM-21, located locally or up to a maximum of 10 miles from the CP, (4) a Radio Tone Command Remote Receiver, Type RC-22, located at the remote experimenter station, and (5) a Battery Voltage Supply, Type PS-223 located with the RC-22, and a Battery Charger, Type SK1110, located in a station designated as the battery charging station.

The SY-199 system parallels the hardwire link in a Timing and Control System. The system provides programmed radio signals used to control remotely located experimenter instrumentation whenever the use of a hard-wire system is impossible or impractical.

Detailed information on each unit of the SY-199 system is available in the following technical manuals: Tone Generator, Type SG-116, EG&G Report No. B-3982; R. F. Command Monitor and Manual Tone Keyer,

Type CD-68, EG&G Report No. B-3980; R. F. Transmitter, Type TM-21, EG&G Report No. B-3981; Radio Tone Command Remote Receiver, Type RC-22, EG&G Report No. B-3972.

1.3 MOTOROLA FM RADIO REPEATER STATION

If a Radio Command System requires the use of a repeater station because of terrain conditions, a modified Motorola station is available. The information for the basic station is contained in Motorola Instruction Manual 68P81044A75-B. The specifications for and the EG&G modifications to the station are attached as the last three pages of this document. In the list of specifications the arrows indicate the models used with the Radio Command System.

When using a repeater station, operating personnel must make sure (1) that the commands transmitted from the Control Point do not exceed 3 kHz deviation, (2) that the RC-22 frequency is set at the frequency of the repeater station transmitter, and (3) that the repeater station transmitter output does exceed a 3-kHz deviation. The above requirements are critical for proper system operation whenever a repeater station is used.

1.4 OVERALL FUNCTIONAL DESCRIPTION OF THE SY-199 SYSTEM

The SY-199 Radio Command System (Figure 1) provides timing and control capabilities to remote experimenter stations where the use of a hardwire system would be impractical or impossible such as in airborne, or over-water applications. The system generates 40 commands in the form of voltages having discrete audio frequencies combined in tone pairs. These voltages modulate the frequency of a transmitter, Type TM-21. The commands are transmitted by the TM-21 to a remote location where they are received by an RC-22 and converted to sequenced relay closures for control of experimenter equipments.

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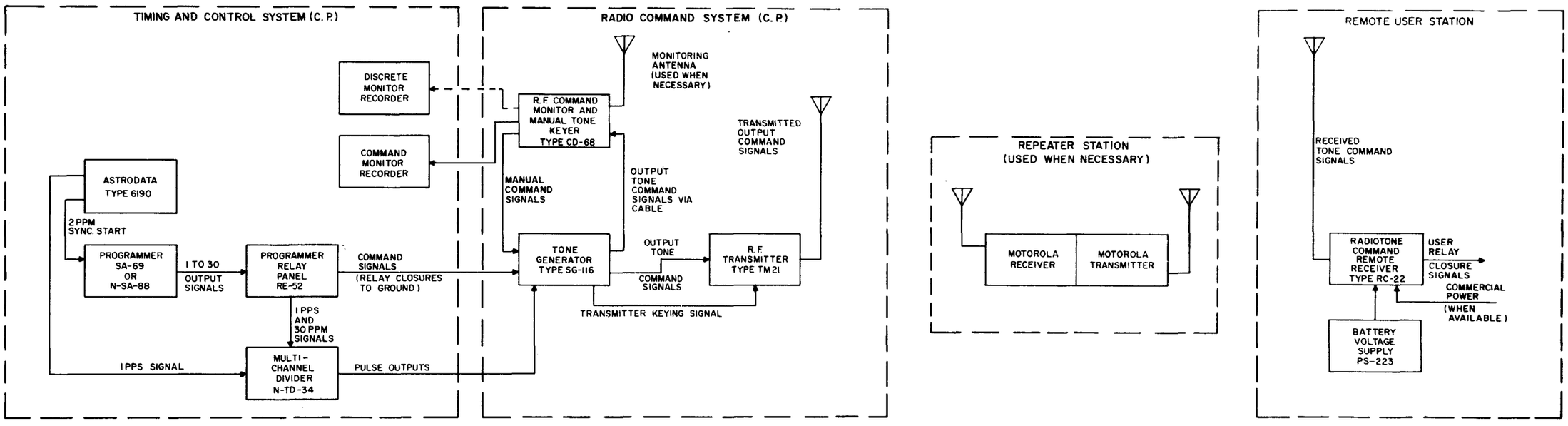

