

MAINTENANCE MANUAL
FEMCO GROUND CHECK MONITOR GM8000 and GM8001

General Information

This manual is an extension of the Reference manual and is intended for use by technicians and maintenance personnel who maintain and repair the Ground Monitor.

Areas to be covered are:

Description

This section completely describes the Ground Monitor's operation through use of a schematic diagram and circuit analysis.

Field and Bench Testing

This section provides information for use in troubleshooting the Ground Monitor when a failure occurs. This consists of instructions for performing tests to determine proper operation and a voltage chart for the unit.

Parts Identification

Necessary assemblies, along with parts lists, are provided to support the maintenance of the Ground Monitor.

For more information on the Ground Monitor ordering repair parts or requesting field service contact your local representative or customer service at Femco Division, P.O. Box 33, High Point, N.C. 27261-0033, (919) 887-2611, TWX 5109261937.

Femco Ground Monitor should be returned to the manufacturer or authorized representative for service. Substitution of components not approved by MSHA will void MSHA Acceptance number.

Circuitry described in this manual is covered by Femco Patent Nos. 3,728,582 and 3,855,501.

ARC TRAP - Femco Registered Trademark
GROUND SENTINEL - Femco Registered Trademark

DO NOT CHANGE WITHOUT APPROVAL OF MINE SAFETY AND HEALTH
ADMINISTRATION.

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MSHA B.T.S. Acceptance No. GM8000: 050884FE
GM8001: 050784FE

SECTION 1 DESCRIPTION

Circuit Description (Refer to Schematic.)

This unit can be divided into three sections: the power supply, the transmitter and the receiver sections.

The power supply provides 20 volts unregulated DC to the relay driver and 12 volts regulated DC to all other circuits. MOV 1 protects the monitor from power line surges while R1 prevents nuisance blowing of FUL.

The transmitter contains a four kilohertz oscillator and a push-pull line driver. R4 adjusts the frequency for optimum operation. MOV 2 protects the monitor from voltage surges on the ground or pilot wires. R12 limits the current output of the monitor and provides a signal voltage to the receiver circuit that is proportional to the quality of the ground check circuit. The test switch provides a convenient way of testing the monitor operation. In the TEST position, a 75 ohm resistor is connected in series with the ground check circuit. The monitor will indicate an open circuit trip by lighting both red LED's; the yellow LED will not be lit. Operation in the UNIT CHECK position depends on the model. On units with the shorted output detector, the .47 ohm resistor will simulate a shorted ground check wire. The monitor will indicate a short circuit trip by lighting both red LED's; the yellow LED will not be lit. On units without this feature, the monitor will indicate normal operation with only the yellow LED lit.

The signal developed across R12 is coupled to the receiver circuit by T3. The strength of this signal, directly proportional to the quality of the ground check circuit, is compared to a fixed reference voltage by IC3. If the ground check circuit has fifteen ohms or less loop resistance, a good ground, four kilohertz pulses will be present at Pin 6 of IC3. These pulses are amplified by Q4 and fed to T4. The output of T4 is rectified and fed to the relay. C7 filters the relay voltage and provides a time delay to prevent false trips. The yellow LED 3 indicates the presence of relay voltage and can be used as a rough tuning indicator. The absence of relay voltage, because of a bad ground or because the test switch is in test position is indicated by the two red LED's. LED 3 is a latched trip indicator that continues to show that a trip occurred even when the relay is energized. Pressing the reset switch turns off this indicator.

On Model GM8000 part of the signal at the secondary of T3 is rectified, filtered, and compared with a fixed reference voltage by IC4. If this signal voltage is great enough, indicating a short circuit that bypasses the normal ground check circuit, the output of IC4 turns on Q7 and blocks the four kilohertz signal that would normally drive Q4. This causes a "short circuit" trip out.

SECTION 2 FIELD AND BENCH TESTING

Maintenance

Preventive Maintenance. The latest version of the periodic checks required by Mine Safety and Health Administration should be followed. Semi-annual tuning of the GM8000/1 per Step 5 below is recommended.

Troubleshooting

In the field - GM8000/1 is tripped.

