GE MOBILE RADIO

MAINTENANCE MANUAL

DC REMOTE CONTROL BOARD 19A704686P3
(2-Frequency Transmit and Receive with Channel Guard)

Maintenance Manual LBI-31594

DC REMOTE CONTROL BOARD 19A704686P3

SPECIFICATIONS *

LINE TERMINATING IMPEDANCE	600 ohms
LINE LOOP IMPEDANCE (MAXIMUM)	11,000 ohms (8000 line and 3000 matching)
INPUT VOLTAGE	+10 Volts DC ±0.5 Volts
CURRENT (standby & transmit)	50 milliamperes maximum
LINE LEVEL (Line to Transmitter)	-20 to +11 dBm
OUTPUT LEVELS	
Transmit	10-200 millivolts (adjustable)
Receive	-20 to +7 dBm
DISTORTION (300-1000-3000 Hz)	
Transmit	Less than 3%
Receive	Less than 5%
FREQUENCY RESPONSE	+1, -3 dB with 6 dB/octave from 300 to 3000 Hz
TEMPERATURE RANGE	-30°C to +75°C (-22°F to +153°F)

*These specifications are intended primarily for the use of the serviceman. Refer to the appropriate Specification Sheet for the complete specifications.

GENERAL ELECTRIC

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DESCRIPTION

DC remote control board 19A704686P3 is used in remote and local/remote station combinations to provide one-and two-frequency with Channel Guard disable (monitor). The DC remote control board provides the interface between a remote control console and the base station.

Connections to the remote control console are made at J1 on the DC remote control board. Station connections are made at J2 and J3. Supply voltage for the DC remote board is taken from the station regulated +10 Volts. Frequency selection is available in wall-mount (remote only) stations.

DC CONTROL FUNCTIONS

The DC remote control board provides up to six remote control functions by the application of different current levels and polarities to select each function. The different control currents and functions are shown in Table I.

TELEPHONE LINE CHARACTERISTICS

The telephone lines used in this DC remote control application requires one metallic pair for both audio and control voltages, with the control voltage simplexed from line to line. To obtain the most satisfactory service over this telephone link, some general knowledge of the capability of these lines is required.

A telephone pair is simply a pair of wires, normally ranging from AWG #19 to AWG #26 in size. These wires, furnished by the local telephone company, pass through overhead cables, underground cables, through junction points, and switchboards. To the user, however, they may be considered a simple pair of wires. Equipment that is designed to operate with such a pair should have nominal impedance of 600 ohms. A telephone pair will normally have a maximum length of about 12 miles before amplification is added by the telephone company to make up for line losses. There is an inherent loss in any telephone line installation due to the series inductance and resistance and the shunt capacitance of the wires.

This loss is a direct function of the length of the line, and varies with the wire size used. As an example, with AWG #19 wire, a distance of six miles may be covered before one-half the input voltage of a 1000 Hz tone is lost. With AWG #26 wire, only two and one-quarter miles may be covered before one-half the input voltage is lost. Line losses as high as 30 dB can be tolerated in operating a transmitter from the Remote but such high losses should be avoided whenever possible. Although the telephone pair is fairly well balanced, some noise will be induced into the line, especially if an unshielded run has to be made in a florescent-lighted building.

The DC resistance of any telephone pair will affect the control circuits between the Controller and the base station. Current regulators incorporated in the Remote Control minimize these variations after initial adjustment. The Remote operates with a total control line loop resistance as great as 11,000 ohms. There is a possibility, however, that stray currents, due to leakage, noise, faults, earth currents, etc., may cause faulty operation.

After the telephone line have been connected, refer to the Adjustment Procedure for setting the input and output line levels. These adjustments are required before the station is put in operation.

TABLE I - Control Current and Function Chart (Remote Only)

FUNCTION	CONTROL CURRENT IN MILLIAMPERES					
	-11	-6	-2.5	0	+6	+11
1 or 2 Freq. Transmit 1 Freq. Receive/CG Monitor			Receive F1 With CG	Receive F1	Transmit F1	Transmit F2
1 or 2 Freq. Transmit 2 Freq. Receive/CG Monitor	Receive F2 With CG	Receive F2	Receive F1 With CG	Receive F1	Transmit F1	Transmit F2
1 Freq. Transmit 1 Freq. Receive/CG Monitor			Receive F1 With CG	Receive F1	Transmit F1	

CIRCUIT ANALYSIS

Remote control board 19A704686P3 provides a maximum of three remote control functions. These functions are two frequency transmitter keying, two frequency receive, and Channel Guard disable (channel monitoring). The remote control board also provides the audio paths for transmit and receive audio.