Figure 1. LASL Radio Command System, Type SY-199

The nucleus of the system at the Control Point is the SG-116 which is designed to accept as many as 40 automatically timed and sequenced ground closure signals from an SA-69 or N-SA-88 programmer unit within a Timing and Control System. A Command Monitor and Decoder, Type CD-68 is also capable of manually initiating similar commands. Each closure activates the tone selection circuit which ultimately provides two tones for that particular closure. The two tones are then combined in an analog adder as a discrete tone pair. This process results in a possible 40 combination of tones to be transmitted by the TM-21. Each tone pair is different and corresponds to a particular input ground closure. The unit is also capable of a triple tone combination.

The SG-116 is also capable of providing simultaneously with the generated tone pair a 28V signal to key the remote transmitter. This function can also be performed by an external source whenever required.

1.4.1 Tone Generator, Type SG-116. Figure 2 shows a block diagram of the SG-116. Commands initiated externally are applied to the input decoder matrix type circuit configuration from which 12 tone control lines are activated. When a command is initiated, two of the lines are energized; when two commands are initiated simultaneously, three lines are energized.

Each control line opens a latched gate which, in turn, closes a reed relay. Each of the 12 oscillator tones are applied to the contacts of the reed relay. Upon closure of the relay contacts, the tones are transferred to a summing amplifier. The combined tones are then added linearly in a variable gain amplifier, amplify and presented as an output to a balanced line for transfer to the TM-21 transmitter.

Other circuitry control the burst length of the tone combination to maintain a constant energy per tone, and key the transmitter for the