Equipment Needed

VOM or digital voltmeter
Spare Board

Procedure

1. Place the test switch in its center or TEST position.
2. Both red LED's should be lit and the yellow LED should be out.
3. Observe all three LED's and move the test switch to the UNIT CHECK position. Hold the switch in this position.
 - a. On units with the shorted output detector(GM8000), the yellow TUNE LED will light briefly and then go out; the red TRIP LED will go out briefly and then come back on. The red LATCH TRIP LED will stay lit.
 - b. On models without the shorted output detector (GM8001), the yellow TUNE LED will light; the red TRIP LED will go out. The red LATCH TRIP LED will stay lit. It will go out if the LATCH RESET button is pushed.
4. Return the test switch to the NORM position. If the unit passes steps 2 and 3 continue to Step 5; if the unit fails, replace the PC board module and repeat test.
5. Tune the GM8000/1 by adjusting the frequency of the transmitter oscillator to the resonant frequency of the filters and stray cable impedance. The reactive components of the circuit impedance are tuned out and the GM8000/1 monitors circuit resistance.
This is accomplished by placing an AC voltmeter in TP1 and TP2 and adjusting R4 for a peak on the meter. This should occur at about 1.2V RMS with a short cable and decrease as the length of the cable monitored increases.

The trip may be checked by adding resistance into the circuit. With no cable (just two filters) the trip resistance should be between 13 and 17 ohms.
6. If the GM8000/1 does not tune the problem is in the external circuit.

Bench Troubleshooting

Equipment Needed

Simpson or digital voltmeter
Oscilloscope
Frequency counter
Ground monitor test set-up

