

0.0

TELEMOTIVE
SERIES 7000
RADIO CONTROL SYSTEM
USER'S MANUAL

TC7000-10-0.0F-Z



TABLE OF CONTENTS

SERIES 7000 RADIO CONTROL SYSTEM

USER'S MANUAL

I. INTRODUCTION

- A. General Radio Control System Information
- B. The Transmitter Unit Description
- C. The Receiving/Control Unit Description

II. SYSTEM OPERATION AND PREVENTIVE MAINTENANCE

- A. General Operation And Preventive Maintenance
- B. Radio System Operating Principles
- C. Radio System Operating Procedures
- D. Radio System Preventive Maintenance

III. SYSTEM TROUBLESHOOTING

- A. General Troubleshooting Approach
- B. Troubleshooting Aids
- C. Troubleshooting Procedures
- D. User's Equipment Interface Troubleshooting Procedures

IV. APPENDIX

- A. Safety Rules



I.0

SECTION I
INTRODUCTION

I.A.1

A. GENERAL RADIO CONTROL SYSTEM INFORMATION

The Telemotive Series 7000 Radio Control System is made up of the following major parts:

1. Transmitter Assembly
2. Control Cabinet Assembly
 - a. Control Rack
 - b. Driver Rack

Each system is constructed to meet the specific application requirements of the user.

B. THE TRANSMITTER UNIT DESCRIPTION

The portable versions of the Series 7000 Transmitter Unit are completely self-contained with control switches, circuit boards, antenna and battery. Fixed versions of the Transmitter may have separate antennas and power sources.

The Transmitter transmits Special Access Codes to initially start up the Control Assembly before any system outputs can be obtained.

The signals from the Transmitter control panel stepped/stepless motion switches and auxiliary function switches are encoded before transmission.

The Transmitter is capable of directly modulating a carrier frequency with a time ordered sequence of binary states. The transmitted frequency depends upon the binary state. This type of transmission is called Direct Frequency Shift Keying (DFSK) time division multiplexed (TDM) modulation.

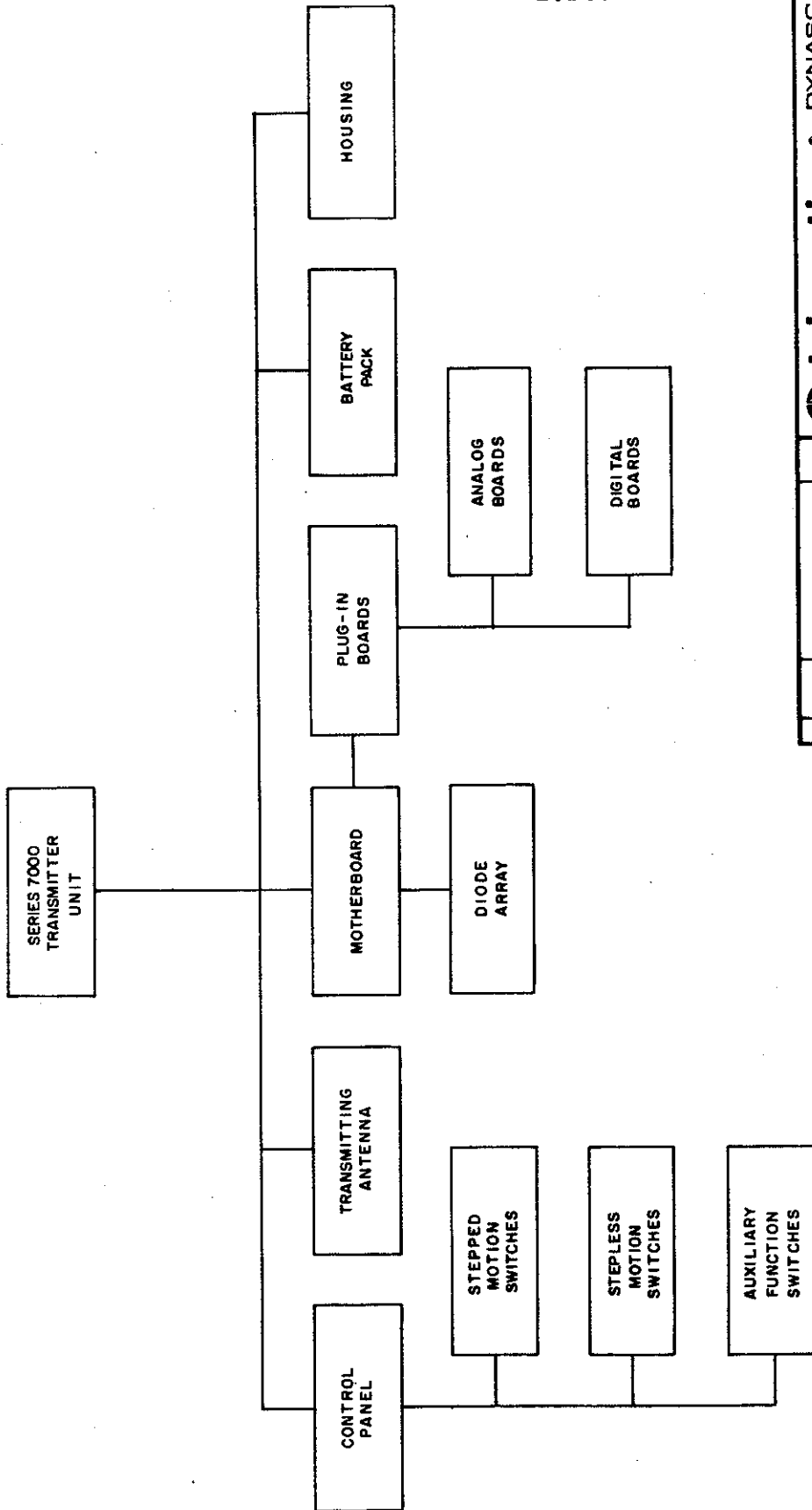
Thus, the actual transmitted RF signal is a serial time ordered sequence of two possible transmitter RF frequency states. Only one of the two possible transmitted RF frequency states is present during any bit period.

I.B.2

The Transmitter has been designed to operate in the VHF and UHF frequency bands with an RF power output option from 50 mW to 400 mW into a tuned 50 ohm antenna.

A block diagram of the Series 7000 Transmitter Unit is shown in Figure # I.B.1.

I.B.3



telemotive <small>DYNASCAN CORPORATION</small>		<small>540 WEST CORLEND ST. CHICAGO, ILL. 60635 / 312-889-9035 / TELEF 25-3475</small>	
SERIES 7000 TRANSMITTER UNIT		BLOCK DIAGRAM	
USER		JOB	W.S.
		DATE	12-7-84
		SCALE	1:1
		APPROV	TC
		DRAWING NO	
		REF.	BD-E7600-X-108-B
		NO.	DATE
		BY	REVISIONS

FIGURE # I.B.1

C. THE RECEIVING/CONTROL UNIT DESCRIPTION

The Receiving/Control Unit contains circuitry that performs the following functions:

1. Receives a signal from a mating Transmitter.
2. Decodes and distributes the decoded signal to the Output Interface Modules.
3. Generates the following types of output driver signals for the User Equipment:
 - a. Stepped Outputs.
 - b. Stepless Outputs.
 - c. Auxiliary Outputs
4. Generates an output signal that enables the user system Main Contactor (MC).

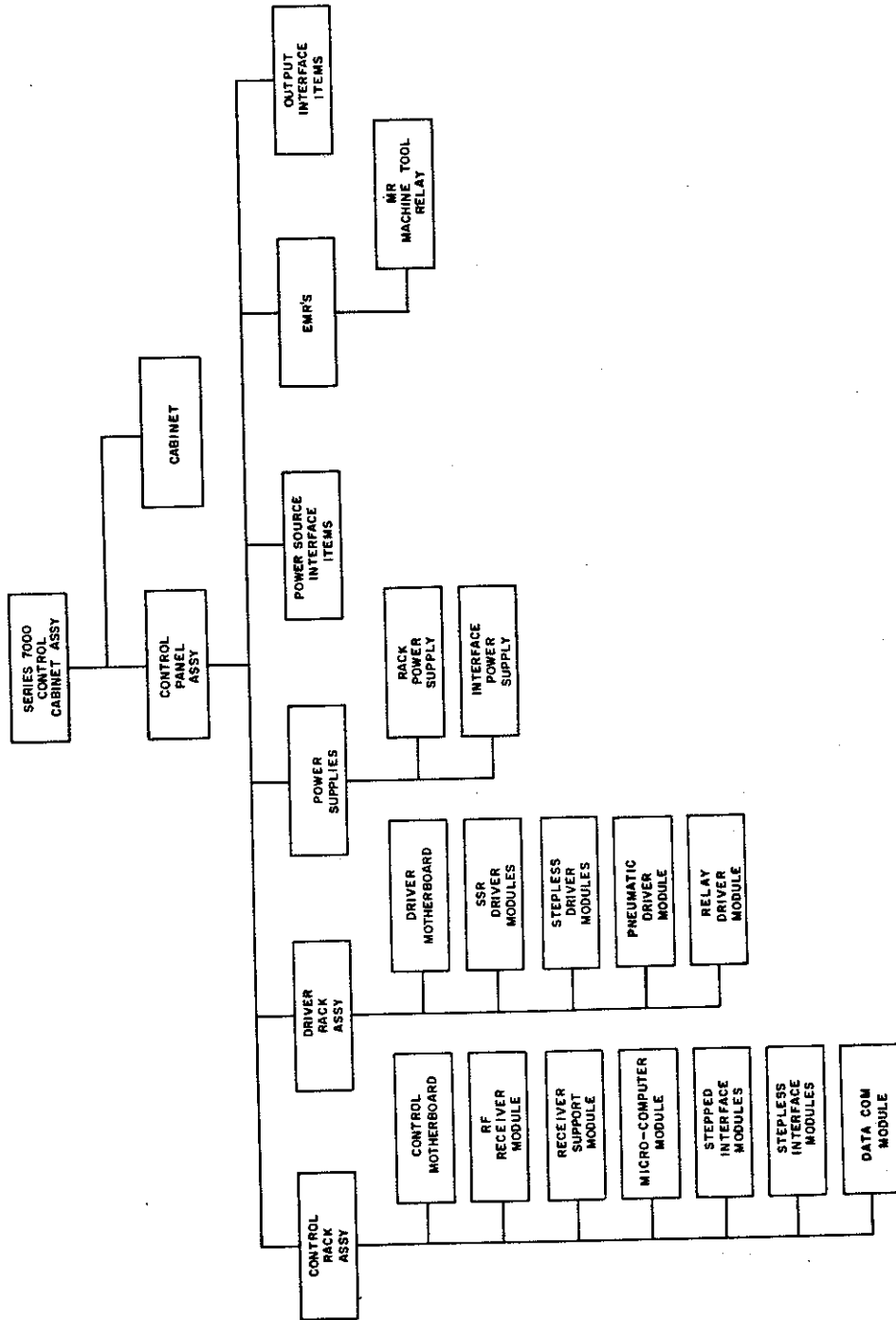
The electronics in the Receiving/Control Assembly is contained on plug-in modules that go into the following two racks:

1. The Control Rack
2. The Driver Rack

The Control Rack contains the electronics that receive and decode the transmitted RF signal.

The Driver Rack contains output driver modules that interface with the user's system.

A block diagram of the Series 7000 Receiving/Control Unit is shown in Figure # I.C.1.



telemotive DYNASCAN CORPORATION		
440 WEST COLUMBIA ST. CHICAGO, ILL. 60607-2311 (800) 541-7111		
SERIES 7000 CONTROL CABINET BLOCK DIAGRAM		
DATE	SCALE	REV.
12-10-94	1:1	1
NO. W.S.	CNO.	APP'D.
	(11/11)	
BY	CHK'D	DATE
		12-10-94
REV.		NO.
BY/DOORS		BY
		80-E7000-X-08-C

FIGURE # I.C.1



SECTION II

SYSTEM OPERATION AND PREVENTIVE MAINTENANCE

II.A.1

A. GENERAL OPERATION AND PREVENTIVE MAINTENANCE INFORMATION

To properly use the Radio Control System, it is important to understand what happens when the Radio Control System is activated. It is also important to know how to start, stop and restart the system and to maintain it in good operating condition.

The material covered in this section of the User's Manual is divided into the following parts:

1. Operating Principles
2. Operating Procedures
3. Maintenance

II.B.1

B. RADIO SYSTEM OPERATING PRINCIPLES

0. General Information:

The material presented in this section describes the principles governing the operation of the Radio Control System. The following topics are covered:

1. Conditions for Starting
2. Frequency Setting
3. Access Code Setting
4. Alarm Auxiliary Function
5. MR Relay Function

1. Conditions For Starting:

The output of the Receiver Rack Assembly cannot be enabled until the following conditions have been met:

- a. The received RF signal must be within the proper frequency passband.
- b. The access code must be received and it must meet the prescribed format.
- c. The received data must meet a prescribed format.

These stringent requirements are unique to each Receiving System and its companion Transmitter.

II.B.2

2. Frequency Setting:

The Transmitter is set to transmit a specific RF carrier frequency that is based upon the frequency generated by the crystal oscillator.

With single-box systems, the RF Receiver Module located in the Receiving/Control Cabinet Assembly is set to respond to a specific RF frequency based upon the settings of the frequency programming switches located on the Receiver Support or the optional Data Communications Module. With multi-box systems and pitch and catch systems the associated Data Communications Module does not have frequency programming switches. Instead, the received frequency is controlled by the program in the applications EPROM located on the Microcomputer Module.

A listing of the frequency code settings for both the Receiver Support Module and the optional Data Communications Module is given in Figure # II.B.1.

3. Access Code Setting:

The Transmitter is capable of transmitting the following two types of access codes:

- a. Start Access Code
- b. Maintain Access Code

II.B.3

The Start Access Code is momentary and is required to initiate the system. It is sent only as long as the Transmitter start button is held depressed.

The Maintain Access Code is sent continuously after starting the system and must always be present for the system to operate.

The Maintain Access Code is the complement of the Start Access Code. This allows a single set of switches to be used to set both access codes.

The transmitted access code is set with switches on the Continuous Access Code Board inside of the Transmitter.

The received access code is set with switches on the Microcomputer Module, which is located in the Receiver Rack Assembly.

The Microcomputer Module decodes the access code data word (Data Word #0) of the received signal and the remaining data words of the received signal.

When the Microcomputer Module decodes the Start Access Code, it enables the MR (Sensitive) (K2) Relay which in turn enables the System MR (Machine Tool) Relay located on the Receiver cabinet back panel. The output interfaces are not enabled since they require the Maintain Access Code to operate. When the start button is released, the Maintain Access Code is sent and the output buffer

II.B.4

latch is enabled and the system can now be operated.

A listing of the access code settings for both the Continuous Access Code Board and the Microcomputer Module are given in Figure # II.B.2.

4. Alarm Auxiliary Function:

The Alarm Auxiliary Function can be activated by the following:

1. When the Start button is pressed, or
2. When the Alarm button is pressed

The Alarm function typically occupies a bit position in the Auxiliary Function Data Word (Data Word #1).

When the Transmitter Start pushbutton switch is pressed, the Receiving/Control Unit MR (Sensitive) Relay is activated. This in turn, enables the Output Interface Modules. At the same time, the Alarm function is also activated.

After The Receiving/Control Unit is started up, the Alarm function can be activated by pressing the Transmitter Alarm button.

II.B.5

5. MR Relay Function:

The purpose of the MR Relay output function, is to act as a master power ON/OFF output drive signal to the user system Master Control (MC) Relay.

Figure # II.B.3 is a block diagram that shows the MR Relay output function in the Radio Control System.

The block diagram shows that the MR Relay output function is made up of the following:

- a. MR Enable Circuit
- b. MR Intermediate Relays
- c. Main Contactor (in the user's equipment)

The MR Enable Circuit is the place where an output is derived directly from the Radio Control System received signal. This approach is taken to guarantee the "no signal no operation" performance feature for the MR Relay function. Thus, power to be applied to the user's equipment will not be enabled if the Received Radio Signal is lost or degraded significantly.

The MR (Intermediate) Relays are present to boost the power level of the MR Enable Signal to the point where they can drive the coil of the Main Contactor (MC) in the user's equipment.