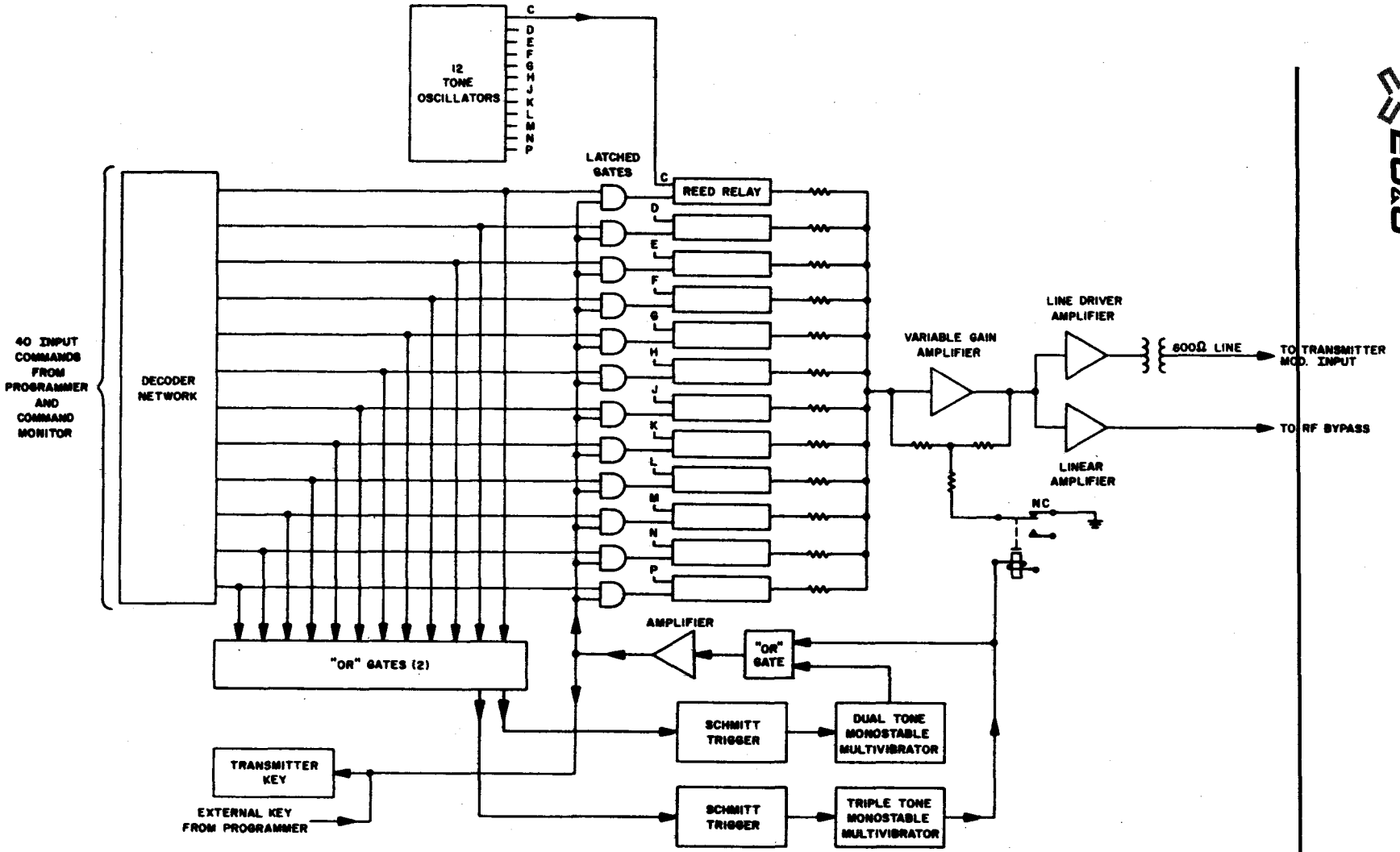

Figure 2. EG&G Tone Generator, Type SG-116, block diagram.

time duration of the tone combination. The tone combination is also provided as an output to the CD-68 for installation testing and routine maintenance purposes.

1.4.2 RF Command Monitor and Manual Tone Keyer, Type CD-68. The purpose of the CD-68 is twofold: First, a Motorola receiver monitors, detects, and demodutes the R. F. commands initiated by the SG-116, a 40-lamp monitor display on the front panel allows a visual observation of the commands received. Second, for testing purposes, 40 switches mounted on the lamp monitor display allow manual keying of the SG-116 tone generator.

The RF commands from the TM-21 are processed through a modified Motorola Receiver Type TRD 1493AB; a crystal-controlled, dual conversion model which operates in the 162-174 MHz frequency range.

The audio signal detected by the receiver is (1) processed through an audio power amplifier to a series-parallel arrangement of resonant relays each of which is sensitive to a different and discrete audio frequency, and (2) fed to a rectifier circuit to provide dc trigger signals (with levels proportional to the level of the audio signal present) which are applied to all the resonant relay contacts. For example, when a dual tone command activates two resonant relays, the dc contact closures energize two discrete relay driver circuits which, in turn, provide an "AND" function for one of 40 tone command circuits. The output of the command circuit(s) then changes the status monitor lamp from a red to a green indication which remains latched until reset.

For testing purposes, the audio tone commands from the SG-116 can be directly coupled via a cable and switch to the CD-68 audio power

amplifier stage. This method assures that the SG-116 commands are being processed accurately without the need of TM-21 transmitter.

1.4.3 RF Transmitter, Type TM-21. The TM-21 is a phase-modulated transmitter which operates on crystal-controlled frequencies within the 162-174 mc band. The power output is 40 watts. The transmitter contains crystal-controlled oscillators, a phase modulator, several amplification and frequency multiplication stages, and a final power amplifier stage. Circuits include an unheated, temperature-compensated crystal oscillator module (channel element), transistorized audio amplifier and IDC ("Instantaneous Deviation Control") circuit varactor phase modulator, completely transistorized exciter (frequency multipliers and amplifiers), and tube-type driver and power amplifier stages. The fundamental crystal frequency is multiplied 12 times to provide the final r-f amplifier output frequency.

The front panel contains the controls necessary for tuning, for power and local keying along with associated monitor lamps.

From the modulator stage, the signal is amplified by two amplifier stages, multiplied in a tripler, and amplified by a third amplifier to produce a frequency three times that of the oscillator. This signal is then multiplied by a doubler and amplified by a fourth amplifier, thus completing the function of the transistorized exciter. The output of the exciter (six times the oscillator frequency) is applied to the doubler-driver tube which operates at the output frequency, 12 times that of the fundamental oscillator frequency. Finally, the signal is fed to the power amplifier tube which produces the high level power output.

1.4.4 Radio Tone Command Remote Receiver, Type RC-22.

The purpose of the RC-22 is to receive and detect command signals at a remote station, and to issue these commands in the form of dry relay closures for remote control of user equipment. The unit is also capable of providing a permanent record of the sequence of commands.

The unit includes a completely transistorized modified Motorola Type TR1493AB crystal-controlled, dual conversion receiver designed to operated in the 162-174 MHz frequency range.

The RF commands from a remoted transmitter station are received by the RC-22 antenna and processed through the Motorola receiver section.