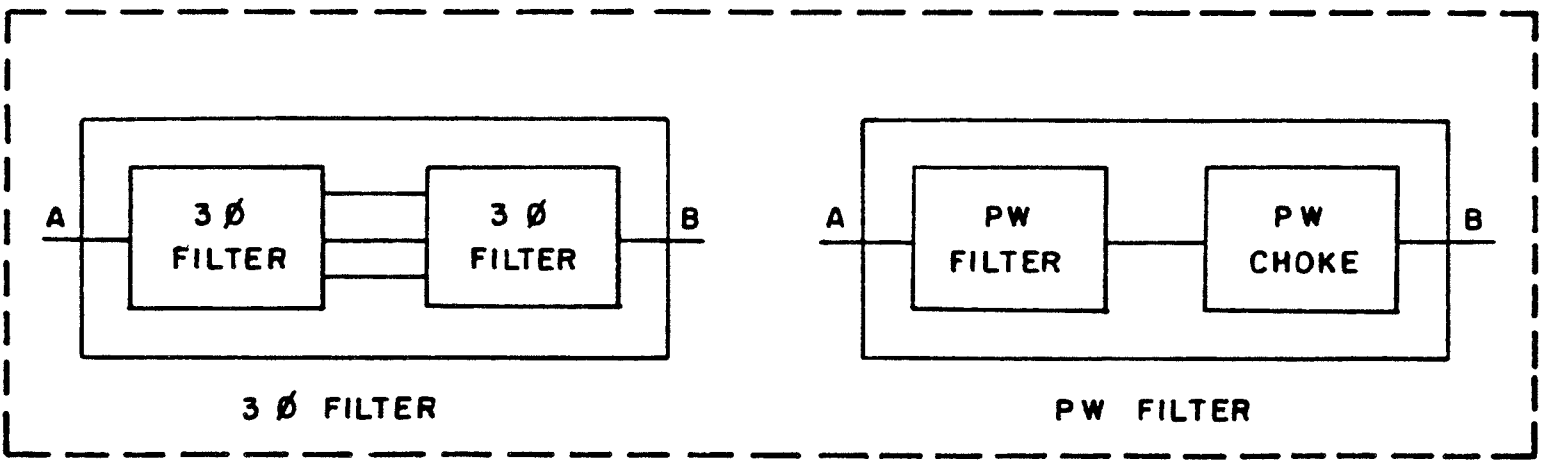
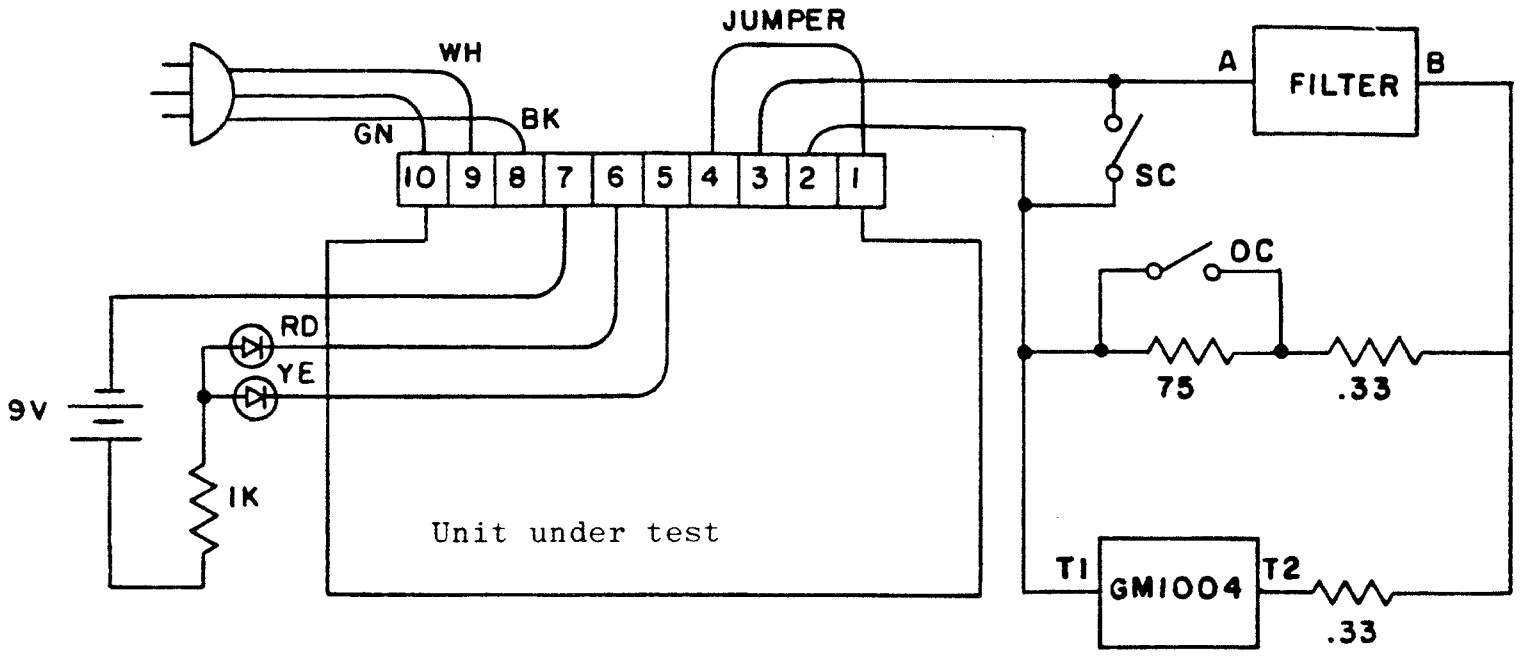
Parts Needed for the Test Set-up

1 Power Cord	1 1K 1/2 Watt resistor	2 .33 ohm resistors
1 Connector	1 Red LED	2 Spdt Switches
1 9-Volt Battery	1 Yellow LED	1 CN3840
1 Battery Chip	1 75 ohm 1/2 W Resistor	1 GM1004
1 FI2559	1 FI2560	1 FI2558

Testing the GM8000/1

1. To test the GM8000/1 follow the field troubleshooting procedure given above, with the unit connected per 2/3.
2. Refer to the following voltage chart and drawings for troubleshooting.