The remote control board consists of four optocouplers (U5 through U8), two operational amplifiers (U2 and U4), a guad-comparator and a 32 X 8 PROM.

TRANSMIT AUDIO

Transmit audio combined with the control current from the remote console is applied to the remote control board at J1-1 and J1-4. Capacitors C1 and C2 block the control currents while passing the audio to transformer T1. The transformer output is coupled through potentiometer R1 to the input of op-amp U4-6. R1 is also used as the feedback resistor across the op-amp. The amplified output at U4-7 is applied to the station transmitter through J2-1 (MIC AUDIO).

RECEIVE AUDIO

Receive audio from the station receiver is applied to the remote control board at J2-9 (RX AUDIO). The audio at J2-9 is coupled through a low-pass filter (R16 and C14) which provides 6 dB/octave de-emphasis. The filter output is applied to pre-amplifier U4-3.

Pre-amplified audio from U4-1 is coupled through bilateral switch U3-1 and -2, and applied to the line driver stages consisting of both sections of op-amp U2. R2 is the level control for the receive audio.

Bilateral switch U3 is controlled by the RUS line from the station. When the RUS line goes high (station receiver unsquelches), U3-13 goes high, turning on U3. This couples the audio output of the pre-amp stage to the line drivers. When the RUS line is low, (receiver squelched) U3 is turned off.

Remote line amplifiers U2 can drive the control line to a level of +7 dBm when the line is terminated into 600 ohms. However, removing the jumper from U2-8 and connecting pin 8 to 13 Volts DC will provide an output of over +11 dBm, if required. The output of U2 is coupled through T1 to the control pair at J1-1 and J1-4.

CONTROL CURRENT

The four optocouplers (U5,U6,U7 and U8) are used for current detection and line isolation. Each optocoupler contains a Light Emitting Diode (LED), and a phototransistor serving as a light detector. When a DC current of the correct polarity is applied to pin 1, the LED conducts and emits light. This light turns on the phototransistor, coupling the input current to the output of the phototransistor (see Figure 1).

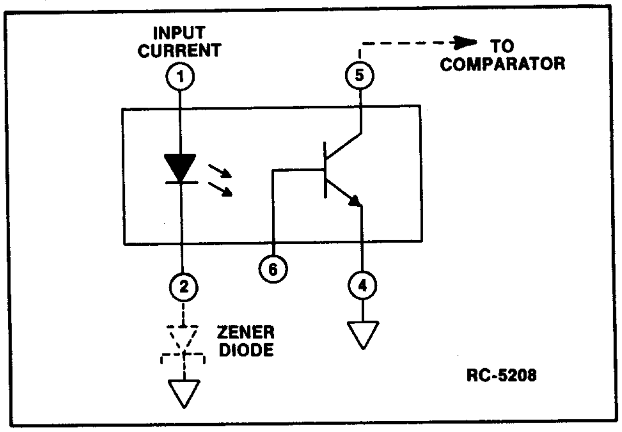


Figure 1 - Simplified Optocoupler Circuit

When zero current is on the control pair (J1-1 and J1-4), all four opto-coupler LED's are off, keeping all four phototransistors off. When the photo-transistors are off, pin 5 of each optocoupler is pulled up to 5 Volts DC through pull-up resistors, R26,R27,R29 and R30. The +5 Volts are applied to the inputs on guad-comparator U10 pins 5,7,9 and 11. A reference voltage for com-parator U10 is provided by voltage dividers R33 and R34, which applies a reference voltage of 1.2 Volts.

Whenever the inputs to U10 are higher than the reference voltage, the outputs at U10-1, -2, -13 and -14 go high (+5 Volts). The outputs of comparator U10 are coupled to the open collector address lines of PROM U9. The unused address line (pin 14) is tied to ground.

With zero current on the control line, all used PROM address lines are held high. When all PROM inputs are high, outputs 01 and 05 of PROM U9 are held low. This holds the radio in the RX1 mode with Channel Guard (CG) enabled.

Table II shows how the PROM outputs are controlled by the PROM inputs in each of the six possible conditions of the remote control board.