FIGURE # II.B.1

S7000 SYSTEM FREQUENCY CODE SETTINGS

ASSOCIATED TELEMOTIVE RF FREQUENCY (in MHz)		E7101 RECEIVER SUPPORT MODULE SETTING			E7103 DATA COMMUNICATIONS MODULE SETTING		
FREQ	T#	S4	S2	S3	S7	S6	S5
72.02	LR11	1	5	0	1	5	0
72.04	LR21	1	4	0	1	4	0
72.06	LR12	1	3	0	1	3	0
72.08	LR22	1	2	0	1	2	0
72.10	LR13	1	1	0	1	1	0
72.12	LR23	1	0	0	1	0	0
72.14	LR14	0	F	F	0	F	F
72.16	LR24	0	E	F	0	E	F
72.18	LR15	0	D	F	0	D	F
72.20	LR25	0	C	F	0	C	F
72.22	LR16	0	B	F	0	B	F
72.24	LR26	0	A	F	0	A	F
72.26	LR17	0	9	F	0	9	F
72.28	LR27	0	8	F	0	8	F
72.30	LR18	0	7	F	0	7	F
72.32	LR28	0	6	F	0	6	F
72.34	LR19	0	5	F	0	5	F
72.36	LR29	0	4	F	0	4	F
72.38	LR20	0	3	F	0	3	F
72.40	LR30	0	2	F	0	2	F
72.44	LR1	0	0	F	0	0	F
72.48	LR2	0	E	E	0	E	E
72.52	LR3	0	C	E	0	C	E
72.56	LR4	0	A	E	0	A	E
72.60	LR5	0	8	E	0	8	E
75.44	LR6	0	A	5	0	A	5
75.48	LR7	0	8	5	0	8	5
75.52	LR8	0	6	5	0	6	5
75.56	LR9	0	4	5	0	4	5
75.60	LR10	0	2	5	0	2	5

SERIES 7000 SYSTEM ACCESS CODE SETTINGS

START ACCESS CODE (IN DECIMAL)	A334 ACCESS CODE BOARD SETTING (IN BINARY)							E7106 MICROCOMPUTER MODULE SETTING (IN HEX)		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz)		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz)	
	S1							S5	S6	T#	FREQ	T#	FREQ
	0	1	2	3	4	5	6	7					
0	0	0	0	0	0	0	0	F	F	NOT AVAILABLE			
1	1	0	0	0	0	0	0	7	F	NOT AVAILABLE			
2	0	1	0	0	0	0	0	B	F	NOT AVAILABLE			
3	1	1	0	0	0	0	0	3	F	NOT AVAILABLE			
4	0	0	1	0	0	0	0	D	F	NOT AVAILABLE			
5	1	0	1	0	0	0	0	5	F	LR75	72.42		
6	0	1	1	0	0	0	0	9	F	LR76	72.80		
7	1	1	1	0	0	0	0	1	F	LR77	72.90		
8	0	0	0	1	0	0	0	E	F	NOT AVAILABLE			
9	1	0	0	1	0	0	0	6	F	LR78	75.34		
10	0	1	0	1	0	0	0	A	F	LR80	75.58		
11	1	1	0	1	0	0	0	2	F	LR81	75.54		
12	0	0	1	1	0	0	0	C	F	LR82	75.84		
13	1	0	1	1	0	0	0	4	F	LR86	72.46		
14	0	1	1	1	0	0	0	8	F	LR84	75.82		
15	1	1	1	1	0	0	0	0	F	LR85	75.90		
16	0	0	0	0	1	0	0	F	7	NOT AVAILABLE			
17	1	0	0	0	1	0	0	7	7	LR127	72.28		
18	0	1	0	0	1	0	0	B	7	LR128	72.32		
19	1	1	0	0	1	0	0	3	7	LR129	72.36		
20	0	0	1	0	1	0	0	D	7	LR130	72.40		
21	1	0	1	0	1	0	0	5	7	LR175	72.42		
22	0	1	1	0	1	0	0	9	7	LR176	72.80		
23	1	1	1	0	1	0	0	1	7	LR178	75.34		
24	0	0	0	1	1	0	0	E	7	LR179	75.42		
25	1	0	0	1	1	0	0	6	7	COMPLEMENT			
26	0	1	0	1	1	0	0	A	7	COMPLEMENT			
27	1	1	0	1	1	0	0	2	7	COMPLEMENT			
28	0	0	1	1	1	0	0	C	7	COMPLEMENT			
29	1	0	1	1	1	0	0	4	7	COMPLEMENT			
30	0	1	1	1	1	0	0	8	7	COMPLEMENT			
31	1	1	1	1	1	0	0	0	7	COMPLEMENT			
32	0	0	0	0	0	1	0	F	B	NOT AVAILABLE			
33	1	0	0	0	0	1	0	7	B	COMPLEMENT			
34	0	1	0	0	0	1	0	B	B	COMPLEMENT			
35	1	1	0	0	0	1	0	3	B	COMPLEMENT			
36	0	0	1	0	0	1	0	D	B	COMPLEMENT			
37	1	0	1	0	0	1	0	5	B	COMPLEMENT			
38	0	1	1	0	0	1	0	9	B	COMPLEMENT			
39	1	1	1	0	0	1	0	1	B	COMPLEMENT			
40	0	0	0	1	0	1	0	E	B	COMPLEMENT			
41	1	0	0	1	0	1	0	6	B	COMPLEMENT			
42	0	1	0	1	0	1	0	A	B	COMPLEMENT			
43	1	1	0	1	0	1	0	2	B	COMPLEMENT			
44	0	0	1	1	0	1	0	C	B	COMPLEMENT			
45	1	0	1	1	0	1	0	4	B	COMPLEMENT			

SERIES 7000 SYSTEM ACCESS CODE SETTINGS

START ACCESS CODE (IN DECIMAL)	A334 ACCESS CODE BOARD SETTING (IN BINARY)							E7106 MICROCOMPUTER MODULE SETTING (IN HEX)		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz)		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz)			
	S1							S5	S6	T#	FREQ	T#	FREQ		
	0	1	2	3	4	5	6	7							
46	0	1	1	1	0	1	0	0	8	B			COMPLEMENT		
47	1	1	1	1	0	1	0	0	0	B			COMPLEMENT		
48	0	0	0	0	1	1	0	0	F	3			COMPLEMENT		
49	1	0	0	0	1	1	0	0	7	3			COMPLEMENT		
50	0	1	0	0	1	1	0	0	B	3			COMPLEMENT		
51	1	1	0	0	1	1	0	0	3	3			COMPLEMENT		
52	0	0	1	0	1	1	0	0	D	3			COMPLEMENT		
53	1	0	1	0	1	1	0	0	5	3			COMPLEMENT		
54	0	1	1	0	1	1	0	0	9	3			COMPLEMENT		
55	1	1	1	0	1	1	0	0	1	3			COMPLEMENT		
56	0	0	0	1	1	1	0	0	F	3			COMPLEMENT		
57	1	0	0	1	1	1	0	0	6	3			SPECIAL USE		
58	0	1	0	1	1	1	0	0	A	3			COMPLEMENT		
59	1	1	0	1	1	1	0	0	2	3			COMPLEMENT		
60	0	0	1	1	1	1	0	0	C	3			COMPLEMENT		
61	1	0	1	1	1	1	0	0	4	3			COMPLEMENT		
62	0	1	1	1	1	1	0	0	8	3			COMPLEMENT		
63	1	1	1	1	1	1	0	0	0	3			COMPLEMENT		
64	0	0	0	0	0	0	1	0	F	D			NOT AVAILABLE		
65	1	0	0	0	0	0	1	0	7	D			COMPLEMENT		
66	0	1	0	0	0	0	1	0	B	D			COMPLEMENT		
67	1	1	0	0	0	0	1	0	3	D			COMPLEMENT		
68	0	0	1	0	0	0	1	0	D	D			COMPLEMENT		
69	1	0	1	0	0	0	1	0	5	D			COMPLEMENT		
70	0	1	1	0	0	0	1	0	9	D			COMPLEMENT		
71	1	1	1	0	0	0	1	0	1	D			COMPLEMENT		
72	0	0	0	1	0	0	1	0	E	D			COMPLEMENT		
73	1	0	0	1	0	0	1	0	6	D			COMPLEMENT		
74	0	1	0	1	0	0	1	0	A	D			COMPLEMENT		
75	1	1	0	1	0	0	1	0	2	D			COMPLEMENT		
76	0	0	1	1	0	0	1	0	C	D			COMPLEMENT		
77	1	0	1	1	0	0	1	0	4	D			COMPLEMENT		
78	0	1	1	1	0	0	1	0	8	D			COMPLEMENT		
79	1	1	1	1	0	0	1	0	0	D			COMPLEMENT		
80	0	0	0	0	1	0	1	0	F	5			COMPLEMENT		
81	1	0	0	0	1	0	1	0	7	5			COMPLEMENT		
82	0	1	0	0	1	0	1	0	B	5			COMPLEMENT		
83	1	1	0	0	1	0	1	0	3	5			COMPLEMENT		
84	0	0	1	0	1	0	1	0	D	5			COMPLEMENT		
85	1	0	1	0	1	0	1	0	5	5			COMPLEMENT		
86	0	1	1	0	1	0	1	0	9	5			COMPLEMENT		
87	1	1	1	0	1	0	1	0	1	5			COMPLEMENT		
88	0	0	0	1	1	0	1	0	E	5			COMPLEMENT		
89	1	0	0	1	1	0	1	0	6	5			COMPLEMENT		
90	0	1	0	1	1	0	1	0	A	5			SPECIAL USE		

II.B.9

SERIES 7000 SYSTEM ACCESS CODE SETTINGS

START ACCESS CODE (IN DECIMAL)	A334 ACCESS CODE BOARD SETTING (IN BINARY)							E7106 MICROCOMPUTER MODULE SETTING (IN HEX)		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz)		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz)		
	S1							S5	S6	T#	FREQ	T#	FREQ	
	0	1	2	3	4	5	6	7						
91	1	1	0	1	1	0	1	0	2	5		410.350		
92	0	0	1	1	1	0	1	0	C	5		411.200		
93	1	0	1	1	1	0	1	0	4	5		412.750		
94	0	1	1	1	1	0	1	0	8	5		413.800		
95	1	1	1	1	1	0	1	0	0	5	LR74	75.80		
96	0	0	0	0	0	1	1	0	F	9		COMPLEMENT		
97	1	0	0	0	0	1	1	0	7	9		COMPLEMENT		
98	0	1	0	0	0	1	1	0	B	9		COMPLEMENT		
99	1	1	0	0	0	1	1	0	3	9		COMPLEMENT		
100	0	0	1	0	0	1	1	0	D	9		467.700		413.850
101	1	0	1	0	0	1	1	0	5	9	U01	467.750		
102	0	1	1	0	0	1	1	0	9	9	U02	467.775		
103	1	1	1	0	0	1	1	0	1	9	U03	467.800		
104	0	0	0	1	0	1	1	0	E	9	U04	467.825		
105	1	0	0	1	0	1	1	0	6	9	U05	467.850		
106	0	1	0	1	0	1	1	0	A	9	U06	467.875		
107	1	1	0	1	0	1	1	0	2	9	U07	467.900		
108	0	0	1	1	0	1	1	0	C	9	U08	467.925		
109	1	0	1	1	0	1	1	0	4	9	U09	467.7625		
110	0	1	1	1	0	1	1	0	8	9	U10	467.7875		
111	1	1	1	1	0	1	1	0	0	9	U11	467.8125		
112	0	0	0	0	1	1	1	0	F	1	U12	467.8375		
113	1	0	0	0	1	1	1	0	7	1	U13	467.8625		
114	0	1	0	0	1	1	1	0	B	1	U14	467.8875		
115	1	1	0	0	1	1	1	0	3	1	U15	467.9125		
116	0	0	1	0	1	1	1	0	D	1	U16	467.9375		
117	1	0	1	0	1	1	1	0	5	1	U17	467.9625		
118	0	1	1	0	1	1	1	0	9	1	U18	467.9875		
119	1	1	1	0	1	1	1	0	1	1	U19	468.0125		
120	0	0	0	1	1	1	1	0	E	1	U20	468.0375		
121	1	0	0	1	1	1	1	0	6	1				
122	0	1	0	1	1	1	1	0	A	1				
123	1	1	0	1	1	1	1	0	2	1				
124	0	0	1	1	1	1	1	0	C	1				
125	1	0	1	1	1	1	1	0	4	1				
126	0	1	1	1	1	1	1	0	8	1				
127	1	1	1	1	1	1	1	0	0	1		NOT AVAILABLE		
128	0	0	0	0	0	0	0	1	F	E		NOT AVAILABLE		
129	1	0	0	0	0	0	0	1	7	E		COMPLEMENT		
130	0	1	0	0	0	0	0	1	B	E		COMPLEMENT		
131	1	1	0	0	0	0	0	1	3	E		COMPLEMENT		
132	0	0	1	0	0	0	0	1	D	E		COMPLEMENT		
133	1	0	1	0	0	0	0	1	5	E		COMPLEMENT		
134	0	1	1	0	0	0	0	1	9	E		COMPLEMENT		
135	1	1	1	0	0	0	0	1	1	E		COMPLEMENT		

SERIES 7000 SYSTEM ACCESS CODE SETTINGS

START ACCESS CODE (IN DECIMAL)	A334 ACCESS CODE BOARD SETTING (IN BINARY) S1							E7106 MICROCOMPUTER MODULE SETTING (IN HEX) S5 S6		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz) T# FREQ		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz) T# FREQ		
	0	1	2	3	4	5	6	7						
	136	0	0	0	1	0	0	0	1	E	E	COMPLEMENT		
137	1	0	0	1	0	0	0	1	6	E	COMPLEMENT			
138	0	1	0	1	0	0	0	1	A	E	COMPLEMENT			
139	1	1	0	1	0	0	0	1	2	E	COMPLEMENT			
140	0	0	1	1	0	0	0	1	C	E	COMPLEMENT			
141	1	0	1	1	0	0	0	1	4	E	COMPLEMENT			
142	0	1	1	1	0	0	0	1	8	E	COMPLEMENT			
143	1	1	1	1	0	0	0	1	0	E	COMPLEMENT			
144	0	0	0	0	1	0	0	1	F	6	COMPLEMENT			
145	1	0	0	0	1	0	0	1	7	6	COMPLEMENT			
146	0	1	0	0	1	0	0	1	B	6	COMPLEMENT			
147	1	1	0	0	1	0	0	1	3	6	COMPLEMENT			
148	0	0	1	0	1	0	0	1	D	6	COMPLEMENT			
149	1	0	1	0	1	0	0	1	5	6	COMPLEMENT			
150	0	1	1	0	1	0	0	1	9	6	COMPLEMENT			
151	1	1	1	0	1	0	0	1	1	6	COMPLEMENT			
152	0	0	0	1	1	0	0	1	E	6	COMPLEMENT			
153	1	0	0	1	1	0	0	1	6	6	COMPLEMENT			
154	0	1	0	1	1	0	0	1	A	6	COMPLEMENT			
155	1	1	0	1	1	0	0	1	2	6	COMPLEMENT			
156	0	0	1	1	1	0	0	1	C	6	LR87	72.50		
157	1	0	1	1	1	0	0	1	4	6	LR88	72.54		
158	0	1	1	1	1	0	0	1	8	6	LR89	72.58		
159	1	1	1	1	1	0	0	1	0	6	LR90	72.62		
160	0	0	0	0	0	1	0	1	F	A	SPECIAL USE			
161	1	0	0	0	0	1	0	1	7	A	COMPLEMENT			
162	0	1	0	0	0	1	0	1	B	A	COMPLEMENT			
163	1	1	0	0	0	1	0	1	3	A	COMPLEMENT			
164	0	0	1	0	0	1	0	1	D	A	COMPLEMENT			
165	1	0	1	0	0	1	0	1	5	A	SPECIAL USE			
166	0	1	1	0	0	1	0	0	9	A	LR91	72.64		
167	1	1	1	0	0	1	0	1	1	A	LR92	72.66		
168	0	0	0	1	0	1	0	1	E	A	LR93	72.68		
169	1	0	0	1	0	1	0	1	6	A	LR94	72.70		
170	0	1	0	1	0	1	0	1	A	A	LR95	72.72		
171	1	1	0	1	0	1	0	1	2	A	LR96	75.62		
172	0	0	1	1	0	1	0	1	C	A	LR83	75.86		
173	1	0	1	1	0	1	0	1	4	A	LR79	75.42		
174	0	1	1	1	0	1	0	1	8	A	LR97	75.64		
175	1	1	1	1	0	1	0	1	0	A	LR98	75.66		
176	0	0	0	0	1	1	0	1	F	2	LR99	75.70		
177	1	0	0	0	1	1	0	1	7	2	LR100	75.72		
178	0	1	0	0	1	1	0	1	B	2	LR101	72.44		
179	1	1	0	0	1	1	0	1	3	2	LR102	72.48		
180	0	0	1	0	1	1	0	1	D	2	LR103	72.52		

SERIES 7000 SYSTEM ACCESS CODE SETTINGS

START ACCESS CODE (IN DECIMAL)	A334 ACCESS CODE BOARD SETTING (IN BINARY) S1							E7106 MICROCOMPUTER MODULE SETTING (IN HEX) S5 S6		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz) T# FREQ		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz) T# FREQ		
	0	1	2	3	4	5	6	7						
	181	1	0	1	1	0	1	0	1	5	2	LR104	72.56	
182	0	1	1	0	1	1	0	1	9	2	LR105	72.60		
183	1	1	1	0	1	1	0	1	1	2	LR106	75.44		
184	0	0	0	1	1	1	0	1	E	2	LR107	75.48		
185	1	0	0	1	1	1	0	1	6	2	LR108	75.52		
186	0	1	0	1	1	1	0	1	A	2	LR109	75.56		
187	1	1	0	1	1	1	0	1	2	2	LR110	75.60		
188	0	0	1	1	1	1	0	1	C	2	LR111	72.02		
189	1	0	1	1	1	1	0	1	4	2	LR112	72.06		
190	0	1	1	1	1	1	0	1	8	2	LR113	72.10		
191	1	1	1	1	1	1	0	1	0	2	NOT AVAILABLE			
192	0	0	0	0	0	0	1	1	F	C	LR114	72.14		
193	1	0	0	0	0	0	1	1	7	C	LR115	72.18		
194	0	1	0	0	0	0	1	1	B	C	LR116	72.22		
195	1	1	0	0	0	0	1	1	3	C	LR117	72.26		
196	0	0	1	0	0	0	1	1	D	C	LR118	72.30		
197	1	0	1	0	0	0	1	1	5	C	LR119	72.34		
198	0	1	1	0	0	0	1	1	9	C	SPECIAL USE			
199	1	1	1	0	0	0	1	1	1	C	LR120	72.38		
200	0	0	0	1	0	0	1	1	E	C	LR23	72.12	LR31	49.61
201	1	0	0	1	0	0	1	1	6	C	LR1	72.44	LR32	49.63
202	0	1	0	1	0	0	1	1	A	C	LR2	72.48	LR33	49.65
203	1	1	0	1	0	0	1	1	2	C	LR3	72.52	LR34	49.67
204	0	0	1	1	0	0	1	1	C	C	LR4	72.56	LR35	49.69
205	1	0	1	1	0	0	1	1	4	C	LR5	72.60	LR36	49.71
206	0	1	1	1	0	0	1	1	8	C	LR6	75.44	LR37	49.73
207	1	1	1	1	0	0	1	1	0	C	LR7	75.48	LR38	49.75
208	0	0	0	0	1	0	1	1	F	4	LR8	75.52	LR39	49.77
209	1	0	0	0	1	0	1	1	7	4	LR9	75.56	LR40	49.79
210	0	1	0	0	1	0	1	1	B	4	LR10	75.60	LR41	49.81
211	1	1	0	0	1	0	1	1	3	4	LR11	72.02	LR42	49.83
212	0	0	1	0	1	0	1	1	D	4	LR12	72.06	LR43	49.85
213	1	0	1	0	1	0	1	1	5	4	LR13	72.10	LR44	49.87
214	0	1	1	0	1	0	1	1	9	4	LR14	72.14	LR45	49.89
215	1	1	1	0	1	0	1	1	1	4	LR15	72.18	LR46	49.91
216	0	0	0	1	1	0	1	1	E	4	LR16	72.22	LR47	49.93
217	1	0	0	1	1	0	1	1	6	4	LR17	72.26	LR48	49.95
218	0	1	0	1	1	0	1	1	A	4	LR18	72.30	LR49	49.97
219	1	1	0	1	1	0	1	1	2	4	LR19	72.34	LR50	49.99
220	0	0	1	1	1	0	1	1	C	4	LR20	72.38		
221	1	0	1	1	1	0	1	1	4	4	LR21	72.04		
222	0	1	1	1	1	0	1	1	8	4	LR22	72.08		
223	1	1	1	1	1	0	1	1	0	4	NOT AVAILABLE			
224	0	0	0	0	0	1	1	1	F	8	LR24	72.16		
225	1	0	0	0	0	1	1	1	7	8	LR25	72.20		

SERIES 7000 SYSTEM ACCESS CODE SETTINGS

START ACCESS CODE (IN DECIMAL)	A334 ACCESS CODE BOARD SETTING (IN BINARY) S1							E7106 MICROCOMPUTER MODULE SETTING (IN HEX)		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz)		ASSOCIATED TELEMOTIVE RF FREQUENCY (IN MHz)		
	0	1	2	3	4	5	6	7	S5	S6	T#	FREQ	T#	FREQ
	226	0	1	0	0	0	1	1	1	B	8	LR26	72.24	
227	1	1	0	0	0	1	1	1	3	8	LR27	72.28		
228	0	0	1	0	0	1	1	1	D	8	LR28	72.32		
229	1	0	1	0	0	1	1	1	5	8	LR29	72.36		
230	0	1	1	0	0	1	1	1	9	8	LR30	72.40		
231	1	1	1	0	0	1	1	1	1	8		COMPLEMENT		
232	0	0	0	1	0	1	1	1	E	8		COMPLEMENT		
233	1	0	0	1	0	1	1	1	6	8		COMPLEMENT		
234	0	1	0	1	0	1	1	1	A	8		COMPLEMENT		
235	1	1	0	1	0	1	1	1	2	8		COMPLEMENT		
236	0	0	1	1	0	1	1	1	C	8		COMPLEMENT		
237	1	0	1	1	0	1	1	1	4	8		COMPLEMENT		
238	0	1	1	1	0	1	1	1	8	8		COMPLEMENT		
239	1	1	1	1	0	1	1	1	0	8		NOT AVAILABLE		
240	0	0	0	0	1	1	1	1	F	0		COMPLEMENT		
241	1	0	0	0	1	1	1	1	7	0		COMPLEMENT		
242	0	1	0	0	1	1	1	1	B	0		COMPLEMENT		
243	1	1	0	0	1	1	1	1	3	0		COMPLEMENT		
244	0	0	1	0	1	1	1	1	D	0		COMPLEMENT		
245	1	0	1	0	1	1	1	1	5	0		COMPLEMENT		
246	0	1	1	0	1	1	1	1	9	0		COMPLEMENT		
247	1	1	1	0	1	1	1	1	1	0		NOT AVAILABLE		
248	0	0	0	1	1	1	1	1	E	0		COMPLEMENT		
249	1	0	0	1	1	1	1	1	6	0		COMPLEMENT		
250	0	1	0	1	1	1	1	1	A	0		COMPLEMENT		
251	1	1	0	1	1	1	1	1	2	0		NOT AVAILABLE		
252	0	0	1	1	1	1	1	1	C	0		NOT AVAILABLE		
253	1	0	1	1	1	1	1	1	4	0		NOT AVAILABLE		
254	0	1	1	1	1	1	1	1	8	0		NOT AVAILABLE		
255	1	1	1	1	1	1	1	1	0	0		NOT AVAILABLE		

NOTES:

1. The binary setting positions for the Access Code Switch S1 are marked on the PCB not on the switch itself.
2. The Microcomputer Module switches S5 and S6 are hexadecimal coded switches.
3. The LR101 to LR200 frequency codes provide for a second set of Access Code assignments for the corresponding frequency codes between LR1 to LR100.
4. This information was derived from the Telemotive Digital Access Code Assignment Chart DE-1000-1-0.05-A.