EQUIPMENT SET-UP



VOLTAGE CHART

TEST POINT	NORMAL OPERATION	OC SWITCH OPEN	SC SWITCH CLOSED
T1 Secondary	16.5VAC	18.8VAC	15.6VAC
+20V Unreg	18.2V	22.5V	16.6V
+12V	11.9V	11.9V	11.9V
Relay Volts	24.2V	0V	0V
<hr/>			
IC2 Pin 1	0V	*	*
2	4Vpp Sawtooth		
3	12Vpp Square Wave		
4	12V DC		
5	7.9V DC		
6	4Vp-p Sawtooth		
7	12V PP Square Wave		
8	12V DC		
<hr/>			
IC3 Pin 1	NC	NC	NC
2	6 VDC	5.7V	6V
3	4Vpp Sine Wave 5.48VDC	1Vpp Semi Sq. Wave 4.9V	5.3V pp Sq.Wave 5.4VDC
4	0	0	0
5	NC	NC	NC
6	12Vpp Semi Sq.Wv	0V	11.5Vpp Semi Sq.Wv
7	11.9V	11.9V	11.9V
8	10.1V	11.9V	8.7V
<hr/>			
IC4 Pin 1	NC	NC	NC
2	3.6V	3.6V	3.6V
3	2.5V	.4V	5.1V
4	0V	0V	0V
5	NC	NC	NC
6	1.3V	1.3V	11.1V
7	11.9V	11.9V	11.9V
8	NC	NC	NC

VOLTAGE CHART CONT'D

TEST POINT		NORMAL OPERATION	DC SWITCH OPEN	SC SWITCH CLOSED
Q1	S	0V	*	*
	G	12V pp Sq.Wave		
	D	12V pp Sq.Wave		
Q2	S	0V	*	*
	G	12V pp Sq.Wave		
	D	24V pp Sq.Wave		
Q3	S	0V	*	*
	G	12V pp Sq.Wave		
	D	24V pp Sq.Wave		
Q4	S	0V	0V	*
	G	5.5V pp Semi Sq. Wave	0V	
	D	40V pp Sq.Wave with Spike	22.3V	
Q5	E	11.9V	11.9V	11.9V
	B	23.3V	11.1V	11.2V
	C	0V	11.7V	11.8V
Q6	C	0V	0V	0V
	G	0V	.8V	.8V
	A	10.5V	.8V	.8V
Q7	E	0V	0V	0V
	B	.3V	.3V	.8V
	C	3V, 5.5V Semi Sq Wave	0V	0V

NC - NOT CONNECTED

* - VOLTAGES AND WAVEFORMS DO NOT CHANGE

TESTING THE FILTERS
Preliminary Set-Up

1. Connect a DVM or VOM set to the 20 or 2.5V AC range to the loop current test jacks TP1 and TP2.
2. Connect a frequency counter to the same test jacks.

Testing the 3-Phase Filters

1. Replace one of the known good filters in the test set-up by the filter in question.
2. Set the switches for NORMAL operation.
3. Adjust R4 (TUNE) for maximum indication on the DVM or VOM. The indication should be approximately 1.3 volts and in no case less than 1 volt. The frequency, as indicated on the counter, should be between 3970 HZ and 4030 HZ.
4. If the frequency is outside this range or you cannot tune for a maximum indication on the DVM or VOM, the filter is bad and should be thrown away.
5. If the voltage indication is less than 1 volt, the filter is bad and should be thrown away.