The audio signal detected by the receiver is (1) processed through an audio power amplifier to a series-parallel arrangement of resonant relays each of which is sensitive to a different and discrete audio frequency, and (2) fed to a rectifier circuit to provide dc trigger signals (with levels proportional to the level of the audio signal present) which are applied to all the resonant relay contacts. For example, when a dual tone command activates two resonant relays, the dc contact closures energize two discrete relay driver circuits which, in turn, provide an "AND" function for one of 40 tone command circuits.

The output of the tone command circuits are then fed to a Program Patch Board which allows any 6 commands out of 40 commands to be distributed. In addition to the 6 normal commands, the capability of receiving 3 separate pulsed commands is also available. The d-c triggers for the discrete tones are supplied to 12 terminals designated for audio tones on the patch board. The second segment of the patch board contains 18 terminals of which two terminals are associated with each command.

The resultant commands from the patch board activate relay driver circuits which, in turn, activate as many as 6 command relays.

All of the command relays have two pair of form C contacts. One pair of contacts on each relay is used to drive an event recorder. Each of four output command relays supplies a completely isolated set of contacts for the user.

One set of contacts on the Deactivate relay provides a series interrupt for the output relays when the unit is in the LIVE RUN condition. During testing of the unit, the deactivate interrupt is defeated by selecting the DRY RUN condition.

A set of contacts on the Reset relay provides a command reset pulse to the Deactivate and the four output relays. In conjunction with the Reset relay, there is a front panel manual RESET provided.

1.4.5 Radio Command System Battery Voltage Supply, Type PS-223. The PS-223 is a battery type power supply used in conjunction with the RC-22 in the Radio Command System whenever commercial or electric generator power is not available. This supply provides the 12V and 24V required for operation of the RC-22.

The unit consists of a standard 19-in. chassis panel which houses commercial rechargeable battery packs and operating controls. The chassis panel can also be secured in its carrying case on which input and output connectors are mounted. These connectors are accessible through a door on the carrying case.

The chassis panel contains two separate voltage supplies;

(1) The 24-V supply is a Gould battery package, Type MP807, which contains 20 Nicad rechargeable 7.0 ampere hour capacity cells.

(2) The 12-V supply consists of two MP-802 Gould battery packages (each package contains 10 Nicad rechargeable 7.0 ampere hour capacity cells) connected in parallel for the OPERATE mode only. When the unit is in CHARGE mode of operation, the MP-802 packages are connected in series.

1.4.6 4-Channel Constant Current Nickel Cadmium Battery Charger. The battery charger (for the PS-223) design uses full-wave rectified voltage from a transformer with the current controlled by means of separate SCR units in each of the 4 channels. The current control level for each channel is individually adjustable and the unit charges at this level for the total preset time of the master timer. When the timer has elapsed, the current falls to 1/10 of the preset charge level and continues to trickle charge the cells until the unit is turned off. Separate voltage and current meters can be switched to monitor any of the 4 battery circuits. The unit is equipped with individual circuit breakers in each channel. The 115-V input is protected by a diode-shunting circuit which will open the channel circuit breakers whenever the batteries are incorrectly polarized.

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2. 1 SPECIAL INSTALLATION REQUIREMENT

All units are designed for installation in a standard 19-inch rack. In addition, the RC-22, the PS-223 and the Battery Charger can be mounted in and operated from their respective portable cases. The TM-21 transmitter must be installed in accordance with FCC regulations (see paragraph 2. 1 of EG&G Report No. B-3981), and in a rack which allows space for proper ventilation. When installing the SG-116 tone generator, care must be taken to adhere to the input command restrictions given in paragraph 3. 1. The CD-68 is installed normally without a receiver antenna because of its close proximity to the transmitter; however, if the signal strength is not sufficient, an antenna could be attached.

2. 2 INSTALLATION OF THE UNITS AT THE CONTROL POINT

The following sequence of connections is intended as a guideline only.

(1) Mount the SG-116, CD-68 and TM-21 in their assigned position in the equipment rack.

NOTE

The TM-21 can be remotely located.

(2) Connect power cables as follows:

a. To SG-116 POWER INPUT connector J1.

b. To CD-68 POWER INPUT connector J1.

c. To TM-21 POWER connector J1.

(3) Connect the cables to the SG-116 as follows:

a. The input cable from the Timing and Control System to the PROGRAMMER INPUT connector J4.

b. The cable from the CD-68 TEST KEYER TO TONE GENERATOR connector J6 to the DECODER INPUT connector J5.

c. The cable from the CD-68 TEST AUDIO connector J2 to the RF BY PASS connector J2.