II.B.13

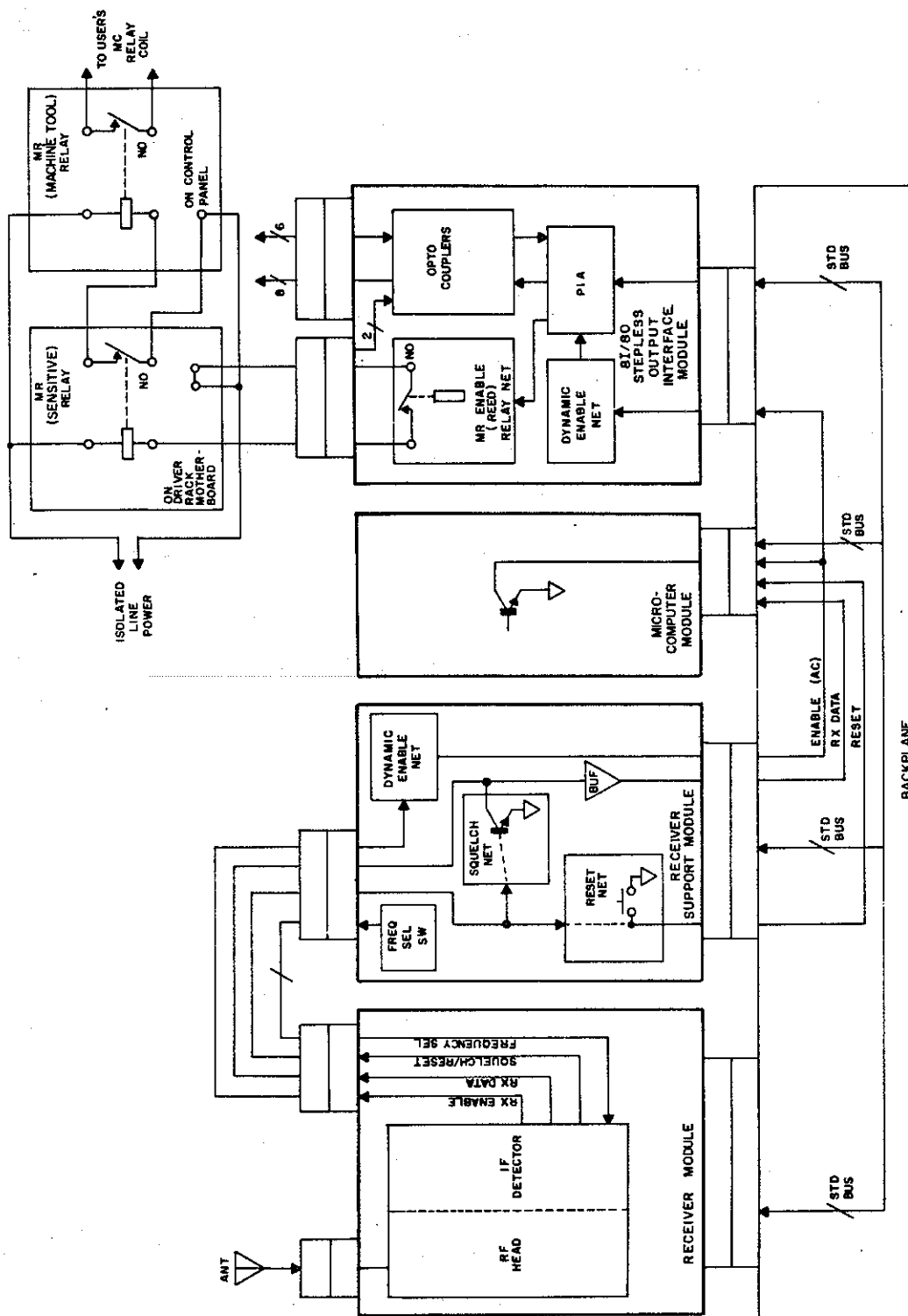


FIGURE # II.B.3

telemotive DYNASCAN CORPORATION <small>2601 WEST CENTURIE ST. CHICAGO, ILL. 60657-2108-9375 1001 25-0147</small>	
TYPE	
REV	
DATE	
BY	
CHKD	
DATE	9.30.85
DRAWING NO.	
APP'D	TC
NO.	BD-E7000-X-3.0A-C

C. RADIO SYSTEM OPERATING PROCEDURES

0. General Information:

The material presented in this section describes the procedures used to start-up the Telemotive Series 7000 Radio Control System. The following topics are covered.

1. MANUAL to RADIO Switchover Procedure
2. Starting Procedure
3. Operating Conditions
4. Maximum Range Control Setting Procedure (RF Receiver Module)
5. Range Control Setting Procedure (Optional Antenna Diversity Kit)
6. Stopping Procedure
7. Restarting Procedures

1. Manual-Radio Switchover Procedures:

The following procedures can be used to switch the Radio Control System between MANUAL and RADIO operation:

a. System Manual Operation:

The overall starting and shutdown procedures are outlined in the instruction manual of the original equipment system manufacturer.

II.C.2

b. Manual to Radio Operation:

1. Make sure that the power to the system that is being controlled is OFF.
2. Set the transfer switch to the RADIO position. Check for push to operate type switches.
3. Turn the system power ON. The system is now ready for the remote radio control operation.

c. Radio to Manual Operation:

1. Turn the Transmitter off by setting the ON/OFF and key lock switches to the OFF position.
2. Set the transfer switch to MANUAL position.
3. The system is now ready for MANUAL operation.

2. Radio System Starting Procedure:

The following procedure is used to start the Radio Remote Control System.

- a. Turn the Transmitter key lock switch to the ON position. This connects the battery to the Transmitter ON/OFF switch. But further action must be taken before the Transmitter transmits any signals.

II.C.3

- b. Turn the Transmitter ON/OFF switch (red boot) to the ON position. This connects the battery to the transmitter circuitry and allows the Transmitter to transmit a properly formatted signal, with the exception that data word # 0 is not filled with an access code.
- c. Press the START button. A properly formatted signal including the START access code is transmitted. The operation of an override auxiliary start function on the system i.e., horn or start light is also activated.
- d. Release the start button. The Transmitter transmits a properly formatted signal including the Maintain Access Code.

3. Radio System Operating Conditions:

To maintain the Receiver Rack Assembly Master Relay (MR) in the ON state, the following conditions have to be met:

- a. The received RF signal must have the proper carrier frequency and be above a minimum level.
- b. A properly coded signal must be continuously received and decoded by the Receiver Rack Assembly.

II.C.4

4. Maximum Range Control Setting Procedure (Using RF Receiver Module):

The RF Receiver Module has an adjustment that provides for setting the maximum operating range of the system.

The following procedure is used to set the maximum operating range of the system after it has been started up in the Radio Control mode:

- a. Set the range adj control on the RF Receiver Module fully counterclockwise (CCW).

This sets the system to operate at its maximum range.

- b. If less than maximum range is desired, turn ON the associated Transmitter and locate it at the maximum desired operating distance between the Receiving Antenna and the associated Transmitter.
- c. At the RF Receiver Module, gradually turn the range adjust control clockwise (CW) until the Received Data light on the Receiver Support Module turns OFF.
- d. Slowly turn the range adjust control on the RF Receiver Module counterclockwise (CCW) until the Received Data light on the Receiver Support Module turns ON. Then back it off slightly to allow for hysteresis.

II.C.5

With this adjustment, the maximum operating range of the system has been set for the typical conditions at the maximum desired operating distance.

- e. Check that this maximum range adjustment is suitable at other desired maximum operating positions for the receiving antenna and Transmitter.

If necessary, repeat steps "a" through "d" under worst operating conditions to achieve maximum operating range settings.

5. Range Control Setting Procedure (Using Optional Antenna Diversity Kit):

When a more precise setting of the operating range of the system is desired, Telemotive has available an optional Antenna Diversity Kit which consists of the following items:

1. A Second Receiving Antenna
2. A Second Antenna Cable
3. An Antenna Switching Assembly
4. A Data Communications Module
5. A New Software Program for the
Microcomputer Module System
EPROM and Applications EPROM

The optional Data Communications Module replaces the standard Receiver Support Module in the system.

II.C.6

The following procedure is used to set the desired operating range of a system which employs the optional Data Communications Module.

- a. Set the range adjust control on the RF Receiver Module fully counterclockwise (CCW).
- b. Set the range adjust control of the Data Communications Module fully counterclockwise (CCW). This sets the system to operate at its maximum range.
- c. In setting up range control, take the Transmitter to a distance which you have determined to be your maximum distance.
- d. Turn the range control on the Data Communication Module CW until the two IED's on the antenna switching box start to switch. Then back off the range control CCW until the switching stops. Leave it at this setting. To make sure your range is set properly, have the person with the Transmitter operate the system.

There are two types of ranges that you must be concerned with. These two ranges are called:

- a. Maximum Calling Range
- b. Dropout Free Range

II.C.7

- a. Maximum Calling Range -- is the range at which the operator can operate the system when standing facing the system and he has line of sight with the receiving antenna. Maximum Calling Range is greater than Dropout Free Range.
- b. Dropout Free Range -- is the range at which the system will operate without losing signal from the Transmitter. In actual operation the operator may operate in areas where he does not have line of sight with the receiving antenna or there may be multipath. This will cause reduction or loss of signal. If this reduction of signal is at a level that is greater than what was set above, the system will shut down. The system will automatically come back on when the operator changes position or walks closer to the system being operated.

The operator should walk around so that the range can be adjusted for best operation.

EXAMPLE: If you want 80 to 100 feet of Dropout Free operation, Maximum Calling Range may be between 100 to 130 feet depending on the type of system being set up and your environment.

You will also note that as the operator stands in different operating locations, the antenna switching may increase or decrease, but that the system will continue to operate even though the antenna switch is switching. This is normal since the system is hunting for the best signal. If the system fails to see a good signal for 2.5 seconds, then the system will shut

II.C.8

down, but as soon as the system sees a good signal, it will automatically start up again.

There are two types of dropouts that we are concerned with:

- a. System Dropout
- b. Controlled Range Dropout

- a. System Dropout -- The system will drop out 2.5 seconds after complete loss of signal. This type of dropout is completely different than Controlled Range Dropout.

When the system drops out, it must be restarted by pushing the start button on the Transmitter.

- b. Controlled Range Dropout -- The system is still receiving a good signal. What is happening is the Microcomputer Module is comparing the level of the input signal to a predetermined level that was set up using the range control adjustment on the Data Communications Module. Once this level has been reached, the Microcomputer Module shuts down the outputs. You can tell the system is still working because the Dynamic enable light on the Data Communication Module and the reset light on the Microcomputer Module are still lit. Even though the lights on the 8-I/8-O and 16-O Output Interface Modules and SSR Output Driver Modules have been disabled, the system is still operating and the antenna diversity system is still hunting for a good signal. Once a good signal has been detected, the system

II.C.9

will automatically start operating. If the operator loses control he will have to walk in closer to regain control of the system.

6. Radio System Stopping Procedure:

To stop the system for any reason, just switch the Transmitter ON/OFF switch (red boot) to the OFF position.

7. Radio System Restarting Procedure:

If the system goes off for any reason, restarting may be attempted by momentarily pressing the START button (grey boot). If this does not work, turn the Transmitter ON/OFF switch (red boot) to the OFF position for more than two seconds. Then turn it back to the ON position. Then momentarily press the Transmitter START button (grey boot).

D. RADIO SYSTEM PREVENTIVE MAINTENANCE

0. General Information:

The System requires a limited amount of routine maintenance to achieve optimum system performance.

The electronic portions of the systems are built in modular form. The complete systems are physically arranged for quick service.

For convenience in servicing the system, a complete set of electronic, electrical and pneumatic spare parts should be available at the job site. A defective assembly can then be simply replaced with a spare.

The material presented in this section describes some of the routine maintenance activities that should be followed with the Radio Control System. The following topics are covered:

1. Routine Inspections
2. Rack Module Preventive Maintenance
3. Transmitter Unit Preventive Maintenance

1. Routine Inspections:

On a periodic basis, the entire system should be routinely checked for proper physical and electrical conditions.

II.D.2

The receiver rack in the receiver enclosure should fit snugly and tightly on the shock mounts. If the rack is loose, the shock mounts should be inspected carefully. Damaged material should be replaced.

2. Rack Module Preventive Maintenance:

CAUTION

Before removing or installing any electronic modules, the power to the system should be turned OFF. This not only protects the equipment from any transients that may be developed, but it also assures that the technician will not come in contact with any high voltages.

- a. Before modules can be installed or removed from a card rack, the hinged card holding bracket must be opened. This is located at the top of the card rack. Opening the bracket removes power from the plug-in modules.
- b. To remove a module, grasp the card ejector with your thumb and index finger. Pull the module straight out. If it does not come out easily, do not force it. Push the modules in firmly. The module should then come out fairly easily.
- c. To install a module, visually line up the top and bottom edges of the card with the card guide and slide the module into its slot until a slight resistance is met. To set the module into its connector, use both thumbs. Place one near the bottom of the module and the other on the card ejector.

II.D.3

Push firmly until the module is seated. The front edge of the installed module should be even with the front of the adjacent modules.

- d. Always lock the card holding bracket when you are finished servicing the modules. This prevents the modules from being dislodged in the card rack, should the equipment be subjected to strong shocks or vibrations.

3. Transmitter Preventive Maintenance:

- a. Keep the Transmitter clean and free of all coatings, especially those that are electrically conductive.
- b. Inspect the case hardware and make sure that it is tightened adequately.
- c. Check the motion lever switches and make sure that they move smoothly in both directions from their neutral position.
- d. Check the Transmitter battery voltage under loaded conditions and make sure it exceeds the prescribed charge value prescribed for the battery being used. See Figure # III.C.1.

II.D.4

- e. Check the Transmitter current drain and make sure that it is within the expected range for a properly working unit. See Figure # III.C.2.

III.0

SECTION III
SYSTEM TROUBLESHOOTING

III.1

SERIES 7000 RADIO CONTROL SYSTEM

SYSTEM TROUBLESHOOTING OUTLINE

- A. General Troubleshooting Approach
- B. Troubleshooting Aids
- C. Troubleshooting Procedure
 - 0. General Information
 - 1. System Completely Inoperative
 - a. General Information
 - b. Transmitter Unit Checks
 - c. Power Supply Assembly Checks
 - d. Receiver Module Checks
 - e. Microcomputer Module Checks
 - f. MR Relay Circuit Checks
 - 2. System Operates Erratically
 - a. General Information
 - b. Transmitter Controls Checks
 - c. Receiver Signal Strength Checks
 - d. Power Supply Assembly Checks
 - e. Receiver Module Checks
 - f. Microcomputer Module Checks
 - g. Output Interface Module Checks
 - h. Driver Rack Output Driver Module Checks
 - i. Control Cabinet Wiring Checks

III.2

3. System Operates Partially

- a. General Information
- b. Transmitter Controls Checks
- c. Output Interface Module Checks
- d. Output Driver Module Checks
- e. Control Cabinet Wiring Checks

D. User Equipment Interface Troubleshooting Procedures

III.A.1

A. GENERAL TROUBLESHOOTING APPROACH

The first step in troubleshooting is to isolate the malfunction to a particular part of the system.

The total System consists of the following parts:

1. Transmitter Unit (with antenna)
2. Receiving/Control Assembly
 - a. Control Rack
 - b. Driver Rack
 - c. The Receiving Antenna
3. The User Equipment Interface Items
 - a. Intermediate Relays
 - b. Pneumatic Controls (where applicable)
4. The User System Mechanism
 - a. Drive Motors
 - b. Manual Controls
 - c. Magnetic Controls

If trouble occurs and the system has manual controls, use the Transfer Switch to place the system in manual operation and operate the system with the manual controls. If the symptoms persist, the trouble is not in the radio controls. Use standard system electrical maintenance trouble shooting procedures to isolate and cure the malfunction.

III.B.1

B. TROUBLESHOOTING AIDS

The Telemotive Series 7000 Radio Control System has diagnostic features that act as aids for troubleshooting when there is a malfunction.

A set of the following documents is furnished with each System:

1. System Drawings
2. Transmitter Engraving Drawing
3. Rack Chart
4. User's Manual
5. Technical Manual (optionally available)

The following pieces of equipment are needed for servicing.