Testing the Pilot Wire Filter and Choke

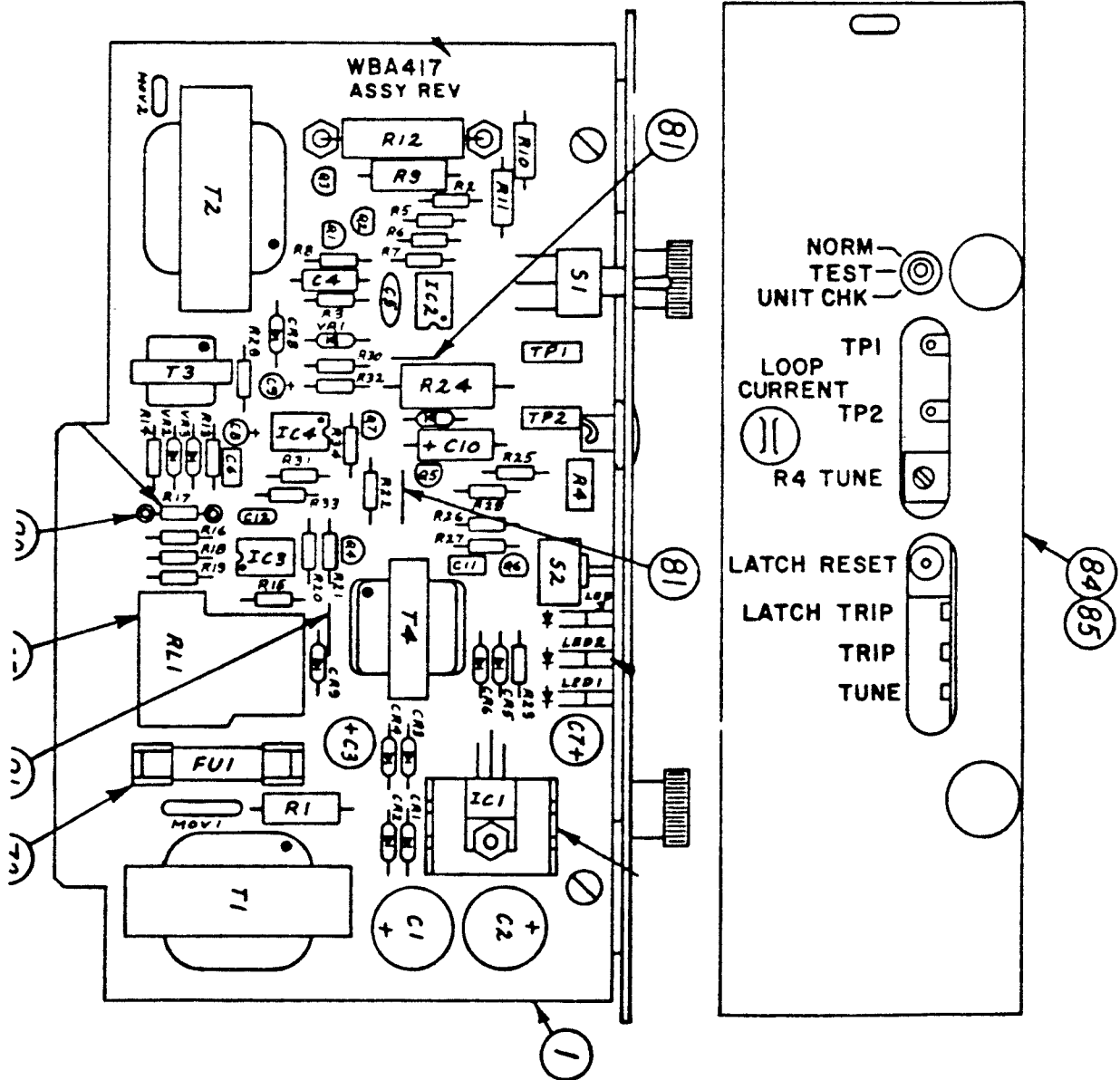
1. Replace the known good pilot wire filter or pilot wire choke by the part in question in the test set-up.
2. Set the switches for NORMAL operation.
3. Adjust R4 (TUNE) for a maximum indication on the DVM or VOM. The voltage indication should be approximately 1.2 volts and in no case less than 1 volt. The frequency indicated by the counter should be between 4080 and 4120 HZ.
4. If the frequency is outside this range or you cannot tune for a "peak" maximum indication, the part is bad and should be replaced. For best results, replace both.
5. If the voltage indication is less than 1 volt the part is bad and should be replaced. For best results, replace both.

Testing the ARC TRAP

1. Jumper out the filters in the test set-up.
2. Set the OC and SC switches to the OPEN position. The GM8000/1 should be tripped out.
3. Replace the known good ARC TRAP with the ARC TRAP in question. The GM8000/1 should be tripped out. If it is not, the ARC TRAP is bad and should be thrown away.
4. Check the ARC TRAP for continuity with an ohmmeter.