TABLE II - Prom Inputs and Outputs vs Current

CONDITIONS:

1. +11 mA ----- TX1
2. -11 mA ----- RX2 with CG Disable
3. +6 mA ----- TX2
4. -6 mA ----- RX2
5. -2.5 mA ----- RX1 with CG Disable
6. 0 mA ----- RX1

	PROM INPUT					PROM OUTPUT					
	11 mA / A3	6 mA / A2	+ mA / A1	- mA / A0	=	CG / 06	PTT / 05	TX2 / 04	TX1 / 03	RX2 / 02	RX1 / 01
1.	0	0	0	1	=	1	1	0	1	1	1
2.	0	0	1	0	=	0	0	1	1	0	1
3.	1	0	0	1	=	1	1	1	0	1	1
4.	1	0	1	0	=	1	0	1	1	0	1
5.	1	1	1	0	=	0	0	1	1	1	0
6.	1	1	1	1	=	1	0	1	1	1	0

When a current on the control pair is greater than 1 milliampere (mA), polarity optocoupler U5 or U6 will turn on. U5 is used as the negative polarity detector, while U6 is used as the positive polarity detector. For example, if the current was -2.5 mA, phototransistor U5 would turn on, pulling U5-5 low. This would be read by the PROM and would provide outputs to allow the radio to monitor RX1. Also, if less than 4 mA is on the control pair, both Q1 and Q2 turn on. When 4 mA or more is on the control pair, Q2 is the first one to turn off. This is because zener diode D6 will not allow the base of Q2 to become greater than 6.8 Volts. As soon as Q2 turns off, the LED in U7 turns on and causes U7-5 to go low, indicating that there is -6 mA on the control pair (RX2).

Transmitter keying is controlled by U9-5(05). When +11 mA or +6 mA is detected, U9-5 goes high. This turns on Q4 and Q5, which applies a low to J2-4 to key the selected channel.

Channel Guard disable is controlled by U9-6(06). When -11 mA or -2.5 mA are detected, U9-6 goes low to disable the selected receive Channel Guard.

ADJUSTMENT PROCEDURE

There are two adjustments on the DC remote control board; audio deviation to the transmitter (R1), and receive audio level to the remote control console.

AUDIO DEVIATION

While receiving a 1000 Hz tone from the remote control console, adjust R1 for ±4.5 kHz deviation. This should provide a reading of 70 to 120 millivolts at J2-1.

RECEIVE AUDIO LEVEL

While receiving a 1000 Hz tone with ±3 kHz deviation that is strong enough to fully quiet the receiver, adjust R2 for 0 dBm across terminals J1-1 and J1-4.

TROUBLESHOOTING

A complete set of DC voltage readings are provided in this manual to assist in servicing the remote control board. (See Page 5).

GENERAL ELECTRIC COMPANY• MOBILE COMMUNICATIONS DIVISION
WORLD HEADQUARTERS• LYNCHBURG, VIRGINIA 24502 U.S.A.

TROUBLESHOOTING

DC VOLTAGE READINGS

DC CONTROL BOARD 19A704686P3

METERING POINT	REFERENCE	CONTROL CURRENT (MILLIAMPERES)					
		-11 mA	-6 mA	-2.5 mA	0 mA	+6 mA	+11 mA
Q1-E	D3 ANODE	12.75	8.15	3.76	0	8.28	12.77
-B		11.5	8.84	4.42	.31	8.97	11.48
-C		13.9	8.25	3.88	.07	8.38	13.91
Q2-E		13.9	8.25	3.88	.07	8.38	13.91
-B		6.46	6.44	4.52	.3	6.43	6.46
-C		15	9.37	3.99	.31	9.49	15.05
U2-1	GROUND	5	5	5	5	5	5
-2		5	5	5	5	5	5
-3		5	5	5	5	5	5
-4		0	0	0	0	0	0
-5		5	5	5	5	5	5
-6		5	5	5	5	5	5
-7		5	5	5	5	5	5
-8		10	10	10	10	10	10
U3-1		0	0	0	0	0	0
-2		5	5	5	5	5	5
-7		0	0	0	0	0	0
-13		10*	10*	10*	10*	0	0
-14		10	10	10	10	10	10
U4-1		5	5	5	5	5	5
-2		5	5	5	5	5	5
-3		5	5	5	5	5	5
-4		0	0	0	0	0	0
-5		5	5	5	5	5	5