Their use will insure that any fault can be easily isolated to a particular module. The defective subassembly can then be replaced, for minimum down time of the equipment.

1. Volt/Ohm Meter
2. Transmitter Test Receiver
3. Dual-trace Oscilloscope with 10MHz Bandwidth

An optional Diagnostics Module that plugs into the Control Rack is also available. The Diagnostics Module has the following two modes of operation:

1. A System Start-up Checking Mode
2. A System Operation Checking Mode

III.B.2

The Diagnostics Module is also useful for Monitoring AGC levels when the System Operating range is being set. Instructions for using the Diagnostics Module are found in the Series 7000 Technical Manual.

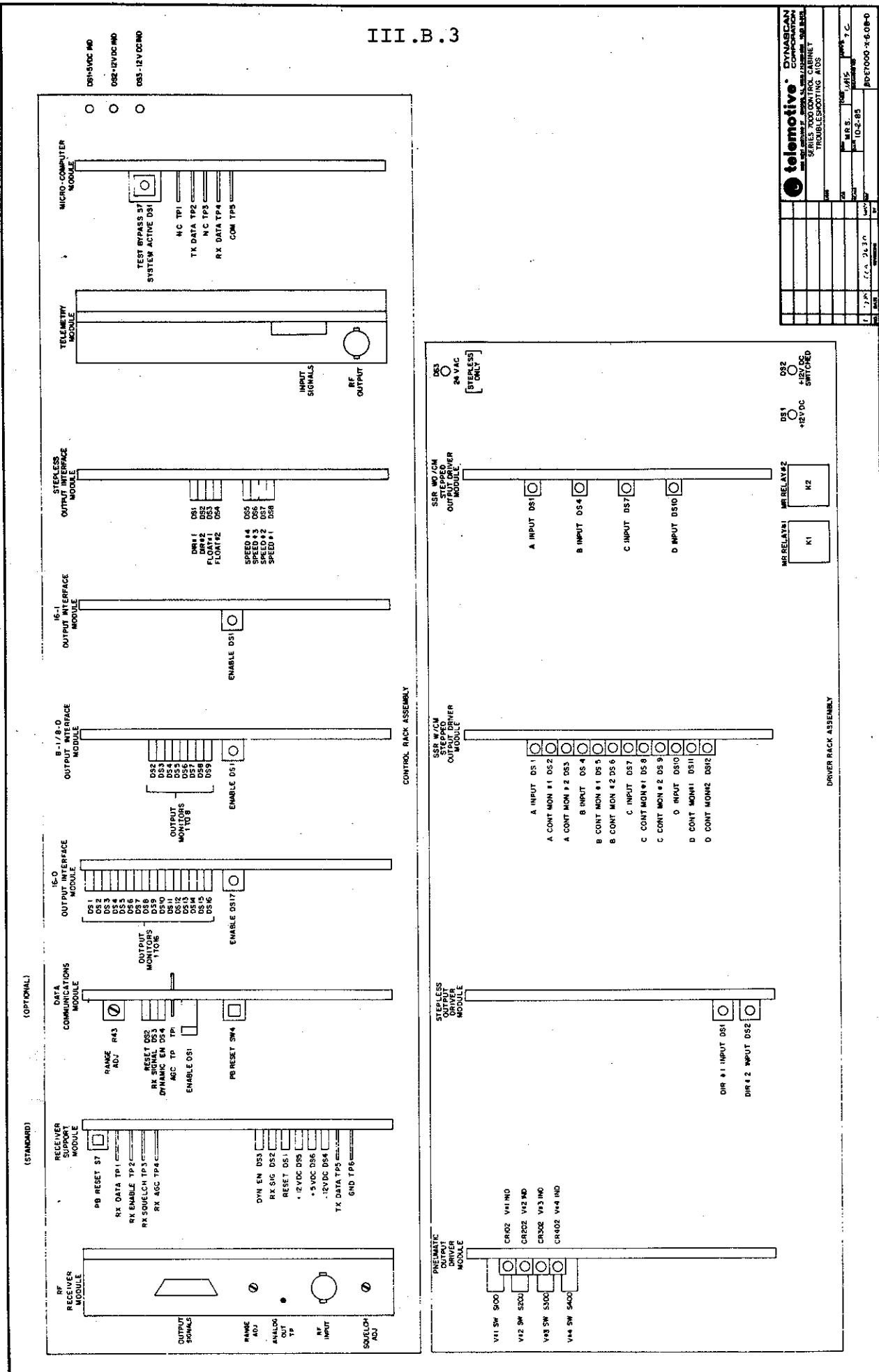
The Receiving/Control Unit has indicator lights and test points that are present on many of the Control Rack Modules and Driver Rack Modules. These are shown in Figure # III.B.3.

A description of the functions of the indicator lights and test points that are present on the Control Rack modules and Driver Rack modules is given in the Troubleshooting Procedures.

In addition to the normal troubleshooting aids, it is recommended that a complete set of electronic and electrical spare parts be available with the system. A questionable subassembly can then be replaced with a known good subassembly to check for proper operation.

The detailed information needed to troubleshoot problems within a replaceable module is contained in the optionally available Technical Manual.

III.B.3



CYANAMIC CORPORATION 1000 W. 10th St., Suite 100 Tulsa, Oklahoma 74103-1000 TEL: (918) 437-1000 FAX: (918) 437-1001 CIRCLE NO. 10-2-85	
MODEL: 10-2-85	PART NO: 10-2-85
DATE: 10-2-85	REV: 10-2-85
DRAWN: J.C. 24.310	CHECKED: J.C.
APPROVED: J.C.	AUTHORITY: J.C.
DATE: 10-2-85	PART NO: 10-2-85
REV: 10-2-85	REV: 10-2-85
DRAWN: J.C. 24.310	CHECKED: J.C.
APPROVED: J.C.	AUTHORITY: J.C.
DATE: 10-2-85	PART NO: 10-2-85
REV: 10-2-85	REV: 10-2-85

FIGURE # III.B.1

III.C.1

C. TROUBLESHOOTING PROCEDURES

O. GENERAL INFORMATION:

The following material is organized to show how the various troubleshooting aids can be used to isolate a fault in the System to a replaceable module or other malfunctioning item.

In the event of a malfunction in the Radio Control System, the logical approach is to determine the nature of the trouble. This can be accomplished by operating the system and observing the output indicators on the Control Rack Output Interface Modules and the Driver Rack Output Driver Modules. Most failures can be classified into one of the following problem areas:

1. System Completely Inoperative
2. System Operates Erratically
3. System Operates Partially

Once the nature of the problem has been classified into one of the listed problem areas, consult the troubleshooting outline at the beginning of this section of the User's Manual. Then turn to the troubleshooting procedure covering that type of problem area and proceed to check the indicated items in the order listed until the defective module is located. The defective module can then simply be replaced with a spare.

To keep the warranty in effect, defective modules should be returned to Telemotive for repair or replacement.

III.C.2

1. SYSTEM COMPLETELY INOPERATIVE:

a. General Information:

The fact that the System is not sending any commands implies the following:

1. A proper signal isn't being sent by the Transmitter.
2. The Receiving/Control Cabinet isn't receiving and decoding the transmitted signal properly.
3. There is a problem with the MR circuit in the Receiving/Control Cabinet.

b. Transmitter Unit Checks:

1. Turn ON the Transmitter Unit key lock switch and ON/OFF toggle switch.
2. Place the Transmitter Test Receiver near the transmitting antenna. Listen for the characteristic rapid keying of tones as the Transmitter controls are being operated.
3. Check that the optional Battery Monitor light on the Transmitter control panel is flashing, indicating proper battery voltage.

III.C.3

4. With the Transmitter turned ON, use the VOM to measure the Transmitter battery voltage. This voltage should be greater than the minimum battery voltage shown in Figure # III.C.1. If this voltage is not present, refer to the Technical Manual or consult Telemotive's Service Department.

NOTE

For 400 mW VHF Transmitter Units and for UHF Transmitter Units, open the Transmitter Unit. On the Transmitter motherboard, use a VOM to check for the presence of the nominal 5.1 VDC output at the Final Amplifier Module. This voltage should be present at the sockets for the remaining Transmitter modules. The measured voltage should be between 4.6 VDC and 5.6 VDC.

5. Using a VOM, measure the Transmitter current drain. The measured value should be within +/- 10% of the value obtained with a known good Transmitter. See Figure # III.C.2. This information is also available in the Technical Manual or by calling Telemotive's Service Department.
6. If the Transmitter appears to be working properly, go to the Control Rack RF Receiver Module Check.

III.C.4

7. If the Transmitter does not appear to be working properly, remove the Transmitter case, then remove the Sub Box cover and reconnect the Antenna to the Final Amplifier Module RF output.
8. If the proper DC voltage and current are present on the Transmitter motherboard, but the proper tones are not heard from the Test Receiver, one at a time, replace the Oscillator/Modulator Module, Multiplier Module and Final Amplifier Module. These modules should be matched in frequency. Then see if the rapid keying of high pitched tones is heard with the Transmitter Test Receiver.
9. If necessary, one at a time, replace the Format Generator Module, Clock Module and Scan/Parity Module, until the system operates properly.

c. Power Supply Assembly Checks:

1. Check the Control Rack backplane to see if the +12VDC, +5VDC and -12VDC, output voltage indicator lights for the Rack Power Supply Assembly are lit.
2. Check the Driver Rack backplane to see if the +12VDC output voltage indicator light for the Interface Power Supply Assembly is lit.
3. If the DC output voltage indicator lights for the Power Supply Assemblies are not lit, check the AC (DC) input

III.C.5

power line to the system. The input voltage tolerance should be within 10% of the nominal voltage. See the system wiring diagram for the AC (DC) input power terminal locations and nominal voltage.

4. If the AC (DC) voltage is not present at the power line input terminals of the Power Supply Assemblies, check the wiring between the input terminals and the power source, and the wiring between the power source and the Control Cabinet Assembly power line input, for loose connections or broken wires. If the wiring is correct and there is still no voltage, check the main power feed.
5. If the AC (DC) power line voltage is present at the Power Supply Assembly's connector and the DC output voltage lights still are not lit, check the Power Supply input line fuse. If the fuse is okay, replace the Power Supply Assembly.
6. If the power supply input line voltage is correct and the output voltages remain incorrect replace the Power Supply Assembly.
7. With AC stepless systems, check the driver rack backplane to see if the 24 VAC Indicator light is lit.
8. If the 24 VAC Indicator light is not lit, check the power source voltage and the power line wiring between the power source and the 24 VAC transformer.

III.C.6

9. If the power line input voltage is correct and the 24 VAC output voltage remains incorrect, replace the 24 VAC transformer.

d. Receiver Module Checks:

1. Use a good Transmitter to start up the Control Cabinet Assembly.
2. Check to see if the Received Signal Indicator light and the Dynamic Enable Indicator lights are lit on the Receiver Support Module or optional Data Communications Module.
3. If the Received Signal Indicator light and Dynamic Enable Indicator lights are not lit, replace the Receiver Module. Be sure that the VCO oscillator has been programmed for the proper frequency. Check the Receiver Support Module or optional Data Communications Module for proper frequency switch programming. See the figure at the end of Section # II.B of this Manual.
4. If the Receiver Module has been replaced, but there is still no Received Signal Indicator light on the Receiver Support Module, or optional Data Communications Module, check the antenna and associated coaxial cable going to the Receiver Module for damage or broken connections.

III.C.7

5. Reposition either the Transmitter Antenna or the Receiving Antenna, in order to obtain an unobstructed signal path. If necessary, bring the Transmitter and Receiver closer together to check their operation.
 6. Check the Range Control Settings on the Receiver Module and Receiver Support Module or optional Data Communications Module to see if they have been changed.
 7. Do not attempt to adjust any controls on the Receiver Module. They have been calibrated at the factory and should not need further adjustment except for future Range Control settings.
 8. Check to see that the Receiver Module case is properly grounded.
 9. On the Receiver Support Module, check to see if the Received Signal Indicator light and the Dynamic Enable Indicator lights are lit. If they are not, replace the Receiver Support Module or optional Data Communications Module.
- e. The Microcomputer Module Checks:
1. Perform the Microcomputer Module checkout with a good Transmitter and with the RF portion of the Control Rack turned ON and working properly.
 2. Turn the Transmitter key lock ON/OFF switch and the control panel ON/OFF switch to the ON position.

III.C.8

3. Observe that the +12 volt the -12 volt and the +5 volt indicator lights on the Receiver backplane are lit.
4. Observe that the Dynamic Enable and the Received Signal Indicator lights on the Receiver Support Module or optional Data Communicatons Module are lit.
5. Observe that the +12 volt indicator on the Driver Rack backplane is lit.
6. Observe that the remaining indicator lights on the Control Rack and the Driver Rack are not lit.
7. Press and then release the momentary START pushbutton on the Transmitter.
8. After the Microcomputer completes its checking, the Red Test Passed Indicator light on the Microcomputer Module should come ON. This, in turn, should cause all the Green Test Enable lights to illuminate on the Output Interface Modules.
9. The whole system is operating correctly when the Transmitter controls are activated and the various associated output indicator lights on the Output Interface Modules and Output Driver Modules are also activated. Consult the System drawings to determine the relationship between the output indicator lights and the proper associated function.

III.C.9

10. If the red Test Passed Indicator light on the Microcomputer Module doesn't come ON, then perform the MR Enable Relay circuit checkout procedure.
11. If the red Test Passed Indicator light on the Microcomputer Module still doesn't come on when the Transmitter START button is momentarily pressed, then perform the following Microcomputer Module error test bypass procedure to determine what Control Rack modules or Driver Rack modules are at fault.
12. Press and hold the Test Bypass switch on the Microcomputer Module. Momentarily press the Pushbutton Reset switch on the Receiver Support Module or optional Data Communications Module. Finally, release the Test Bypass switch.
13. Unless there is a serious problem with the Microcomputer Module, the green Test Enable lights on the Control Rack Output Interface Modules should come ON.
14. When the Transmitter controls are varied, the associated function indicator lights on the output Interface Modules and the output Driver Modules should illuminate. If there is a problem here, replace the associated Output Interface Module or Output Driver Module.
15. If the MR Circuit, the Output Interface Modules, and the Output Driver Module are working properly, there is most likely a problem with the Microcomputer Module and it should be replaced.

III.C.10

f. MR Relay Circuit Checks:

1. Use a good Transmitter that is known to operate properly for the MR relay circuit checks.
2. Apply Power to the control cabinet.
3. Observe that the +12 volt, -12 volt and +5 volt Rack Power Supply output voltage indicators are lit on the Receiver Support Module and the Control Rack backplane.
4. Observe that the +12 volt interface power supply output voltage indicator is lit on the Driver Rack backplane.
5. Turn the Transmitter ON/OFF key and control panel ON/OFF switch to the ON positions.
6. Observe that the Receive Signal Enable Indicator and the Dynamic Enable Indicator on the Receiver Support Module or optional Data Communications Module are lit.
7. Press the Transmitter momentary START pushbutton.
8. Observe that if the Receiving/Control Cabinet Assembly is configured and is operating correctly, the red Test Passed indicator light on the Microcomputer Module should be lit.

III.C.11

9. One of the checks made by the Microcomputer Module before it turns on its Test Passed Indicator light is that the MR relay function is activated.
10. If the Test Passed Indicator light doesn't come on, replace the 8-1/8-0 output Interface Module containing the MR(Reed) Relay.
11. If a problem still exists, replace the MR(Sensitive) Relay on the Driver Rack motherboard.
12. If the Test Passed Indicator Light on the Microcomputer Module comes on, but the user's equipment fails to operate, check the operations of the MR (Machine Tool) Relay on the Control Cabinet back panel.

2. SYSTEM OPERATES ERRATICALLY

a. General Information:

The fact that the Radio Control System starts up but some or all outputs become erratic implies that there is an intermittent problem with one of the following causes:

1. The Transmitted Signal.
2. The Power Supplies in the Receiving/Control Cabinet
3. The Received Signal.
4. Decoding the Received Frame of Data.
5. Output Interfacing of a Specific System Output Signal.
6. A Problem in the Receiving/Control Cabinet.

b. Transmitter Controls Checks:

1. If the problem is not caused by the Receiving/Control Cabinet, the Transmitter Controls may be at fault.
2. Observe whether the problem follows the Transmitter control activation. If so, replace the associated Transmitter control.

III.C.13

3. When troubleshooting, it is possible to interchange similar Transmitter controls, but a stepless switch should never be interchanged with a stepped switch or with an auxiliary function switch.

c. Received Signal Strength Checks:

1. Using the Volt/Ohm Meter, measure the DC voltage between a system ground point and the AGC test point on the Receiver Support Module or optional Data Communications Module. For proper operation, the reading should be between 0.7 VDC and 10 VDC and the Received Signal Indicator light located on the Receiver Support Module or optional Data Communications Module should come ON.
2. If the Receiver Support Module AGC TP reading is below 0.7 VDC and the Received Signal Indicator light located on the Receiver Support Module does not illuminate, then the problem is most likely in the Control Rack RF Section. The Control Rack RF Section consists of the following modules:
 - a. The RF Receiver Module
 - b. The Receiver Support Module
3. One by one, replace each of the Control Rack Analog Modules until the problem is eliminated.

d. Power Supply Assembly Checks:

1. Check the Receiver Rack backplane to see if the +12 VDC, +15 VDC, -12 VDC output voltage indicator lights for the Rack Power Supply Assembly output voltages are intermittent or dim.
2. Check the Driver Rack backplane to see if the +12 VDC output voltage indicator light for the Interface Power Supply Assembly are intermittent or dim.
3. If the Power Supply Assembly output voltage indicator lights on the Driver Rack backplane are intermittent or dim, check the AC (DC) input power line to the system. The input voltage should be steady and be within 10% of the nominal voltage. See the system wiring diagram for the AC/DC input power terminal locations and nominal voltage.
4. If the AC (DC) voltage is intermittent at the power line input pins of the Power Supply Assemblies, check the wiring between the input terminals and the power source, and the wiring between the power source and the Control Cabinet power line input, for loose connections or broken wires. If the wiring is correct and there is still an intermittent voltage, check the main power feed.
5. If the Rack Power Supply input line voltage is correct and its output voltages remain intermittent, replace the Rack Power Supply Assembly.

III.C.15

6. With AC Stepless Systems check the Driver Rack backplane to see if the 24 VAC Indicator light is intermittent or dim.
7. If the 24 VAC Indicator is intermittent or dim, check the power line wiring between the power source and the 24 VAC transformer.
8. If the power line input voltage is correct and the 24 VAC output voltage remains incorrect, replace the 24 VAC transformer.

e. Receiver Module Checks:

1. Use a good Transmitter to start up the Control Cabinet Assembly.
2. Check to see if the Received Signal Indicator light and the Dynamic Enable Indicator lights are lit on the Receiver Support Module or optional Data Communications Module.
3. If the Received Signal Indicator light and the Dynamic Enable Indicator lights are not lit, replace the Receiver Module.
4. If the Receiver Module has been replaced, but there are still no Received Signal Indicator lights on the Receiver Support Module or optional Data Communications Module, check the antenna and associated coaxial cable going to the Receiver Module for damaged or broken connections.