SECTION 3 PARTS IDENTIFICATION

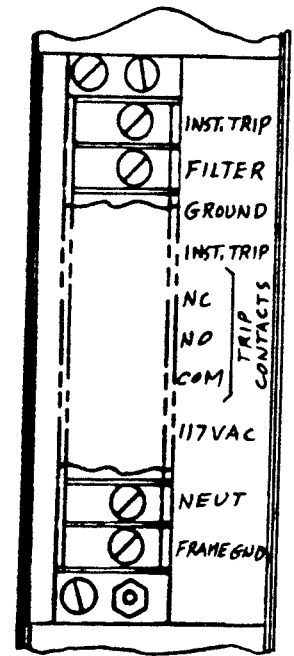
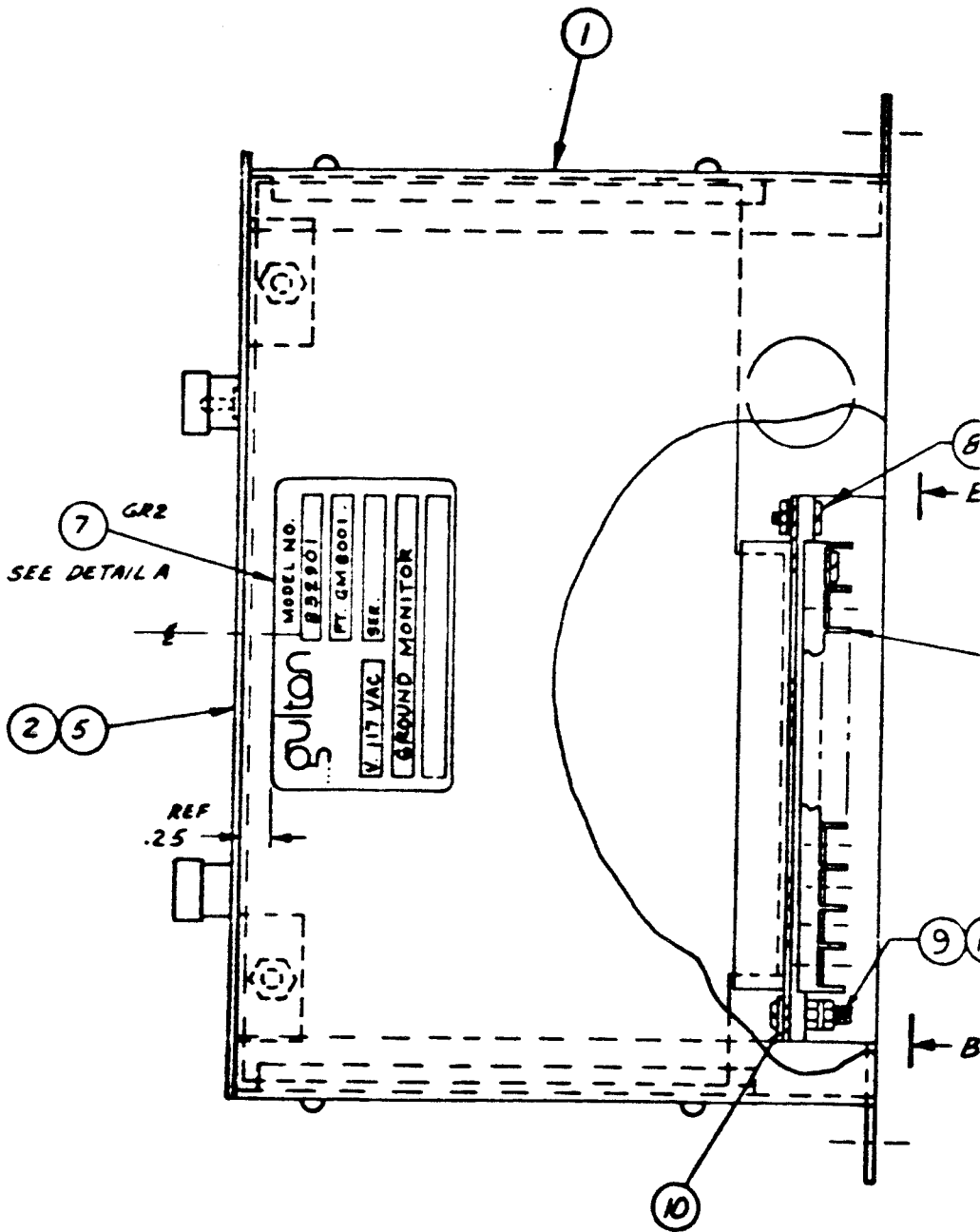
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ASSEMBLY:

GR1 WBA4170
GR2 WBA4171

IT.	DESCRIPTION	PART NO	DWG NO.	QTY	UNIT
1	PRINTED CIRCUIT BOARD	WB4170	832901-601	1	1
2					
3	RESISTOR, FC, 22, 1/4W, 5%	R1	RF33035	1	1
4	RESISTOR, FC, 1K, 1/4W, 5%		RF10275		
	12, 5, 6, 7, 8, 22, 26, 28, 34			9	
	21, 5, 6, 7, 8, 22, 26, 28			8	
5	RESISTOR, MF, 20, 3K, 1/4W, 1%	R3	RF3067	1	1
6	RESISTOR, POT, 5K, 1/2W, 10%	R4	RF3601	1	1
7	RESISTOR, FC, 1, 1/4W, 10%	R9	RF10431	1	1
8	RESISTOR, FC, 75, 1/2W, 5%	R10	RF75025	1	1
9	RESISTOR, FC, .47, 1/2W, 10%	R11	RF47021	1	1
10	RESISTOR, WM, 4, 5W, 5%	R12	RF3602	1	1
11	RESISTOR, FC, 5.1K, 1/4W, 5%	R13, 14	RF51275	2	2
12	RESISTOR, FC, 15K, 1/4W, 5%	R15	RF3305	1	1
13	RESISTOR, FC, 2K, 1/4W, 5%	R16	RF20275	1	1
14	RESISTOR, FC, 10, 1/4W, 5%	R17	R	1	1
15	RESISTOR, FC, 27K, 1/4W, 5%	R18, 19	RF27275	2	2
16	RESISTOR, FC, 220K, 1/4W, 5%	R20	RF22475	1	1
17	RESISTOR, FC, 1.2K, 1/4W, 5%	R21	RF3570	1	1
18	RESISTOR, FC, 2.7K, 1/4W, 5%	R23	RF27225	1	1
19	RESISTOR, FC, 680, 2W, 5%	R24	RF68145	1	1
20	RESISTOR, FC, 91K, 1/4W, 5%	R25	RF3380	1	1
21	RESISTOR, FC, 220, 1/4W, 5%	R27	RF3493	1	1
22	RESISTOR, FC, 9.3K, 1/4W, 5%	R29, 33	RF39275	2	2
23	RESISTOR, FC, 200K, 1/4W, 5%	R30	RF20475	1	1
24	RESISTOR, MF, 30K, 1/4W, 2%	R31	RF3616	1	1
25	RESISTOR, MF, 13K, 1/4W, 2%	R32	RF3659	1	1
26					
27					
28	CAPACITOR, ELEC, 470uF, 35V	C1, 2	CD9041	2	2
29	CAPACITOR, ELEC, 47uF, 35V	C3	CD9026	1	1
30	CAPACITOR, FILM, .0068uF, 200V	C4	CD3877	1	1
31	CAPACITOR, CER, .01uF, 100V	C5	CD5018	1	1
32	CAPACITOR, CER, .1uF, 50V	C6, 11	CD5022	2	2
33	CAPACITOR, ELEC, 100uF, 35V	C7	CD9025	1	1
34	CAPACITOR, ELEC, 1uF, 50V	C8, 9	CD9030	2	2
35	CAPACITOR, ELEC, 22uF, 16V	C10	CD3362	3-7959	1
36	CAPACITOR, MICA, 39pF, 500V	C12	CD2570	3-7879	1
37					
38					
39	DIODE (1N4005)	CR1, 2, 3, 4, 5, 6, 7, 9	TU1500	8	8
40	DIODE (.470A)	CR8	TU1510	1	1
41	DIODE, ZENER (1N757A)	VR1	TU1725	1	1
42	DIODE, ZENER (1N746A)	VR2, 3	TU1717	2	2
43	DIODE, LIGHT EMITTING, YEL	LED1	LA2738	1	1
44	DIODE, LIGHT EMITTING, RED	LED2, 3	LA2737	2	2
45					
46	TRANSISTOR (2N4043)	Q1, 4	TU6051	2	2
47	TRANSISTOR (2N4220A)	Q2, 3	TU6052	2	2