NOTE

The cable should remain connected at all times, for loading purposes. This connection allows checking the output of the SG-116 without transmitting the signals through the TM-21.

d. The cable from the TM-21 CONTROL AND TONE INPUT connector J5 to the TO TRANSMITTER connector J3.

(4) Connect the cables (not connected in Step 3) to the CD-68 as follows:

a. Cables from Recorders in the Timing and Control System to the CHANNELS 1 THROUGH 20 (J4), CHANNELS 21 THROUGH 40 (J5), and DISCRETE TONE MONITOR OUTPUT (J7) connectors.

NOTE

This step is optional.

b. An antenna to ANTENNA connector J3, if necessary.

(5) Connect the cables (not connected in Step 3) to the TM-21 as follows:

a. The cable from the transmitting antenna to the R. F. OUTPUT connector J3.

b. If desired, a cable from a microphone to the MIKE INPUT connector J2, provided the necessary internal modifications are made to the TM-21 circuit.

(6) Check all units for proper fuses in fuse holders.

2. 3 INSTALLATION OF THE REMOTELY LOCATED RC-22

Perform the following installation steps:

(1) Install the RC-22 in the proposed operational area and attach the quarter-wave whip antenna (Motorola NAD-6132A and Amphenol Type UG-646/U Connector) to J105. The antenna should be mounted in the vertical plane, and the RC-22 should be placed such that the control panel is parallel to the mounting platform plane. Other antenna types may be used if needed to increase the r-f signal strength.

NOTE

Make sure that the internal connectors J1 and J2 are mated with the case connectors.

(2) Inspect the recorder for sufficient paper (Rustrak Supply Style "E").

(3) If a 115 VAC power source is available, connect the power cable to connector J106. If an AC power source is not available, connect a PS-223 Battery Voltage Supply to the RC-22 via a power cable to connector J107.

(4) To check the power supply voltage levels, turn the POWER switch ON and rotate the meter selector switch first to 12V TEST and then to 28V TEST. A reading of at least 1/2 scale must be observed to indicate the proper voltage levels.

(5) Turn the meter selector switch to SIGNAL STRENGTH. Request the control point to transmit an R. F. signal. When R. F. is present, a minimum reading of about 2 is necessary for proper operation. It may be necessary to remotely locate the antenna from the receiver to obtain sufficient signal strength.

(6) Turn the meter select switch to AUDIO. Request the control point to transmit a continuous command. Observe that the meter deflects to approximately a reading of 4.

(7) When all of the above conditions have been met satisfactorily, the RC-22 is ready for operation.

(8) Connect the cables from the user stations to J101, J102, J103 and J104 as necessary.

3.1 OPERATIONAL RESTRICTIONS

The SG-116 schematic labels the input commands by tone pair: for example, PC, DF, DM, etc. For convenience we will assign a channel number to each input command as follows:

Channel No.	Corresponding Input Command Pair
1	PC
2	DF
3	DM
4	PD
5	EK
6	PE
7	PH
8	GN
9	FH
10	DN
11	DG
12	DJ
13	DK
14	NL
15	PN
16	PG
17	PJ
18	PL
19	FN
20	CE
21	EH
22	EL
23	EM

Channel No.	Corresponding Input Command Pair
24	EN
25	CN
26	CF
27	CH
28	CJ
29	CL
30	NJ
31	HN
32	HK
33	FJ
34	FK
35	FL
36	FM
37	GJ
38	GK
39	GL
40	EG

Some restrictions must be observed when simultaneously transmitting more than one command. For example, when a PN (Channel 15) and a PG (Channel 16) are transmitted simultaneously, three tones are generated (P, N, and G). Care must be taken so that commands for triple tone are not initiated by combinations which should not be used. The following rules should be adhered to:

Channel	May be combined with
1 through 9	None (each command for these channels must be issued separately).
10	11, 12, 13 or 14 (or separately).
11	10 only
12	10 only
13	10 only
14	10 only
15	16, 17, 18 or 19 (or separately)
16	15 (or separately)
17	15
18	15
19	15
20	21, 22, 23, or 24
21	20
22	20
23	20
24	20
25	26, 27, 28, or 29
26	25
27	25
28	25
29	25
30 through 40	None (each command for these channels must be issued separately).