TROUBLESHOOTING

METERING POINT	REFERENCE	CONTROL CURRENT (MILLIAMPERES)					
		-11 mA	-6 mA	-2.5 mA	0 mA	+6 mA	+11 mA
-6		5	5	5	5	5	5
-7		5	5	5	5	5	5
-8		10	10	10	10	10	10
U5-5		.1	.15	.2	5	5	5
-6		.6	.6	.6	0	0	0
U6-5		5	5	5	5	.1	.1
-6		0	0	0	0	.6	.6
U7-5		.1	.1	5	5	.1	.1
-6		.6	.6	0	0	.6	.6
U8-5		.1	5	5	5	5	.1
-6		.6	0	0	0	0	.6
U9-1		**	**	0	0	**	**
-2		0	0	**	**	**	**
-3		**	**	**	**	0	**
-4		**	**	**	**	**	0
-5		.1	.1	.1	.1	4.8	4.8
-6		0	5	0	5	5	5
-10		0	0	0	5	5	5
-11		5	5	5	5	0	0
-12		0	0	5	5	0	0
-13		0	5	5	5	5	0
-16		5	5	5	5	5	5
U10-1		5	5	5	5	0	0
-2		0	0	0	5	5	5
-3		0	0	0	5	5	5
-4,6,8,10		1.2	1.2	1.2	1.2	1.2	1.2

TROUBLESHOOTING

METERING POINT	REFERENCE	CONTROL CURRENT (MILLIAMPERES)					
		-11 mA	-6 mA	-2.5 mA	0 mA	+6 mA	+11 mA
-11		.1	5	5	5	5	.1
-12		0	0	0	0	0	0
-13		0	5	5	5	5	0
-14		0	0	5	5	0	0