48	TRANSISTOR (2N3906)	Q5	TU2769	1	1
49	TRANSISTOR (2N3904)	Q7	TU2767	1	1
50	THYRISTOR (2N5060)	Q6	TU2804	1	1
51	VARISTOR	MOV1	PS2709	1	1
52	VARISTOR	MOV2	PS2785	1	1
53					
54	INTEGRATED CIRCUIT (7812)	IC1	TU2586	1	1
55	INTEGRATED CIRCUIT (555)	IC2	TU2579	1	1
56	INTEGRATED CIRCUIT (ICL7610DCPA)	IC3	TU2153	1	1
57	INTEGRATED CIRCUIT (LM741CN)	IC4	TU2152	1	1
58					
59	TRANSFORMER, POWER	T1	TR3143	2AT3143	1
60	TRANSFORMER, LINE DRIVER	T2	TR3144	2AT3144	1
61	TRANSFORMER, INPUT	T3	TR3112		1
62	TRANSFORMER, RELAY DRIVER	T4	TR3145	2AT3145	1
63					
64	RELAY, 24V	K1	RL2979		1
65	RELAY COVER		RL2981		1
66	SWITCH, DP, 3 POS TOGGLE	S1	SN3298		1
67	SWITCH, DPST MOM PUSHBUTTON	S2	SN3299		1
68	STUD OVAL HEAD		MS3887		1
69	TEST JACK	TP1, 2	TE3061		2
70	SNAP RING		MS3886		1
71	FUSE, 1/4AMP SLO-BLO	FU1	FU2520		1
72	FUSE CLIP		FU2586		2
73	EASTMAN 910 BLUE		MC3599		X
74	HEAT SINK	HS1	HS2640		1
75	SCREW, #4-40 X 3/4 PAN HD SLOT		SC2910		1
76	WASHER, #4 INT SHAPE		WA2503		1
77	WASHER, COMPRESSION		WA2558		1
78	NUT, HEX #4-40		NU2537		1
79	STANDOFF, PLASTIC		MS4267		2
80	TURRET TERMINAL		TF2862		2
81	WIRE, ELEC, 20AWG, BARE COPPER	1" OF	WF2863		3
82	MONITOR BOARD ASSY	WBA4170	832901-60001		
83	MONITOR BOARD ASSY	WBA4171	832901-60002		
84	FACEPLATE	800747	832901-603		
85	FACEPLATE	800748	832901-603		
86	SCREW, #6-32 X 3/4 PAN HD SLOT	887L	SC3078		
87	WASHER, #6 INT SHAPE	887L	WA2067		
88	NUT, HEX #6-32	887L	NU2065		
89	KNOB		KN2542		
90	SCREW, #8-32 X 3/4 PAN HD SLOT	887L	SC3142		
91	WASHER, #8 INT SHAPE	887L	WA2083		
92	LOCKWITE TYPE A #271 RED		MC3602		



IT.	DESCRIPTION	PART NO.	DWG. NO.	GR1	GR2
1	HOUSING	BO4746	832901-602	1	1
2	PCB/FACEPLATE ASSY	CE2995	832901-801	1	
3	CONNECTOR (10 POS CARD EDGE)	CN3840		1	1
4	CARD GUIDE	M04177		2	2
5	PCB/FACEPLATE ASSY	CE2996	832901-801	1	
6					
7	NAMEPLATE (TYPED PER ASSY DWG)	NP2638		1	1
8	SCREW #6-32 X 3/8 SSSL	SC3078		3	3
9	NUT #6 HEX SSSL	NU2945		5	5
10	WASHER #6 EXT SHAKE SSSL	WA2867		5	5
11					
12	SCREW #6-32 X 5/8 SSSL	SC3100		1	1
13	NAMEPLATE	NP2964	832901-605	1	1