Certain commands have been predesignated for special applications:

Channel No.	Application
40 (EG)	Reset
25 (CN)	1 pps
28 (CJ)	6 ppm
1 (PC)	Deactivate

The basic tones and frequencies are as follows:

Tone Designation	Frequency
C	346.7
D	384.6
E	426.6
F	473.2
G	524.8
H	582.1
J	645.7
K	716.1
L	794.3
M	881.0
N	977.2
P	1084

The tones are generated by self-contained oscillators included within the unit.

When the 1 pps command is being issued, the closure initiating the command should not exceed 100 milliseconds in duration. There is no relation between the time length of the tone burst and the time length of the

closure. However, since the input to the generator is AC coupled, the duty cycle of the coupling unit is somewhat sensitive to repetition frequency, and hence, may not recover sufficiently if the closure exceeds 100 milliseconds by an appreciable amount.

3. 2 PRE-OPERATIONAL CHECK

3. 2. 1 Operational Check Using the CD-68. For setup and test purposes, the CD-68 unit is used. The CD-68 is placed in the TEST position and manually reset. To ascertain that the commands are being properly generated through the SG-116, depress in sequence the display switches on the front panel of the CD-68. As each switch is depressed, the illumination will change from red to green. Each switch checks that the tone pair generated is correct and of the proper amplitude and time duration. As each CD-68 switch is depressed, make sure that the COMMAND ON and KEY ON indicators on the SG-116 illuminate.

3. 2. 2 Operational Check Using the Command Signals From the Timing and Control System. After the installation outlined in Section 2 has been accomplished, perform the following operational check:

(1) Energize all units of the Radio Command system,

(2) Make sure that the CD-68 ENABLE/DISABLE and NORMAL/TEST switches are respectively in the DISABLE and NORMAL positions. Depress the CD-68 MANUAL RESET switch to assure that all command lights are reset.

(3) If the operation of a remote RC-22 is to be included in this checkout procedure, make sure that the steps in Section 2 paragraph 3. 2. 1 of the manual

Report No. B-3972, have been accomplished at the remote station.

(4) Request the Timing and Control system operator to generate the programmed sequence of commands.

NOTE

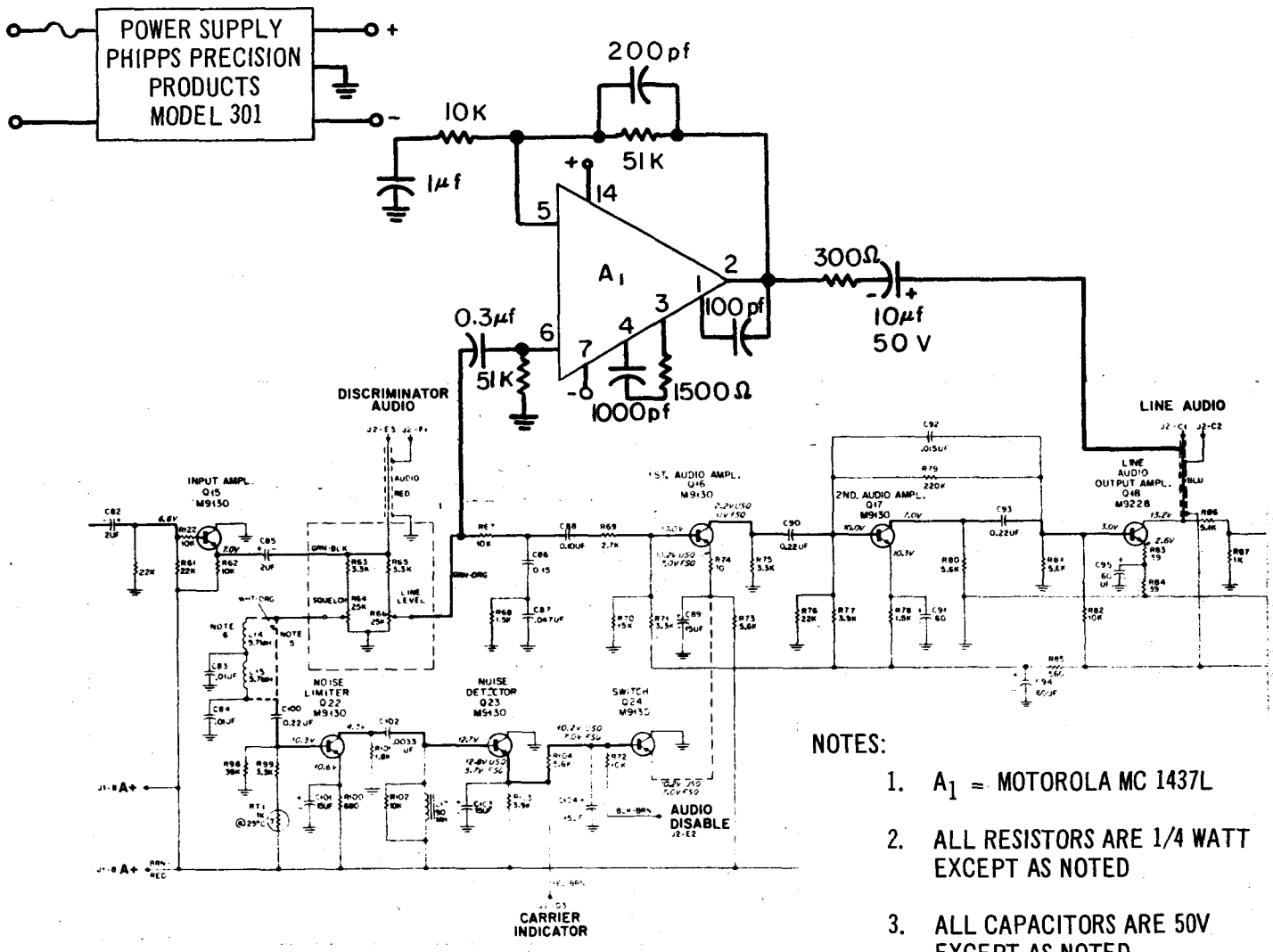
Every series of dry run commands should be preceded by Deactivate command and followed by a Reset command.