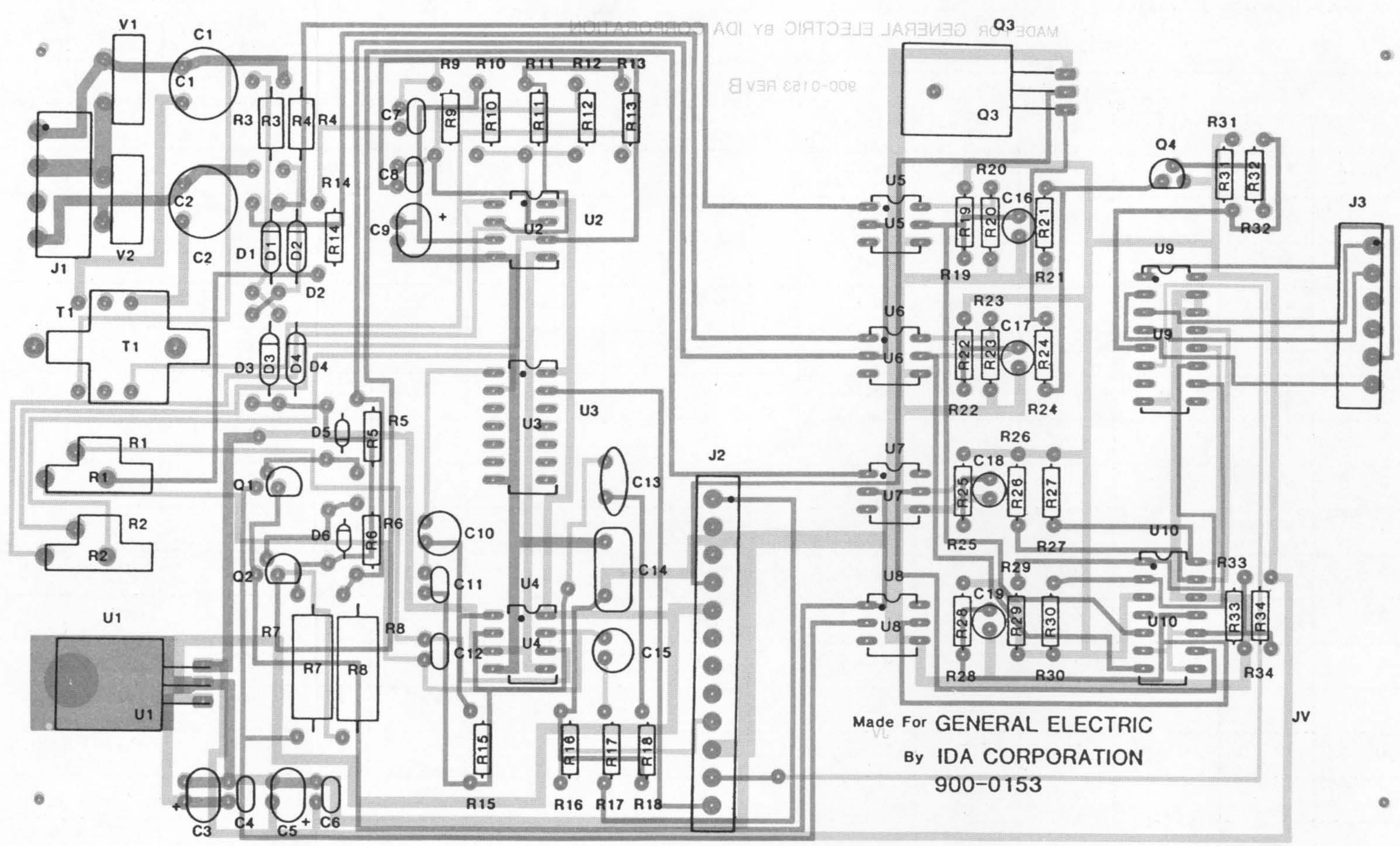
* Carrier present in receiver

** Open collector output is open

G.E. DC. PANEL 900-0153 11/26/85

GE PART NUMBER - 19A704686P3

ITEM	REF.NO.	PART NO.	DESCRIPTION	QTY.
1		900-0153	DC PANEL PC BD	1
2	U1	130-0022	UA7805-T0220	1
3	U2;4	130-0120	TL062 IC	2
4	U3	130-0067	4066 IC	1
5	U5;6;7;8	130-0097	4N36 IC	4
6	U9	130-0213	74S188 IC	1
7	U10	130-0117	LM339 IC	1
8	R1;2	351-0002	10K 1T POT	2
9	R3;4	313-0010	22 5% 1/2 W RES	2
10	R5;6;34	312-0015	22K 5% 1/4 W RES	3
11	R7;8	315-0022	1.5K 5% 2 W RES	2
12	R9;17	312-0045	620 1% 1/4 W RES	2
13	R10;11;13	312-0014	33K 5% 1/4 W RES	3
14	R12	312-0028	470 5% 1/4 W RES	1
15	R14;24;32	312-0019	1K 5% 1/4 W RES	3
16	R16;19;21;22; 25-30	312-0011	10K 5% 1/4 W RES	10
17	R18;31	312-0040	4.7K 5% 1/4 W RES	2
18	R20;23;15	312-0046	470K 5% 1/4 W RES	3
19	R33	312-0018	6.8K 5% 1/4 W RES	1
20	C1;2	361-0001	4uf NP ELEC CAP	2
21	C3;5;9	390-0007	10uf 35V TANT CAP	3
22	C4;6;	362-0001	.1uf MONO CAP	2
23	C8;11;12	362-0004	330pf MONO CAP	3
24	C7;10;15	361-0003	1uF ELEC NP	3
25	C13	362-0002	.47uF MONO CAP	1
26	C14	380-0011	.68uf MYLAR CAP	1
27	C16-19	360-0004	10uf 16V ELEC CAP	4
28	D1-4	110-0002	1N4003 DIODE	4
29	D5	111-0003	12V ZENER DIODE	1
30	D6	111-0012	6.8V ZENER DIODE	1
31	Q1;2;4	180-0008	MPSA43 TRANSISTOR	3
32	Q3	180-0007	TIP47 TRANSISTOR	1
33	T1	410-0003	600 Ohm COUP TRANS	1
34	VR1;2	300-0001	VARISTOR	2
35	J1	231-0001	4 POS ELECTROVERT	1
36	J2;J3	231-1066	6 POS CONN	3
37		220-0001	16 PIN IC DIP SOCKET	1
38		220-0002	14 PIN IC DIP SOCKET	2
39		220-0003	8 PIN IC DIP SOCKET	2
40		220-0006	6 PIN IC DIP SOCKET	4
41	U1	210-0002	HT SINK T0220	1
42	U1;Q3	199-0020	6-32 HEX NUT	2
43	U1;Q3	199-3070	6-32 X 1/4 SCREW	2
		Cable assembly and mounting hardware		
44		199-3070	6-32 X 1/4 SCREW	4
45		231-1052	Conn.CE156F22-12 recept.	2
46		231-1056	Conn.CE156F22-6 recept.	2
47		222-0014	22awg wire	9ft.
49		231-1051	POLARIZING KEY	2