III.C.16

5. Reposition either the Transmitter antenna or the receiving antenna, in order to obtain an unobstructed signal path. If necessary, bring the Transmitter and Receiver closer together to check their operation.
6. Do not attempt to adjust any controls on the Receiver Module. They were adjusted at the factory and should not need further adjustment except for future Range Control adjustments.
7. Check to insure the Receiver Module case is properly grounded .
8. On the Receiver Support Module or optional Data Communications Module, check to see if the Received Signal Indicator light and the Dynamic Enable Indicator lights are lit. If they are not, replace the Receiver Support Module or the optional Data Communications Module.

f. Microcomputer Module Checks:

1. Perform the Microcomputer Module checkout with a good Transmitter and with the analog portion of the Control Rack turned ON and working properly.
2. Turn the Transmitter keylock ON/OFF switch and the control panel ON/OFF switch to the ON position.
3. Observe that the + 12 volt, the -12 volt, and the +5 volt indicator lights on the Control Rack backplane are lit.

III.C.17

4. Observe that the Dynamic Enable and the Received Signal Indicator lights on the Receiver Support Module or optional Data Communications Module are lit.
5. Observe that the +12 volt Indicator light on the Driver Rack Backplane is lit.
6. Observe that the remaining indicator lights on the Control Rack and the Driver Rack are not lit.
7. Press and then release the momentary start pushbutton on the Transmitter.
8. After the Microcomputer does its checking, the red Test Passed Indicator light on the Microcomputer module should come ON. This, in turn, should cause all of the green Test Enable Indicator lights on the Output Interface Modules to illuminate.
9. If all is well, the Transmitter Unit controls could be activated and the various associated output indicator lights on the output Interface Modules and the output Driver Modules should be activated. Consult the system's drawings to determine the relationship between the output indicator lights and the proper associated function.
10. If the red Test Passed Indicator light on the Microcomputer Module still doesn't come ON when the Transmitter Start button is momentarily pressed, then perform the following Microcomputer error test bypass procedure to determine what Control Rack Modules or Driver Rack Modules are at fault.

III.C.18

11. Press and hold in the Test Bypass switch on the Microcomputer Module. Momentarily press the Reset push-button switch on the Receiver Support Module or optional Data Communication Module. Finally, release the Test Bypass switch.
12. Unless there is a serious problem with the Microcomputer Module the green Test Enable Indicator lights on the Control Rack Output Interface Modules should illuminate.
13. When the Transmitter controls are varied, the associated function indicator light on the Output Interface Modules and the Output Driver Modules should illuminate. If there is a problem here, replace the associated Output Interface Module or Output Driver Module.
14. If the MR circuit, the Output Interface Modules, and the Output Driver Modules are working properly, there is a likely problem with the Microcomputer Module and it should be replaced.

g. Output Interface Module Checks:

1. Use a good Transmitter to activate the various output functions in the Control Cabinet.

III.C.19

2. Observe the indicator lights on the Output Interface Modules. A light should be lit for every module output that corresponds to the selected control function. If a module does not have an indicator light that functions correctly, replace the module.

h. Output Driver Module Checks:

1. Use a good Transmitter to activate the various functions in the Receiving/Control Cabinet Assembly.
2. If the Output Interface Modules Indicator lights are operating properly, but the corresponding indicator lights in a related Output Driver Module is either non-operating or stuck, replace the corresponding Output Driver Module.

i. Control Cabinet Wiring Checks:

1. Use a good Transmitter to activate the various output functions in the Control Cabinet.
2. If the Indicator Lights on the Output Interface Modules and on the Output Driver Modules are operating properly but the system output functions are not working properly, use the VOM to check the signal on the wiring between the Output Driver Module and the Control Cabinet output terminal block.

3. SYSTEM OPERATES PARTIALLY:a. General Information:

The fact that the System starts up and is transmitting, receiving and outputting some commands properly, implies the following:

1. The Transmitter is encoding and transmitting the signal properly but some of its controls which relate to specific output functions are not operating properly.
2. The Control Cabinet is starting-up, receiving, and decoding its received signal properly. But some of its Output Interface Modules or Output Driver Modules, related to specific output functions, are not operating properly.
3. There is a Control Cabinet wiring problem related to a specific output function.

b. Transmitter Controls Check:

1. Using the Transmitter under test, start the system and determine which Transmitter switch functions are not operating properly.

2. The Transmitter switches which are malfunctioning can be verified by replacing them. Motion switches of the same kind may be checked by interchanging them.

CAUTION: Do not replace a stepless motion switch with a stepped motion switch or an auxiliary function switch.

c. Output Interface Module Checks:

1. Use a good Transmitter to activate the various output functions in the Control Cabinet.
2. Observe the Indicator lights on the Output Interface Modules. A light should be lit for every module output that corresponds to the selected control function. If a module has an indicator light that does not function correctly, replace the module.

d. Output Driver Module Checks:

1. Use a good Transmitter to activate the various output functions in the Control Cabinet.
2. If the Output Interface Modules Indicator lights are operating properly, but the corresponding indicator lights in a related Output Driver Module is either non-operating or stuck, replace the corresponding Output Driver Module.

III.C.22

3. If the defective output function is stepless, check that the 24 VAC Indicator light on the Driver Rack backplane is lit before replacing the Stepless Output Driver Modules. If it does not light, check the 24 VAC power source.

e. Control Cabinet Wiring Checks:

1. Use a good Transmitter to activate the various output functions in the Control Cabinet.
2. If the indicator lights on the Output Interface Modules and on the Output Driver Modules are operating properly, but the system's output functions are not working properly, use the VOM to check the signal on the wiring between the Output Driver Module and the Control Cabinet output terminal block.

FIGURE # III.C.1

TELEMOTIVE BATTERY SUMMARY

ITEM #	PART #	TYPE	V/CELL nom (Min)	NO. OF CELLS	V/AH nom (Min)	COMMENTS
1.	BT101B	Ni/Cad	1.25V (1.00V)	9	10.8V/1.2AH (9.00V)	Rechargeable, light blue
2.	BT103	Alkaline	1.50V (0.80V)	6	9.00V/0.5AH (4.80V)	Disposable metallic, Duracell
3.	BT104A	Ni/Cad	1.25V (1.00V)	4	5.00V/4AH (4.00V)	Rechargeable, light orange
4.	BT625B	Mercury	1.325V (1.20V)	4	5.30V/14AH (4.80V)	Disposable, yellow ochre
5.	BT640A	Mercury	1.325V (1.20V)	4	5.30V/14AH (4.80V)	Disposable, yellow ochre, BT625 with 10 ohm, intrinsically safe
6.	BT641A	Ni/Cad	1.25V (1.00V)	4	5.00V/4.0AH (4.00V)	Rechargeable, orange, BT104 with 10 ohm, intrinsically safe
7.	BT644-6	Lead/Acid	2.0V (1.81V)	3	6.00V/2.5AH (5.43V)	Rechargeable, white
8.	BT644-10	Leac/Acid	2.0V (1.81V)	5	10.0V/2.5AH (9.05V)	Rechargeable, white
9.	BT-644-12	Lead/Acid	2.0V (1.81V)	6	12.0V/2.5AH (10.86V)	Rechargeable, white

III.C.24

FIGURE # III.C.2

NOMINAL TELEMOTIVE TRANSMITTER CURRENT DRAIN

TPN	RF Power Out	nom Battery Voltage	nom Current Drain
E7600-1	50mW	5.3V	50mA
E7600-2	100mW	5.3V	65mA
E7600-3	400mW	10.0V	120mA

III.D.1

D. USER'S EQUIPMENT INTERFACE TROUBLESHOOTING PROCEDURE

The interface between the Telemotive Radio Control System and the user's equipment can take the following forms:

1. Intermediate Relays (SSR or EMR)
2. Magnetic Controls
3. Pneumatic Controls

Telemotive job drawings are provided that give elementary diagrams showing the following:

1. The wiring between the outputs of the Telemotive Series 7000 Receiving/Control Cabinet and the user's equipment controls.
2. The wiring of the transfer switch (if provided).

Normal electrical equipment troubleshooting techniques for isolating a defective circuit or a defective component, such as the following checks, should be employed:

1. Continuity check
2. Resistance checks
3. Voltage checks
4. Visual Functional checks

Procedures for these checks should be available from the manufacturer of the user's equipment.

IV.0

SECTION IV

APPENDIX



RECOMMENDED SAFETY RULES
FOR
RADIO CONTROLLED CRANES



RECOMMENDED SAFETY RULES
FOR RADIO CONTROLLED CRANES

THESE SAFETY RULES ARE NOT NECESSARILY INTENDED TO SUPERSEDE RULES OR REGULATIONS OF OUR CUSTOMERS OR ANY APPLICABLE LOCAL, STATE OR FEDERAL GOVERNING ORGANIZATIONS. THE INFORMATION CONTAINED HEREIN IS BASED ON DATA GATHERED FROM VARIOUS USERS OF RADIO CRANE CONTROL IN THIS COUNTRY AND ABROAD.

TABLE OF CONTENTS

Paragraph	Title	Page
1.00	Preface.....	1
2.00	Persons Authorized to Operate Radio Controlled Cranes.....	1
3.00	Training Check List for Operation of Radio Controlled Cranes.....	1
4.00	Operating Area for Radio Controlled Cranes.....	2
5.00	The Radio Control Box (Transmitter).....	2
6.00	Operating the Radio Controlled Crane.....	3
7.00	Boarding the Radio Controlled Crane.....	5
8.00	Minor Repairs of the Radio Controlled Crane.....	5
9.00	Major Repairs of the Radio Controlled Crane.....	6
10.00	Using the Radio Controlled Crane for a Work Platform.....	7
11.00	The Condition of the Radio Controlled Crane.....	7

SAFETY RULES

1.00 PREFACE

1.01 Radio controlled overhead travelling cranes operate in three directions. They are large, bulky pieces of equipment that handle heavy loads efficiently at comparatively high speeds. Quite frequently they are operated in restricted areas where workmen are engaged in various tasks on the floor below. Under these conditions, extreme care must be used by the crane operator, and workmen must be constantly on the alert to avoid accidents.

1.02 The following rules have been assembled and issued to you to indicate how your careful and thoughtful actions may save a life or prevent damage, protecting yourself and your fellow workmen.

1.03 These rules cover cranes when they are on radio control. If a radio crane is operated on cab control, special care must be taken to secure the Radio Control Box (transmitter).

2.00 PERSONS AUTHORIZED TO OPERATE RADIO CONTROLLED CRANES

2.01 Only employees designated by management shall be permitted to operate such equipment and only after they have been properly trained.

2.02 Such equipment shall not be operated by any persons who can not read and understand the signs, notices, and operating instructions.

SAFETY RULES

2.03 Such equipment shall not be operated by a person with seriously defective eyesight or hearing, or who may be suffering from a disease which may cause physical failure.

3.00 TRAINING CHECK LIST FOR OPERATORS OF RADIO CONTROLLED CRANE

3.01 Knowledge of hazards inherent to crane operation.

3.02 Knowledge of safety rules for radio controlled cranes.

3.03 Ability to judge distance to stationary objects.

3.04 Knowledge of the radio control box (transmitter).

3.05 Limit switch test procedure.

3.06 Instructions as to plugging of crane motions, where authorized.

3.08 Observance of signal lights on crane.

3.09 Avoidance of striking any obstructions in building.

3.10 Proper clearance of lifts or hooks before moving bridge or trolley.

3.11 Proper storage space for radio control box when not in use.

3.12 Transferring radio control box to another person

3.13 Reporting unsafe or unusual operating conditions.

SAFETY RULES

- 3.14 Caution in approaching bridge or trolley bumpers.
- 3.15 Capacity of the equipment.
- 3.16 Making lifts below floor level.
- 3.17 Making side pulls.
- 3.18 Keeping body clear of lifts, avoiding "pinch" points.
- 3.19 Inspection of cables and hooks.
- 3.20 Procedure for testing hoist, trolley and bridge brakes.

4.00 THE OPERATING AREA FOR THE RADIO CONTROLLED CRANE

- 4.01 Unobstructed aisleways between equipment, stock, etc., should be maintained for the radio controlled crane operator's movement. These aisleways should be a minimum of 3 feet wide, or per local regulations.
- 4.02 The radio controlled crane operator shall always position himself for the best view of the crane he is controlling. He shall never operate the crane blindly. He should always keep the crane and load in his sight and stay as close as possible to the crane load. He should never position himself in a "pinch" point.

SAFETY RULES

5.00 THE RADIO CONTROL TRANSMITTER

5.01 On some transmitter units, the motion lever switches are of the "dead man" type (spring return to off). The handle acts as a guard for these switches to prevent accidental movement of the switches. These switches shall never be mechanically blocked in an on position.

5.02 The key lock on the radio control box shall always be turned off when the box is not in use or when the operator is putting on or taking off the control box and belt assembly.

5.03 A prescribed storage space shall be provided for the radio control box. The radio control box shall always be placed there when not in use. This precaution will prevent unauthorized people from operating the radio controlled crane.

6.00 OPERATING THE RADIO CONTROLLED CRANE

6.01 The crane limit switches shall be checked at the beginning of each turn or when a new operator takes control of the crane. While checking the limit switches, the hoist should be centered over an area free of personnel and equipment so that if the limit switches fail and the hook and block assembly falls, no one will be injured or no equipment will be damaged.

SAFETY RULES

6.02 The limit switches shall never be used as a regular stopping device. They are intended to be protective devices only.

6.03 The bridge and trolley brakes shall be tested at the beginning of each turn or when a new operator takes control of the crane. They should be tested with the bridge and trolley at low speed.

6.04 When lifting maximum loads or loads near maximum, the operator shall test the hoist brakes by raising the load a few inches from the floor. If brakes do not hold, the load shall be immediately lowered to the floor and a report made to the supervisor.

6.05 Do not make lifts in excess of the rated capacity of the equipment. Consult your supervisor for the exceptions, if any.

6.06 When making lifts, the bridge and trolley should be centered directly over the load to prevent swinging when the load is raised.

6.07 Side pulls shall be made only with permission of the supervisor. When such a lift is being made, the operator shall not position himself in the line or path of travel of the load, but shall operate the crane from a position either to the side or to the opposite of the line of travel.

6.08 When raising or lowering a load, proceed slowly and make certain the load is under control. Tag lines shall be used for

SAFETY RULES

handling unusual lengths or bulky loads. Take the slack out of the chains or slings gradually. Make sure all persons are clear before making a lift.

6.09 The Crane operator shall keep all parts of his body away from the lift and shall never position himself under the lift.

6.10 Do not make a lift or move the crane if anyone is in a dangerous position.

6.11 If the radio controlled crane operator is being helped, he shall not move the crane until he has received a signal from his helpers that they are in the clear.

6.12 When a load is hanging from the hook of the radio controlled crane, and the crane is being moved, the operator shall sound the warning device frequently.

6.13 Loads shall not be carried over workmen's heads.

6.14 If anyone is in the path of travel, the radio controlled crane operator shall stop and clear the area before proceeding.

6.15 Bumping into runway stops or other cranes on the same runway is prohibited.

6.16 When moving the crane, the operator of the radio controlled crane shall be sure that the hook block, attachments, or cables will not foul on nearby equipment.

SAFETY RULES

6.17 The radio controlled crane operator shall not drag slings, chains, etc., along the floor. They could snag on something causing the cables to break and to strike the operator or a fellow workman, causing serious injury.

6.18 Where gloves are not required for more compelling safety reasons, they shall not be worn when operating the radio control box.

6.19 All loose material or parts shall be removed from the load before starting the lift. Such material can fall, striking people below.

6.20 The radio controlled crane operator shall hoist lifts high enough to clear all apparatus and workmen below the crane.

6.21 Plugging shall not be used as a regular means of stopping the crane. Plugging is intended for emergency stops only, except when authorized by the plant supervisor. Caution must be used when plugging with the radio control box.

6.22 If the radio controlled crane operator is asked to do something that he believes unsafe, he shall call his supervisor for advice.

6.23 The radio controlled crane operator shall never permit anyone to ride on the load or hook except when authorized by his supervisor.

SAFETY RULES

6.24 When another crane on the same runway is stationary and hanging a load, the radio controlled crane operator shall maintain a safe distance between cranes.

6.25 If the power goes off, the radio controlled crane operator shall position his switches in the off position and keep them off until power is restored.

6.26 The radio controlled crane operator shall stop operation and turn off the master channel on the radio control box if his crane fails to respond correctly. He should report the condition to his supervisor immediately.

6.27 Outside cranes, subject to movement by winds, storms, etc., shall be securely anchored when left unattended. If the crane is equipped with bridge brakes, the parking brake should be set.

7.00 BOARDING THE RADIO CONTROLLED CRANE

7.01 The radio controlled crane shall not be boarded without permission of the supervisor in charge of crane operations in the area.

7.02 The person boarding the radio controlled crane shall turn off the master channel on the radio control box and take the radio control box with him on the crane.

SAFETY RULES

7.03 If more than one person is boarding the radio controlled crane, one person shall be made responsible to see that all are off the crane before the radio control box is returned to operation.

8.00 MINOR REPAIR OF THE RADIO CONTROLLED CRANE

8.01 Minor repairs are intended to include routine repairs such as greasing, cleaning, etc., and troubleshooting of control.

8.02 If the repair crew consists of more than one person, one person shall be designated as the leader of the repair crew.

8.03 Warning signs shall be placed on the floor beneath the crane or suspended from the crane.

8.04 The leader of the repair crew shall turn off the key switch on the radio control box and take the radio control box with him when boarding the crane. The leader shall board the crane first, open and lock out the main switch, and then signal the other members of the crew that it is safe for them to board the crane.

8.05 If work on the crane is to be done in areas other than those protected by standard handrails, safety belts shall be worn by the repair crew.

SAFETY RULES

8.06 All tools and equipment shall be moved onto the crane by the use of hand lines. The tools and equipment should be adequately secured.

8.07 If it is necessary to have the control circuits on the crane energized, the leader of the repair crew will open all power circuits to the motions before closing the main switch.

8.08 If during the course of repairs it becomes necessary to move the crane, it shall be the responsibility of the leader of the repair crew to see that all members of the repair crew and tools and equipment are in safe positions before the crane is moved.

8.09 It shall be the responsibility of the leader of the repair crew to see that all members are off the crane before he closes the main switch when the repair work is completed.

8.10 Head room is at a minimum in some crane cabs and on some crane walkways. Caution should be exercised by people boarding such cranes. Hard hats should be worn if possible.