(5) As the commands are being generated check (1) the SG-116 COMMAND ON indicator to make sure that it lights whenever a command signal is processed, and (2) the CD-68 command lights, to make sure that the lamps illuminate (green) in the same sequences as the programmed command signals.

(6) When the checkout has been completed, verify that the RC-22's have received the proper commands by reading the paper records.

3.3 OPERATION

When the conditions of paragraph 3.2.2 have been satisfied and when the RC-22 LIVE RUN/DRY RUN switch is placed in the LIVE RUN position), the radio command system operates automatically upon commands from the Timing and Control system.



NOTES:

1. A_1 = MOTOROLA MC 1437L
2. ALL RESISTORS ARE 1/4 WATT EXCEPT AS NOTED
3. ALL CAPACITORS ARE 50V EXCEPT AS NOTED

GENERAL

POWER OUTPUTS AVAILABLE	MODEL		FREQUENCY	INPUT POWER	AC CURRENT DRAIN	
	Indoor Cabinet	Outdoor Weatherproof Cabinet			Standby	Transmit
50 watts	B53MPB-1102	J53MPB-1102	136-174 mc	117 VAC, 50/60 cps, Single Phase	0.7 amp	3.0 amp
70 watts	B53MPB-Series	J53MPB-Series			0.7 amp	3.7 amp
100 watts	B63MPB-Series	J63MPB-Series			0.7 amp	4.0 amp
120 watts	B73MPB-Series	J73MPB-Series			0.7 amp	4.3 amp
250 watts	B93MPB-1102	J93MPB-1102			0.9 amp	10.3 amp
375 watts	B93MPB-Series	J93MPB-Series			0.9 amp	10.3 amp

Squelch Options: Carrier noise type, —1000 Series Models; "Private-Line" tone-coded type, —3100 Series Models

Metering: Panel mounted meters, with associated selector switches, provide resonant indication of all receiver, exciter, and power amplifier circuits essential to tuning and checking, plus d-c control line current. Two meters are used in 50-120 w. models, 3 meters in 250 and 375 w. models.

Dimensions: Indoor cabinet: 70" high x 21¾" wide x 20¼" deep overall.
Outdoor Weatherproof cabinet with rain shield: 74⅝" x 23¾" x 25⅓" overall.
(Without rain shield: 70" x 23¾" x 24½" overall)

Weight:

	50-120 W. Models	250 & 375 W. Models
Indoor cabinet, 1 receiver:	328 lbs.	409 lbs.
Indoor cabinet, 2 receivers:	342 lbs.	423 lbs.
Outdoor Weatherproof cabinet, 1 receiver:	413 lbs.	494 lbs.
Outdoor Weatherproof cabinet, 2 receivers:	427 lbs.	508 lbs.

(Shipping weight: Add 63 lbs. to the above).