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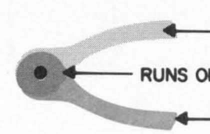
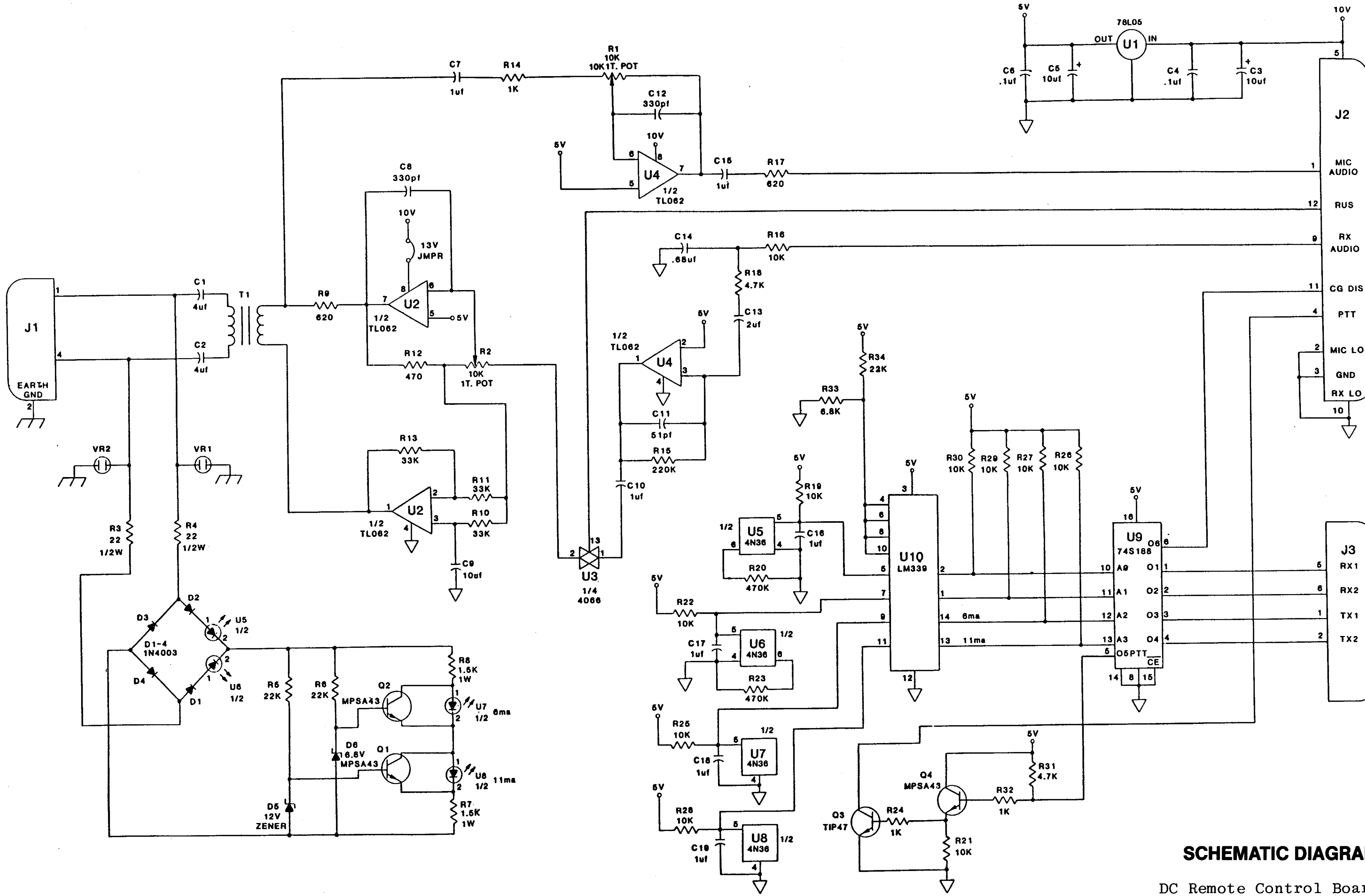


OUTLINE DIAGRAM

DC Remote Control Board
19A704686P3



SCHEMATIC DIAGRAM

DC Remote Control Board
19A704686P3

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