9.00 MAJOR REPAIRS OF THE RADIO CONTROLLED CRANE

SAFETY RULES

9.01 ALL persons operating other cranes on the same or adjacent runways, if any, must be notified prior to starting of repairs. Such notification should include the nature of the job, safeguards provided, as well as the limitations of their movements while repairs are in progress.

9.02 Radio controlled cranes which must be positioned for repairs and cannot be moved during repairs, must be protected wherever practical against being bumped by other cranes on the runway. Suitable bumpers adequate for the job should be installed on the exposed side or sides of the crane under repair and as far away from the crane as possible with a minimum distance of 20 ft. The location of these bumpers shall be indicated by red lights placed so that they are clearly visible to other persons operating cranes travelling on the same runway. When it is impossible to use bumpers for protection, red lights must be placed in clear view of other persons operating cranes on the runway to indicate the repair or restricted travel zone. It is desirable that such red lights be located a minimum of 20 ft. from the crane under repair. All operators of cranes on the same runway must be informed of the repair work contemplated, thoroughly instructed as to what their conduct is for the duration of said repairs, and also be told that they will be notified when repairs are completed.

SAFETY RULES

9.03 When there is a runway adjacent to that of the crane being repaired and if any hazard exists involving repairmen, the adjacent runway must be blocked off in accordance with Paragraph 9.02. When it is necessary to continue operation of the cranes on adjacent runways, warning lights must be installed and be visible to persons operating such cranes on the adjacent runways and identifying the restricted area. All cranes on the adjacent runways should come to a full stop prior to entering the restricted area and only proceed through this area upon receiving permission from a signal man posted for this purpose.

9.04 A member of the repair crew should be designated as leader of the repair crew and it shall be his responsibility to turn off the key switch on the radio control box and take the radio control box with him to the crane. After boarding the crane, the leader will open and lock out the main electrical switch on the crane, and then signal other members of the repair crew that it is safe for them to board the crane.

9.05 Access of persons to and from the crane being repaired shall be under the control of the leader of the repair crew.

9.06 The floor area below the point where crane repairs are being made shall be roped off and posted with danger signs.

SAFETY RULES

9.07 The handling of all small tools and materials, etc., from ground level to men working above shall be accomplished by the use of hand lines. Tools, materials, etc., shall not be tossed from the crane to the ground level upon completion of the work.

9.08 If the nature of repairs to the crane makes it necessary for members of the repair crew to work on areas of the crane other than those protected by standard handrails, the members of the repair crew shall wear approved safety belts.

9.09 If it is necessary to move the crane to check the performance of operation, it shall be the responsibility of the leader of the repair crew to designate who is to remain on the crane and to see that they are in safe position before the main switch is closed and the crane is put into operation.

9.10 Upon completion of repairs, it shall be the duty of the person in charge of the repair crew to see personally that each person has left the crane and is in the clear before he removes the lock above the main switch and puts the crane back in operation.

10.00 USING THE RADIO CONTROLLED CRANE FOR A WORK PLATFORM

10.01 When the radio controlled crane is to be used as a stationary working platform for work to be performed on the building or structure, the rules outline in section 9.00 apply.

SAFETY RULES

10.02 When it is necessary to perform work such as cleaning lights, painting, etc., from the crane and the crane has to be moved from time to time, the radio controlled crane operator should position himself on the crane with the radio control box. The operator should satisfy himself that all persons working on the crane are in a safe position before moving the crane to the next working station. It should also be the operator's duty after each movement to see that that main switch is open and locked before work is resumed.

11.00 THE CONDITION OF THE RADIO CONTROLLED CRANE

11.01 It is recommended that a written report be sent to your supervisor whenever you detect any condition that makes your crane unsafe. Many plants supply printed forms for this purpose. The radio controlled crane operator should fill out these forms and turn them in at the end of each shift. Certain faults which the radio controlled crane operator may detect might be so dangerous that the crane should be shut down at once and not operated until the fault is corrected.

SAFETY RULES

11.02 The following is a check list as to what points should be covered in these reports.

1. Condition of hoisting cable and hook block (broken strands, clipped sheave wheels, etc.).
2. Condition of brakes (hoist, trolley and bridge).
3. Alignment of bridge (screeching or squealing wheels indicate bridge is out of line).
4. Broken or cracked or chipped rails on trolley or runway.
5. Condition of all limit switches.
6. Conditions of control (electrical or mechanical defects which give faulty operation).
7. Condition of gears (grinding or squealing may mean a lack of lubrication or foreign materials in gear teeth).
8. Frequent overload relay tripping of power circuits.
9. Mechanical parts loosened by vibration (loose rivets, covers, etc.).
10. Bumpy riding (worn wheels).
11. Collector shoes or bars.

SAFETY RULES

12. Warning or signal lights (burned out or broken).
13. Uncommanded stopping or starting of any crane motion, warning device, lights, or auxiliary function.

WARNING

THE CONTROL OPERATOR SHOULD NOT ATTEMPT TO MAKE THESE REPAIRS HIMSELF. THE CONDITION SHOULD BE REPORTED TO HIS SUPERVISOR SO THAT A QUALIFIED REPAIRMAN CAN EXECUTE THE REPAIRS.

NOTES

TELEMOTIVE BATTERIES

PERSONNEL SAFETY PRECAUTIONS

WARNING

The following precautions must be observed to help prevent conditions which are dangerous to persons servicing the equipment and persons in the area of the equipment.

1. Never incinerate batteries. Incinerating most batteries causes an explosion hazard.
 2. Store batteries in a cool, dry, well-ventilated area.
 3. Only Lead-Acid and Nickel-Cadmium ("Ni-Cad") batteries can be recharged. Never attempt to recharge non-rechargeable batteries; recharging such batteries presents an explosion hazard.
 4. If battery electrolyte is leaked on skin, rinse skin with clean cool water for at least fifteen minutes. Get medical attention immediately.
 5. Only use approved Telemotive Battery Chargers when recharging rechargeable batteries.
2. If battery electrolyte leaks in transmitter battery compartment, Transmitter Unit must be removed from case for cleaning. Thoroughly clean any trace of electrolyte from case or circuitry. Wear proper safety garments such as rubber gloves and safety glasses when cleaning electrolyte.
 3. Only use a battery having the same voltage rating as the battery being replaced.
 4. Do not allow battery terminals to short. Many Telemotive batteries are internally fused for safety. Shorting will necessitate replacement of the battery.

OBTAINING MAXIMUM BATTERY LIFE

Following the steps listed below will help maximize the life of both rechargeable and disposable batteries:

1. Turn Transmitter Unit OFF if use in the next few minutes is not anticipated.
2. Recharge lead/acid battery as soon as possible following a low-battery indication. Continual deep discharging and recharging of lead/acid batteries reduces the maximum charge a battery can hold.
3. Whenever possible, recharge NiCad batteries using the "Trickle" setting on the battery charger: A slow, low-current charge more thoroughly recharges a battery than a quick, high-current charge.
4. If a battery is not in normal use for an extended period, trickle-charge the battery periodically.

EQUIPMENT PROTECTION PRECAUTIONS

CAUTION

The following precautions will help avoid damage to the battery and Transmitter Unit.

1. Immediately discard any battery leaking electrolyte. Discard battery safely.

TELEMOTIVE BATTERIES

Telemotive Batteries are identified by a label listing Telemotive Part Number, Voltage, and Amp-Hour ratings. Safe operation and satisfactory performance is obtained using batteries of identical voltage and current ratings as the battery being replaced.

TELEMOTIVE BATTERIES

<u>Telemotive Part Number</u>	<u>Type</u>	<u>Nominal Volts</u>	<u>Nominal A-H</u>	<u>Comments</u>
BT622-0	Lithium	5.4	14	Non-Rechargeable. Suited for outdoor use in extreme cold.
BT624-0	Lithium	10.8	14	Non-Rechargeable. Suited for outdoor use in extreme cold.
BT625-0	Mercury	5.3	14	Non-Rechargeable.
BT626-0	Lead-Acid	10.0	2.5	Rechargeable.
BT627-0	Lead-Acid	12.0	2.5	Rechargeable.
BT644-0	Lead-Acid	6.0	2.5	Rechargeable.
BT101-0	Ni-Cad	10.8	1.2	Rechargeable.
BT104-0	Ni-Cad	5.0	4.0	Rechargeable.

TC4023-0-0.0A-Z

AC INPUT

LEAD-ACID

BATTERY CHARGER

OPTION



1950

1

1951

1952

1953



1. GENERAL INFORMATION

The material covering the Telemotive AC input lead-acid battery charger option is divided into the following five parts:

1. General Information
2. Specifications
3. Battery Charging Principals
4. Battery Charger Circuit Description
5. Battery Charger Checkout Procedure
6. Battery Charger Operating Procedure

The Telemotive AC input lead-acid battery charger option is made up of the following items:

1. E1012-1 or E1012-3 or E1012-6 or E1012-8
2. A101 Battery Charger Cable and WA272-0 Battery Charger Cable
3. BT626-0 or BT627-0, or BT644-6 or BT652-0, or BT653-12, or BT657-0 or BT658-0 lead-acid battery pack.

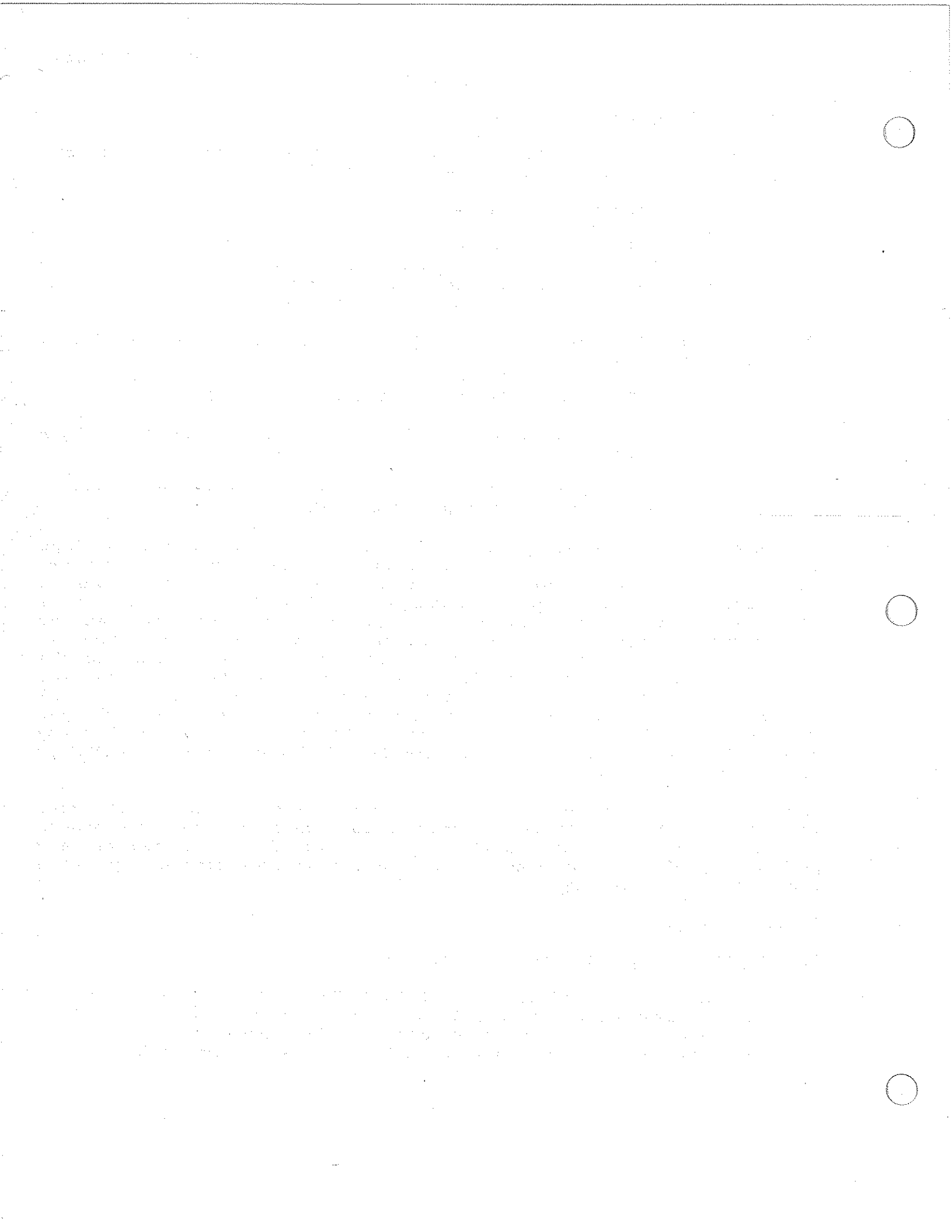
The Telemotive E1012 AC input Battery Charger is a constant voltage type with provisions for simultaneous float charging of up to two lead-acid battery packs and two lead-acid battery powered transmitters. A battery pack discharged to 100% of capacity will take 50 hours to recharge to 100% of capacity. Only one discharged battery pack should be connected to the charger, any more will only increase the time needed to charge. Most of the capacity is returned to the cells in 16 hours, thus an application where the battery pack is used three times a week and left on charge the rest of the time, will maintain capacity and optimize total cycle life. The battery charger unit is designed to be used only with the Telemotive lead-acid battery pack. DO NOT ATTEMPT TO CHARGE MERCURY, LITHIUM, OR NICKEL-CADMIUM CELLS.

The lead-acid battery pack is connected directly to the charger. Telemotive A101-0 or WA272-0 battery charger cable is used to charge a battery pack in the transmitter. The Telemotive lead-acid battery pack is capable of providing up to 25 hours of operation at the 100mA level before recharging.

2. SPECIFICATIONS

A. E1012 AC Input Battery Charger Unit

1. AC input voltage: 103 VAC to 127 VAC @ 60 Hz
2. Maximum charging output current: 1.5A nominal
3. Float charging output current: 3mA nominal
4. Battery: For use only with Telemotive battery pack



B. Lead-Acid Battery

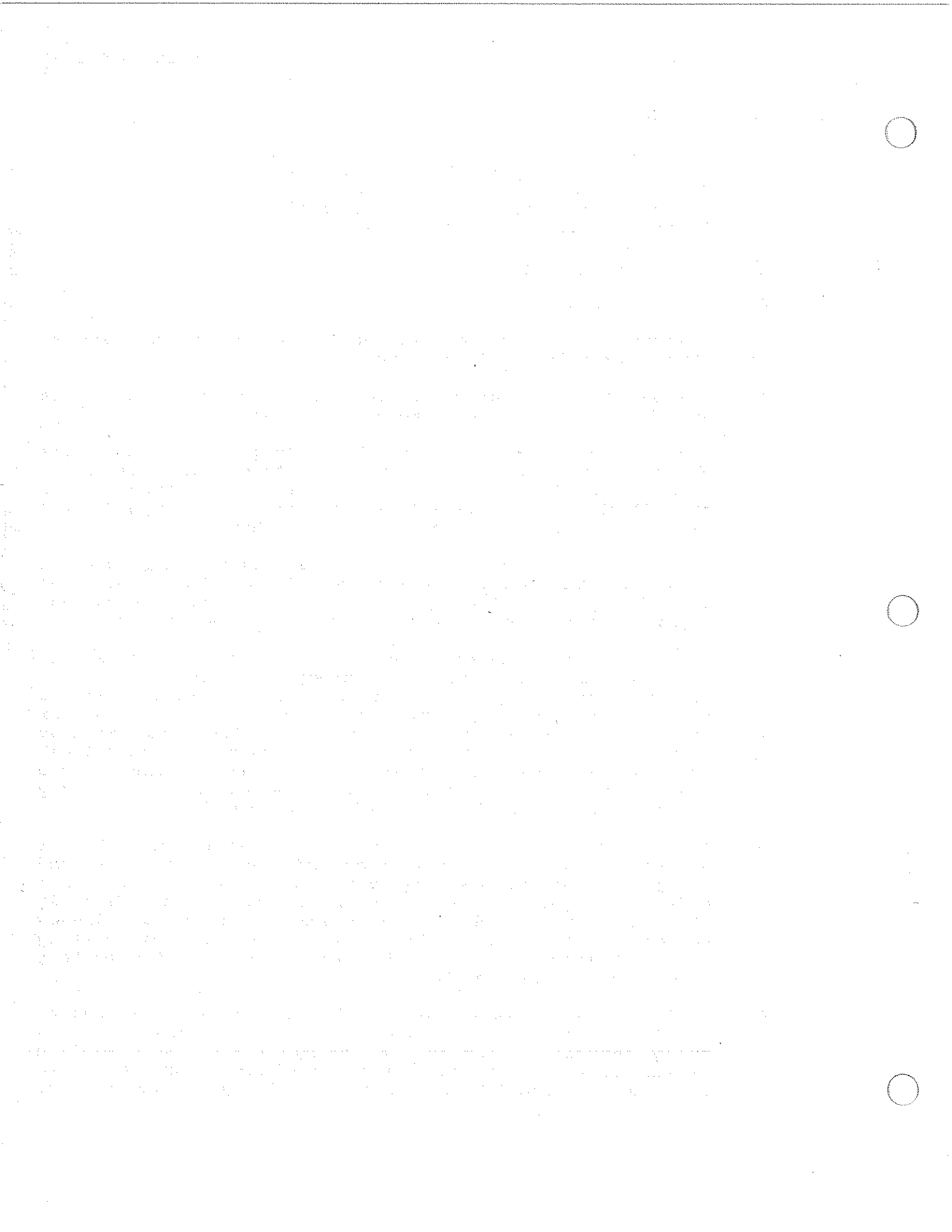
1. Number of cells: 3,5,6 or 12 cells
2. Min. charge voltage: 2.35 Volts/cell
3. Nominal voltage: 2.00 Volts/cell
4. Voltage at discharge: 1.81 Volts/cell
5. Charge Capacity: 2.5 Amp-Hour Min.

3. BATTERY CHARGING PRINCIPLES

A. General Principles

The following is a list of some general principles relating to the charging of a lead-acid battery:

1. The electrical charge holding capacity of a battery is usually given as an Amp x Hour (A-Hr) rating.
2. The battery A-Hr rating is directly proportional to the charge in coulombs stored by the battery. The electrical charge taken from a battery in a given time is approximated by multiplying its average current drain (in amps) by the length of time the current is taken (in hours).
3. Electrical charge is added to a battery by injecting current into it. The amount of electrical charge added in a given time is approximated by multiplying the average current injected by the length of time the current is applied.
4. When a battery is being charged, we are witnessing a case of the conversion of electrical energy into chemical energy. With the charging process, a current is made to flow into a battery that presents a given voltage drop. In a resistor these conditions would result in the generation of heat energy in an amount proportional to Volts x Currents x Time. In a battery the electrical energy is not converted into heat, instead, it is converted into chemically stored energy in an amount proportional to Volts x Current x Time.
5. After a battery is fully charged, further conversion of electrical energy to chemical energy stops. With continued charging the battery starts to act as a load resistor, thus a fully charged battery will start to heat up significantly if it left at a high rate of charge after it has already accepted a full charge. Furthermore, this excessive heating of the battery can cause harmful effects on the battery chemicals that reduces battery life.
6. A "float charge" is a level of charging voltage that can be maintained over a long period of time to keep a battery fully charged. This rate of charging will cause minimum detrimental effects to the battery and is sufficient to overcome the normal "self-discharge" effects of the battery.