TRANSMITTER

MODEL	MINIMUM RF POWER OUTPUT	MAXIMUM PLATE INPUT POWER	FCC DESIGNATION (±.0005%)	(±.0002%)	LICENSABLE UNDER FCC RULES PARTS:
B J53MPB-1102	50 watts	100 watts	CC3063	CC3063C	21, 81, 89, 91, and 93
B/J53MPB-Series	70 watts	120 watts	CC3038	CC3038C	21, 81, 89. 91, and 93
B/J63MPB-Series	100 watts	180 watts	CC3039	CC3039C	21, 81, 89, and 91
B J73MPB-Series	120 watts	220 watts	CC3040	CC3040C	21, 81, 89, and 91
B J93MPB-1102	250 watts	425 watts	CC3064	CC3064C	21, 81, 89, and 91
B J93MPB-Series	375 watts	600 watts	CC3041	CC3041C	89 and 91

Modulation: 15F2, 16F3 (narrow band): ±5 kc for 100% at 1000 cps.
36F3 (wide band): ±15 kc for 100% at 1000 cps.

Frequency Stability: Channel element maintains oscillator frequency within ±.0005% (±.0002% optional) from −30°C to +60°C ambient (+25°C reference).

Spurious and Harmonics: More than 85 db below carrier

Audio Sensitivity: 0.1 volt, ±3 db for ⅔ maximum deviation at 1000 cps

Audio Response: +1, −3 db from 6 db/octave pre-emphasis, 300-3000 cps, referenced to 1000 cps

Audio Distortion: 2% (1000 cps at ⅔ max. dev.); 3% (full audio range at ⅔ max. dev.)

FM Noise: 55 db below ⅔ maximum deviation at 1000 cps

AM Noise: 35 db

Output Impedance: 50 ohms

RECEIVER

	NARROW BAND	WIDE BAND	WITH PRECISION CRYSTAL FILTER
CHANNEL SPACING:	±30 kc	±60 kc	±30 kc
MODULATION ACCEPTANCE:	±7 kc minimum	±16 kc minimum	±7 kc minimum
FREQUENCY STABILITY:	Channel element maintains oscillator frequency within ±.0005% (±.0002% optional) from −30°C to +60° C (+25°C reference).	Same as narrow band	Same as narrow band
SELECTIVITY (EIA SINAD):	−85db @ ±30kc	−85db @ ±60kc	−98db @ ±30kc
SENSITIVITY— 20db QUIETING:	0.5μv (no preamplifier) 0.25μv (with preamplifier)	0.5μv (no preamplifier) 0.25μv (with preamplifier)	1.0μv (no preamplifier) 0.5μv (with preamplifier)
EIA SINAD:	0.35μv (no preamplifier) 0.175μv (with preamplifier)	0.35μv (no preamplifier) 0.175μv (with preamplifier)	0.7μv (no preamplifier) 0.35μv (with preamplifier)
INTERMODULATION: (EIA SINAD)	−80 db (no preamplifier) −70 db (with preamplifier)	−80 db (no preamplifier) −70 db (with preamplifier)	−97 db (no preamplifier) −87 db (with preamplifier)
SPURIOUS AND IMAGE REJECTION:	100 db min (no preamplifier) 80 db min (with preamplifier)	100 db (no preamplifier) 80 db (with preamplifier)	100 db (no preamplifier) 80 db (with preamplifier)
SQUELCH SENSITIVITY— (at threshold)			
CARRIER SQUELCH: (adjustable)	.25μv or less (no preamplifier) .125μv or less (with preamplifier)	.25μv or less (no preamplifier) .125μv or less (with preamplifier)	0.5μv or less (no preamplifier) 0.25μv or less (with preamplifier)
TONE-CODED SQUELCH: (fixed)	.25μv or less (no preamplifier) .125μv or less (with preamplifier)	not available in wide band	0.5μv or less (no preamplifier) 0.25μv or less (with preamplifier)
AUDIO CHARACTERISTICS— TELEPHONE LINE:	Output: +18 dbm at 600 ohms Response: +1, −3 db Distortion: 3% at 1000 cps Hum & Noise: −50 db	Same as narrow band.	Same as narrow band.
LOCAL SPEAKERS:	Output: 3 watts at 3.2 ohms Response: +1, −8 db Distortion: 5% at 1000 cps Hum & Noise: −50 db		
RF INPUT IMPEDANCE:	nominal 50 ohms	nominal 50 ohms	nominal 50 ohms