7. The total charge required to charge a battery is usually a little more than the charge stored. This takes into account the internal resistive losses and "self-discharge" effects in the battery.
8. The total charge removed from a battery is usually a little more than the charge taken by the load. This takes into account the internal resistive losses and "self-discharge" effects in the battery.
9. A partially charge battery will obtain full charge in a period of time proportional to its state of discharge. For example, a battery that is 80% discharged will obtain full charge in less time than required to charge a fully discharged battery with the same level of current.

B. Lead-Acid Principles

The following material applies more specifically to lead-acid batteries:

1. Lead-acid batteries do not have many of the problems associated with other systems, such as cell reversal, memory and thermal runaway.
2. The lead-acid battery packs should not be allowed to self-discharge below 1.81V per cell because this would appreciably change the recharge characteristics and adversely affect the cycle life.
3. Under load 100% of the available capacity has been removed at about 1.75V per cell. Discharging the battery pack below 1.4V per cell will impair the ability of the cell to accept a charge.
4. Avoid recharging lead-acid batteries at temperatures below -40°C or above 65°C .
5. Do not dispose of lead-acid batteries in a fire they may explode!

C. State of Charge

Table 1 shows the state of charge versus the open circuit voltage for the Telemotive lead-acid battery packs. These figures are representative of an ideal battery. They are useful for getting "ball park" estimates for the state of charge for the actual battery pack.

The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

Furthermore, it highlights the need for regular audits and reviews to identify any discrepancies or areas for improvement. This process should be conducted in a systematic and thorough manner to ensure the integrity of the data.

In addition, the document outlines the various methods and tools used for data collection and analysis. It provides a detailed overview of the different techniques employed to gather and process the information, ensuring that the results are reliable and valid.

The second section of the document focuses on the implementation of the proposed system. It describes the steps involved in the rollout, from the initial planning and design to the final deployment and user training. This section aims to provide a clear and concise guide for the project team.

Moreover, it addresses the potential challenges and risks associated with the implementation process. By identifying these issues in advance, the organization can develop effective strategies to mitigate them and ensure a smooth transition to the new system.

The document also includes a section on the evaluation and monitoring of the system's performance. It outlines the key performance indicators (KPIs) that will be used to assess the system's effectiveness and identify any areas for further optimization.

Finally, the document concludes with a summary of the key findings and recommendations. It reiterates the importance of ongoing communication and collaboration between all stakeholders involved in the project to ensure its successful completion.

The overall goal of this document is to provide a comprehensive and practical guide for the implementation and management of the proposed system. It is intended to serve as a valuable resource for all those involved in the project, ensuring that the organization can achieve its objectives efficiently and effectively.

In conclusion, the document emphasizes the need for a proactive and collaborative approach to the implementation process. By following the guidelines and recommendations provided, the organization can ensure that the new system is implemented successfully and meets the needs of all its stakeholders.

STATE OF CHARGE

Table 1

% OF RATED CAPACITY	V/CELL	OC VOLTS PER BATTERY PACK			
		BT644-6 BT652-0	BT626-0	BT627-0 BT658-0 BT653-12	BT657-0
0	1.98	5.94	9.90	11.88	23.76
10	2.00	6.00	10.00	12.00	24.00
20	2.02	6.06	10.10	12.12	24.24
30	2.04	6.12	10.20	12.24	24.48
40	2.06	6.18	10.30	12.36	24.72
50	2.08	6.24	10.40	12.48	24.96
60	2.10	6.30	10.50	12.60	25.20
70	2.12	6.36	10.60	12.72	25.44
80	2.14	6.42	10.70	12.84	25.68
90	2.16	6.48	10.80	12.96	25.92
100	2.18	6.54	10.90	13.08	26.16
MIN	1.81	5.43	9.05	10.86	21.72
MAX	2.35	7.05	11.75	14.10	28.20

The % of rated capacity remaining is accurate to within 20% if the cells have not been charged or discharged within 24 hours and is accurate to within 5% if the cells have not been charged or discharged within the past 5 days.

The cells should not be allowed to self-discharge below the minimum open circuit voltage.

The maximum voltage would be obtained with the cells right off the battery charger.



4. BATTERY CHARGER CIRCUIT DESCRIPTION

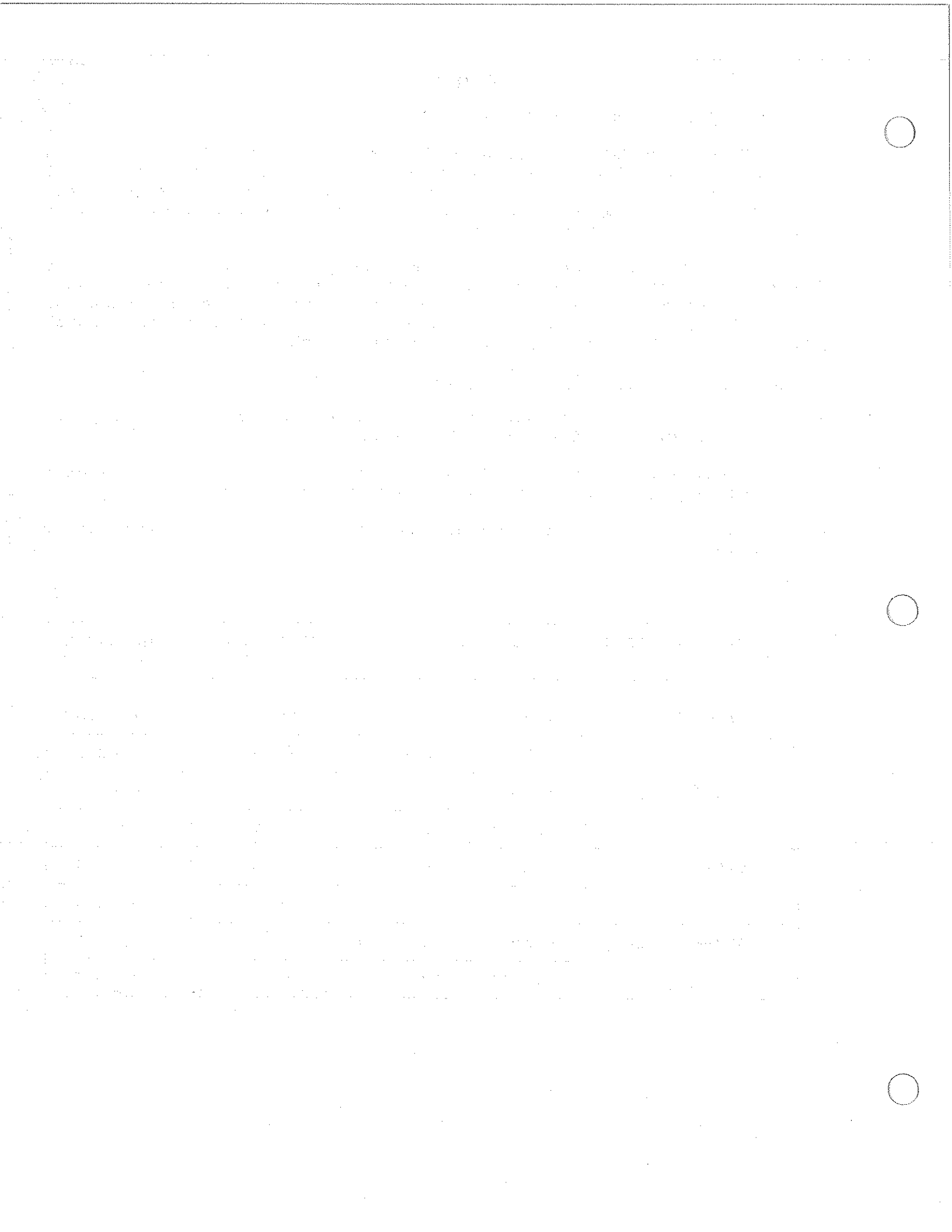
In the Telemotive AC input lead-acid battery charger unit, the AC line voltage is stepped down by transformer T-1 and rectified by a full wave center tapped rectifier circuit. The rectified DC voltage is fed to a voltage regulator which is set to provide the correct charging voltage to the four output jacks.

The two jacks that connect to the battery packs directly are set to charge the packs at a nominal 2.35V/cell. The two jacks that connect to the charging terminal on the transmitters are set higher because of the voltage drop across two diodes inside the transmitter which prevent accidental discharge of the battery pack.

5. BATTERY CHARGER CHECKOUT PROCEDURE

- a. With 115V AC +/-5% input to the charger, measure the voltage at each receptacle with a volt OHM meter.
- b. Connect a 1K ohm 2 watt resistor across each receptacle, one at a time, and measure the voltage across the resistor.
- c. Listed below are the normal readings for those tests listed above:

BATTERY CHARGER	LOAD	TX JACK J1 & J2	BATTERY JACK J3 & J4	TOLERANCE
E1012-1 (10V)	None	13.7	12.9	+/-0.3
	1K	13.4	11.9	+/-0.3
E1012-3 (6V)	None	8.8	8.1	+/-0.2
	1K	8.5	7.1	+/-0.2
E1012-6 (12V)	None	16.0	15.3	+/-0.4
	1K	15.7	14.3	+/-0.4
E1012-8 (24V)	None	30.4	29.7	+/-0.7
	1K	30.1	28.7	+/-0.7



6. BATTERY CHARGER OPERATING PROCEDURE

- a. Connect a charging cable between the receptacle on the charger and the transmitter or connect a battery pack directly to the charger.
- b. The transmitter ON/OFF switch must be set to the OFF position when charging through the panel jack on the transmitter.
- c. Move the toggle switch below the indicator lamp to the ON position. The lamp should light, indicating that the unit is on.
- d. All four jacks can be used for float operation to keep batteries at full charge for over 8 years at room temperature.
- e. Only one discharged battery should be connected at any time.
- f. When a new battery is received, always charge it for at least 16 hours before attempting to use it.
- g. Cycle life depends on depth of discharge, temperature and charging rate. Under normal operation with occasional long charge periods, in excess of 200 charge-discharge cycles can be expected.

The first part of the document discusses the importance of maintaining accurate records. It emphasizes that proper record-keeping is essential for ensuring the integrity and reliability of the data collected. This section also outlines the various methods used to collect and analyze the data, highlighting the challenges faced during the process.

The second part of the document provides a detailed description of the experimental setup. It includes information about the equipment used, the procedures followed, and the conditions under which the data was collected. This section is crucial for understanding the context and limitations of the study.

The third part of the document presents the results of the study. It includes a series of tables and graphs that illustrate the findings. The data shows a clear trend, indicating that the variables studied are significantly related. The statistical analysis confirms the significance of these findings.

The final part of the document discusses the implications of the study. It highlights the potential applications of the findings and suggests areas for further research. The authors conclude that the study has provided valuable insights into the relationship between the variables studied and that these findings have important implications for the field.

The authors would like to thank the following individuals and organizations for their support and assistance during the course of this study:

Dr. John Doe, Department of Statistics, University of ABC, for providing the necessary resources and facilities.

Mr. James Smith, Research Assistant, for his diligent work and assistance in data collection and analysis.

The funding agency, XYZ Foundation, for their generous support of this research project.

The authors also wish to express their appreciation to the anonymous reviewers for their constructive comments and suggestions, which have greatly improved the quality of this manuscript.

Correspondence should be addressed to the first author, Dr. Jane Doe, at the Department of Statistics, University of ABC, 123 Main Street, City, State, ZIP. Email: jane.doe@abc.edu

SERIES 8000 VHF TMS USER/INSTALLATION MANUAL SUPPLEMENT

TC8000-5-0.0A



SERIES 8000 VHF TMS USER/INSTALLATION MANUAL SUPPLEMENT

Table Of Contents

GENERAL

TMS System Description
TMS Theory of Operation
TMS Specifications

RECEIVER

Description
Theory of Operation
E7150-X Receiver Module
E8001-X Microcomputer (uC) Module
Software
Installation
Diagnostics and Troubleshooting

TRANSMITTER (S)

Description
Theory of Operation
LTX Transmitter Model
SLTX Transmitter Model
Access Code Plugs (Optional)
Batteries

SYSTEM

TMS System Components
Unique TMS Features
Unique TMS Options
Access Code Plug Operation
Operating Characteristics
Rack Charts

GENERAL

The **Series 8000 VHF TMS User/Installation Manual Supplement** covers the unique features of the Series 8000 VHF TMS System. The transmitter and receiver/control unit portions of the **System Description** in the **User/Installation Manual** are superseded by the information in this Supplement. This Supplement also contains a new section covering the **SLTX Transmitter Model**, the **E7632 Transmitter Microcomputer (uC)** and **E7650 RF Modules**. The Membrane Transmitter (MTx) is not available with Series 8000 VHF TMS systems.

TMS System Description

The **TMS (Time Multiple Shared)** system allows for the use of several systems on the same frequency in the same area. This is accomplished by a proprietary (patent pending) system which compresses data and transmits it in a predetermined burst pattern. Each transmitter operates independently; there is no need for complex frequency coordination of equipment. The independent operation allows for overlap of data from different transmitters; because of the burst pattern there is no chance of several data packets in a row overlapping, and with a transmission every 100 ms on average (50 ms when a switch is moved), these infrequent overlaps have no noticeable effect on system performance. The packet data is protected against corruption by several layers of error checking and redundancy. This makes data corruption virtually impossible.

TMS Theory of Operation

TMS operation involves intermittent, "packet" transmissions. A TMS transmitter transmits on average, only 10% of the time, versus 100% for a standard "continuous carrier" Series 8000 transmitter model. This allows other systems to use the open time that the packet system frees up to operate on the same channel, something that is impossible on a conventional system.

A TMS transmitter is similar to the standard Series 8000 transmitters except for the software. The software protocol has been significantly advanced to a) compress the control information, b) increase the data rate, c) add more data protection, and d) transmit data in intermittent packets. The SLTX also has a new "turn-off" feature added whereby the transmitter sends a positive "shut-down" signal upon "turn-off". Should an operator "turn-off" the transmitter in an emergency, the system will immediately "shut-down" and all motion will cease instead of waiting for the "time-out" feature. An emergency stop button can also be accommodated. This feature will also become standard on LTX transmitters after December 1992.

It should also be noted that since the power amplifier stage in the transmitter RF module consumes over half of the battery power, changing to intermittent TMS operation adds almost 40% to the battery life.

The receiver/control sub-system uses the E7150-X Receiver Module. This hardware has been optimized for packet data transmission and can recover the first data bit from an intermittent packet eliminating the need for the long preamble needed to settle other receivers. In addition, the software has been significantly updated allowing the E8001-X uC module to handle the new packet data format and still retain the usual Series 8000 operating characteristics. The back plane and output relay systems are unchanged, although a new E8003 output board has been developed for interface to programmable logic controllers and other electronic interfaces.

TMS Specifications

<u>PARAMETER</u>	<u>SPECIFICATION</u>
FCC REQUIREMENTS:	Part 90/ End-User License Required
AUTHORIZED FREQUENCIES:	VHF: 72-76 MHz
NUMBER OF CHANNELS:	200
CHANNEL SPACING:	20 KHz
FREQUENCY GENERATION:	Rx: Synthesized Tx: Crystal Controlled
FREQUENCY STABILITY:	10 PPM
MODULATION:	FSK: +/- 3 KHz Deviation
DATA RATE:	4800 Baud
OPERATING TEMPERATURE:	-30°C to +70°C
STORAGE TEMPERATURE:	-40°C to +100°C
HUMIDITY:	0-95% Non-Condensing
OPERATING VOLTAGES:	Rx: 120/240 VAC, 60 Hz, 0.25 A Tx: Battery Powered

RECEIVER

Description

The Series 8000 VHF TMS Receiver Model is an "Engineered System", customized for your particular application. However, there are several common modules. The E8001-X Microcomputer (uC) Module is common to all Series 8000 systems, although it has several variants. The variants that are usually deployed in Series 8000 VHF TMS systems either have the typical manual frequency control as shown in the **Radio System Operating Principles** of this manual, or cause the receiver to scan several RF channels under computer control for the multibox option. Note that the software employed in a Series 8000 VHF TMS system is quite different from the standard Series 8000 software. Also note that the output board module configurations are virtually identical to standard Series 8000 product.

The E7150-X Receiver Module RF, however, is significantly different. It is optimized for high efficiency packet data reception. While it receives direct FSK like other Series 8000 products, it uses a 4800 baud data rate instead of the 2400 baud rate employed in standard Series 8000 systems.

Theory of Operation

The Receiver Model is comprised of several sub-assemblies. Operation of the E7150-X Receiver and E8001-X Microcomputer (uC) Modules follows:

E7150-X Receiver Module

The E7150-X Receiver Module is a dual conversion "superhet", with a synthesized first local oscillator. The final conversion and quadrature detection are built around the Motorola MC3362 multi-function IC. The uniqueness of this module lies in the data processing which preserves the level of the audio from the beginning to the end of a data packet regardless of length. This insures that the data conversion is valid throughout the duration of the packet. Data conversion simply becomes a straightforward level detection.

The synthesized first local oscillator allows for computer control of the radio control carrier frequency. The TMS data format and software is set-up so that several channels can be scanned without missing a "turn-on" signal on any of the scanned channels. This function is identical to the multibox function of standard Series 8000 systems and is similarly transparent to the user.

E8001-X Microcomputer (uC) Module

The standard E8001-X Microcomputer (uC) Module used in the Series 8000 VHF TMS system is the version with manual frequency selection described elsewhere (**Radio System Operating Principles**) in this manual. If the multibox option is selected, an electronically scanning version of the E8001-X is provided. Note that with this option, the channels are programmed in an EPROM and cannot be manually set to any channel in the band. The uC module controls all relay actions, as well as processing incoming data from the receiver and controlling channel operation. The software, along with the wiring and output board selections made for your system, determines how your system will respond to commands from the transmitter.

Software

The software version used for TMS operation is unique and interprets the TMS protocol and adapts the intermittent TMS system so that it operates like a standard Series 8000 system. Relay operation is very similar to normal Series 8000 system.

Much effort goes into insuring the integrity of the data. The data has a unique format. First, there is an access code that is unique to each system. On standard Series 8000 TMS systems, only a transmitter with that access code can start the system. With the multibox option or the Access Code Plug option, several transmitters are capable of starting a receiver, but only the transmitter that starts the receiver can operate it. This allows the use of "universal spare transmitters" while insuring that normal operation is not disrupted. There also is an error checking system (Cyclic Redundancy Count, or CRC) which protects against corrupted data. Corruption is further protected against by a four bit double redundant direction command for each direction; only half of the possible combinations are valid. It is virtually impossible to get a sequence of proper commands, proper access code, and correct CRC word from noise or other undesired transmissions.

Installation

A Series 8000 VHF TMS system is installed in a similar manner to standard Series 8000 systems. However, there are certain issues that should be addressed for best performance:

- 1) Never mount the antenna on the receiver cabinet.
- 2) If there is a problem with receive noise, remove or re-route the excess coaxial cable out of the receiver cabinet.
- 3) The antenna should be able to be seen from most operating positions on the ground. The antenna should not be obstructed by the crane.
- 4) Do not attach the receiver to a case for a variable frequency drive. Do not use the same power line for the receiver as for a variable frequency drive. Make sure that the receiver power feed is separate from the variable frequency drive feed, at least to the pickup shoe. If a separate line is not available, install a line conditioner before the receiver.

Diagnostics and Troubleshooting

NOTE: If you should change the E8001 uC module, MAKE SURE THAT THE SWITCHES ARE SET TO THE FACTORY SETTINGS AND THAT THE CORRECT SOFTWARE FOR YOUR SYSTEM IS INSTALLED.

The receiver RF has an LED to indicate synthesizer lock similar to other radios. It works identically to the LED on standard Series 8000 receivers. It also has a signal output, again similar to standard Series 8000 receivers.

The various output modules are common to all Series 8000 systems.

The Microcomputer Module has two (2) rows of LEDs, similar to most E8001-X uC modules. However, the operation of some of the diagnostics are different. The following lists the differences in operation of the LED diagnostics of a Series 8000 VHF TMS system versus the standard Series 8000 diagnostics:

Table 1: System Frequency Code Settings - The frequency selection of Series 8000 TMS multibox systems is under computer control; SW2, SW3, and SW4 do not exist on the E8001 version used in multibox TMS. Single frequency TMS systems have manual selection identical to standard Series 8000, and Table 1 applies.

Table 2: Access Code Settings - The main transmitter access code is set in SW10. If the access code plug option is ordered, the transmitter access code is set by the code plug.

The decimal to binary access code translation contained in Table 2 is applicable. However, the access codes are assigned differently; refer to your rack chart (at the end of this supplement, or supplied with the receiver) for the correct access code(s) for your system. Access codes should not be changed from the factory setting. Any spare or substitute uC modules should be set to the factory setting.

Maximum Range Control Setting - This is preset at the factory. Incorrect setting can disable your Series 8000 VHF TMS system.

System Troubleshooting Changes:

AGC Level - AGC does not operate normally in TMS due to the intermittent nature of the radio signal. This reading (SW9 in positions 2, 3, 4, and 5) described in the **Microcomputer Board Checks** 5c should be ignored. This check appears in two places, **Completely Inoperative System**, and **Partially Operative System**. The same applies to the **Receiver Signal Strength Checks** in the **Erratically Operating System** section, and this check should also be ignored.

Squelch - The squelch is "high" at all times in a TMS system; therefore, the squelch light should always be "on".

The following functions and procedures remain unchanged from the **Series 8000 User/Installation Manual**:

- o Alarm Auxiliary Function
- o Main Relay (MR) Function
- o Manual-Radio Switching Procedure (if applicable)
- o Radio System Starting Procedure
- o Radio System Shut Down Procedure
- o Radio System Restarting Procedure

TRANSMITTER(S)

Description

There are two transmitter models currently available for the Series 8000 VHF TMS system. They are; 1) the Lever Transmitter (LTX), and 2) the Small Lever Transmitter (SLTX). Both transmitter models contain an RF, a Microcomputer and an Antenna module. They also contain a battery and lever switches. However, only the lever switches are common between them, so each transmitter will be described separately.

Theory of Operation

The Series 8000 VHF TMS system is available with either the LTX or SLTX transmitter models. A Series 8000 VHF TMS transmitter is electrically very similar to a standard Series 8000 transmitter. The SLTX has a new electronic "shut-off" switch that will be described in detail in the SLTX section. As with the receiver, the transmitter software is significantly different. The software generates the unique data packets and keys the transmitter for intermittent RF carrier operation. As with standard Series 8000 and other Telemotive equipment, the software reads the switches and interprets their positions to the desired signals to be sent to the receiver.

LTX Transmitter Model

The LTX transmitter is the standard Series 8000 transmitter. It has been adapted to TMS operation by the inclusion of special TMS software. The E7630 Microcomputer (uC) and E7123 RF Modules are quite similar to their standard Series 8000 counterparts. Some small changes have been made to the E7123 RF Module that improve its performance with TMS; these improvements are reflected in current standard Series 8000 product. The electronic "shut-off" switch will become standard on LTX transmitters after December 1992.

SLTX Transmitter Model

The SLTX transmitter model contains a different uC module, the E7632 which does the same job as the E7630 except for different dimensions and the new electronic "shut-off" switch. The SLTX also has a different RF Module, namely the E7650 which performs the same function as the LTX RF Module.

The SLTX has an electronic "shut-off" switch that replaces the usual physical switch on standard Series 8000 and most other Telemotive equipment. This change was made so that turning off the transmitter would cause a shut-down command to be sent, resulting in an immediate system shut-down.

Access Code Plugs (Optional)

Some customers desire positive activation of one of several receivers by the same transmitter. For these situations Telemotive has developed access code plugs. By changing the access code plug, an operator can determine which receiver is controlled, even though several receivers are within range of the transmitter.

The access code plug is a military style connector (for ruggedness) which is hard wired for a particular code. access code plug transmitters get their actual access code from the access code plug. The receiver only responds to one access code, just like standard Series 8000 systems.

To operate a different receiver, the access code plug should be changed, and the new receiver started. **NOTE:** If you remove the access code plug while operating a system, the system will "shut-down" and will need to be restarted. This prevents any possibility of two transmitters trying to operate the receiver with the same access code plug.

Batteries

The TMS system improves battery life due to the intermittent nature of the transmissions. A standard Series 8000 transmitter transmits continuously when turned on, except for the 16 minute time-out. A Series 8000 VHF TMS transmitter transmits intermittently for between 10 and 20 percent of the time. This causes the transmitter to use about 60% of the power that it otherwise would, leading to a 40% increase in battery life.

It should also be noted that the SLTX case has a different battery arrangement. Access is through the side plate that has the thumbscrews and the battery compartment is smaller than the LTX battery compartment. Therefore, many of the batteries used with the LTX cannot be used with the SLTX.

SYSTEM

TMS System Components

A single Series 8000 VHF TMS system consists of one or more receivers and one or more transmitters. While several Series 8000 VHF TMS systems can operate on the same frequency, each system is completely independent. Generally, there is one receiver per system unless the Access Code Plug option is ordered.

Unique TMS Features

The Series 8000 VHF TMS system offers as its primary unique feature the ability to operate several systems independently on one channel without the systems interfering with each other. This is inherent in the TMS system.

Unique TMS Options

The Series 8000 VHF TMS system is available with most of the options available on standard Series 8000 systems. In addition, the following TMS options are available:

- o Access Code Plug receiver selection
- o Electronic "Turn-Off" with "Positive Stop" (standard on SLTX transmitter models)

For control of multiple selectable trolleys or bridges from a single transmitter, please inquire about the Telemotive Series 8000 VHF TDMA (Time Division Multiple Access) system.

Access Code Plug Operation

Use of optional access code plugs is very simple. Each receiver will have a corresponding access code plug. If the correct plug for a given receiver is not in place already, remove any plug that is in place by twisting and pulling it out, then insert the correct plug by pushing it into the socket and twist it in. The operating socket will be on top of the transmitter; any storage sockets will be on back. Once the correct plug is inserted, make sure that you are in range, and start the system. Operate the system as usual. Remember not to remove the plug while you are operating a system, or the system will shut-down.

Operating Characteristics

Operating characteristics are the same as with standard Series 8000 systems, except for some time-outs that slightly differ. Refer to the **Series 8000 VHF TMS/TDMA Technical Manual Supplement** (optional), for details.

Rack Charts

Rack charts for your system are inserted after this page.



11-10-87

LOCOMOTIVE - 8000
DIAGNOSTIC CHECKS - SWITCH 9

POSITION C

- LED 7 - DIRECTIONAL ERROR - Based on transmitted signal. On when both direction commands are transmitted simultaneously. The Receiver ignores both signals and does not apply either direction. If the condition exists for 5 seconds, the system shuts down.
- LED 6 - THROTTLE ERROR - Based on transmitted signal. On when throttle increase and decrease commands are transmitted simultaneously. The Receiver ignores both signals and immediately outputs throttle decrease. If the condition exists for 5 seconds, the system shuts down.
- LED 5 - BRAKE ERROR (either Locomotive or Train Brake) - Based on transmitted signal. On when brake apply and release commands are transmitted simultaneously. The Receiver ignores both signals and immediately outputs brake apply. If the condition exists for 5 seconds, the system shuts down.

If the Personality Module is being used in the Transmitter, and if the output bit combining Train Brake and Locomotive Brake operation from the train brake switch is operational, and if the fault occurred in the train brake switch, both Brake Functions would be manipulated, as mentioned above, prior to system shut down.

- LED 4 - KNUCKLE ERROR - Trackmobile type systems only. Based on transmitted signal. On when opposite knuckle commands are transmitted simultaneously. The Receiver ignores both signals and outputs nothing. If the condition exists for 5 seconds, the system shuts down.

Normally, there are multiple knuckle control loops used. You will have to determine by other means which knuckle command caused the error.

- LED 3 - DRAG BRAKE LATCH - On when Drag Brake command is transmitted.



LOCOMOTIVE - 8000
DIAGNOSTIC CHECKS - SWITCH 9

Page 2

- LED 2 - CONTACT MONITORING ERROR - On with a contact monitoring problem in the Receiver.

The Locomotive C/M program is different than the Crane C/M program. Loco C/M is associated with both energized and de-energized states; i.e., the Loco C/M always compares the transmitted signal against the Receiver outputs, and will shut down with any maintained conflicts. This also causes LED 2 to blink occasionally when commands change state, due to momentary computer memory differences in the C/M data comparison operation.

- LED 1 - BELL TIMER LATCH - Used with Automatic Bell Control with machine movement programs. On when a direction is selected, brakes released, and a throttle increase command is initiated. Bell operates for 10 seconds, or continuously, depending on which program is selected. LED 1 follows; i.e., on for 10 seconds, then off, or, on continuously.

- LED 0 - BELL TIMER FLAG - Used with Auto Bell programs. On when LED 1 turns on. Stays on until control status changes; i.e., throttle returned to idle or brakes applied. Resets bell timer latch.



LOCOMOTIVE - 8000
DIAGNOSTIC CHECKS - SWITCH 9

Page 3

POSITION D

This diagnostic position monitors the Pneumatic Self-Check program. The self-check program occurs each time the system is started from the Transmitter. The status LEDs operate in a different manner than in other diagnostic switch positions. These LEDs are used to indicate operating changes of pressure switches mounted on certain pneumatic modules. The pressure switches monitor the output changes of these modules. As these changes occur, specific LEDs are powered by the computer to indicate that a switch change was monitored in its correct sequence. There is a maximum time limit of 5 seconds for each operational step in the program. If the computer doesn't see the correct change asked for in any portion of the self-check program within the 5 second limit, it will cancel the start command and shut down the system. If the self-check program fails, the computer powers a LED indicating this fault or failure. The purpose of the remaining status LEDs is to indicate where the self-check program was interrupted. This indicates which pneumatic module failed to operate as required by the computer program.

LED 7 - Pneumatic Self-Check Fault Indication

- ON if self-check program failed.
- OFF if normal (passed self-check),
OR system start failed due to other problems.

LED 6 - Locomotive (Independent) Brake Module

- ON if both pressure switches, mounted on the module, change state on initial brake pressure drop (Release command).
- OFF if one or both pressure switches failed to change with initial brake pressure drop.

LED 5 - Locomotive (Independent) Brake Module

- ON if both pressure switches change state on re-application of brake pressure.
- OFF if one or both pressure switches failed to change with rise of brake pressure.



LOCOMOTIVE - 8000
DIAGNOSTIC CHECKS - SWITCH 9

Page 4

LED 4 - Train Brake Module

- ON if the pressure switch, mounted on the module, changes state on initial train brake pressure rise (Release command).
- OFF if the pressure switch failed to change with rise of brake pressure,
OR if train brake module is not used.

LED 3 - Train Brake Module

- ON if the pressure switch changes state with a pressure drop (Apply command).
- OFF if the pressure switch failed to change with pressure drop,
OR if train brake module is not used.

LED 2 - Pneumatic Throttle Module (or Modules)

- ON if the pressure switch, mounted on one of the modules, changes state on initial throttle pressure rise (Increase command).
- OFF if the pressure switch failed to change with rise of throttle pressure,
OR if pneumatic throttle module is not used.

LED 1 - Pneumatic Throttle Module (or Modules)

- ON if the pressure switch changes state on drop of throttle pressure (Decrease command).
- OFF if the pressure switch failed to change with pressure drop,
OR if pneumatic throttle module is not used.

LED 0 - Error Bypass Flag - Normally OFF. May occasionally blink. No use for troubleshooting. Used only by Application Software Program.



Gerald Berger
1-7-87
REV. 8-06-87
6-30-88
10-19-90

DOCUMENT NO. TC2800-0-0.05

**PRODUCT DESCRIPTION FOR THE PNEUMATIC THROTTLE
LOCOMOTIVE CONTROL SYSTEM**



**PRODUCT DESCRIPTION FOR THE PNEUMATIC THROTTLE
LOCOMOTIVE CONTROL SYSTEM**

The Locomotive Control System differs from the Crane Control System in that pressure switches are utilized in various pneumatic lines to monitor the pressure in these circuits. Depending upon the pressure in these monitored lines, the software will modify the transmitted commands in accordance to the specified requirements of the Locomotive System. This essentially produces a closed loop system in which the computer is required to make intelligent decisions on the operation of the machine based on the status of sensing elements on the locomotive itself.

A. DESCRIPTIONS OF CONTROL FUNCTIONS

The following is a description of the various functions available for this type of Control System:

1. HORN

The horn will sound each time the momentary horn pushbutton or start button is depressed and will continue to sound so long as the button is depressed. The horn will also sound for 2 seconds after the pneumatics has passed its self-check when the system is started.

2. BELL

The bell will respond each time the momentary pushbutton is depressed and will continue to respond so long as the button is depressed. The bell will also respond for a ten-second period each time the conditions are such that a motion takes place. That is, if a directional has been selected, the brakes released and the throttle applied, the bell will sound for ten seconds on an automatic software timer. If the throttle is released before the ten seconds has elapsed, the bell will shut off instantly. Any time the throttle is returned to its neutral position and then again advanced, the timer will reactivate the ten second period for the bell. The bell will also sound even though brake pressure is present if the drag brake command has been transmitted. The bell software time is a selected feature and can be selected by Telemotive and therefore will be present at all times. This feature can also be user selected by setting a dip switch which is located in a personality module plugged into Word 7 of the transmitter. Therefore, the

customer can elect to use or not to use this feature at his own option.



3. BRAKE RELEASE

This is a momentary toggle switch which will release the brakes when activated. The brake release can also be performed automatically by activating the throttle. This feature is also user selectable by means of the personality module. With this optional method of control a directional has to first be selected and then the throttle control activated. The software will then decrease the brake pressure but will not permit the throttle command to come through until brake pressure has dropped, at which time the throttle command will be permitted to go through and motion will take place. If the automatic bell timer option has been selected, the bell will then sound for ten seconds.

4. FORWARD, REVERSE

These commands will only be acknowledged or permitted to be changed if the brakes are fully applied and the throttle is in the idle position. When a direction has been selected, while the brakes are applied, the throttle command will be blocked out and not permitted. However, if the brakes are released or the drag brake applied, the throttle command will be recognized and motion will take place. Once the brakes have been released, the directional condition selected just prior to the release of the brakes will be locked into memory and cannot be changed regardless of the position of the directional switch until the brakes have been reapplied. This feature prevents plugging of the locomotive.

When the directional switch on the transmitter is changed from that which is locked into memory the throttle commands will be blocked. This blocked throttle condition will be released if the directional switch on the transmitter is returned to the position that matches that in memory or the brakes are applied and the throttle control is released long enough to allow the directional memory to change and then release the brakes again. The directional status lights show the direction the locomotive will move and not necessarily the direction setting of the transmitter switch.

5. HEAD LAMPS

When this toggle switch is activated on the transmitter both front and rear lamps of the locomotive will turn on in a dim condition. If a directional had been selected,



then that lamp which faces the direction in which the locomotive has been commanded to go in will be at full brightness. The operator does not select which lamp he desires to be bright, he just selects lamps and the software will determine which, if any, of the lamps will be operated at full brightness.

6. DRAG BRAKE

This is a momentary toggle switch or pushbutton, when depressed will release brake pressure down to its low brake pressure point and will set a software latch so as to maintain this command without the need for continuously transmitting the drag brake function. If a directional had not been chosen prior to the transmission of the drag brake, the throttle command will operate, however, the directionals can not be changed under these conditions. Full brakes will have to be applied and then a directional selected. The drag brake latch will be canceled when the brake release or brake apply command are activated. This prevents a conflict in commands and allows full brake pressure to be applied in an emergency when the brake apply command is sent.

7. SAND

This command is activated from a momentary pushbutton and will activate a sander either on the front or rear of the locomotive, depending upon which directional has been selected. The Sand command gets its directional information from internal memory and does not read the transmitted function which may not correspond to the actual direction of the vehicle. This command will not activate the sander if a directional has not been selected.

8. FIVE SPEED THROTTLE AND BRAKE APPLY

The throttle control will only be acknowledged if the brakes are applied and a directional has not been selected, or if the brakes are released with or without the directional. The throttle command will also be acknowledged when only the low pressure brake switch is activated and the drag brake command latch has been set with a directional selected.

The throttle will also be blocked whenever the transmitted directional does not match the directional locked into memory. See Forward, Reverse.



Each time this control is moved to the brake apply position, the brake pressure will increase under a controlled rate. This increase in pressure will stop if this control is released. When the brake apply causes the brake pressure to activate the high brake pressure switch, the brake apply command will be maintained by the computer until a brake release command lowers the pressure below this preset high pressure setting.

9. UNCOUPLE

This is a momentary pushbutton. When depressed, will uncouple the locomotive from its load.

10. PERSONALITY MODULE

This is a small PC Board with an eight position dip switch which plugs into the transmitter motherboard at word location #7. This board allows the user to select certain features such as brake release with the throttle command lever and bell timer when a motion is selected, to be selected as he sees fit. Other special features can be programmed in so as to be selectable by the user as they are developed in the future.

Since this system has been made as universal as possible and needs minimal application engineering time, all functions that have been listed are available if the transmitter is configured to transmit them and the receiver system is wired to respond to them. No special application engineering time would be required to configure the receiving panel other than to label those functions or features that are to be utilized on a given job and to mark the transmitter print to show the functions that are to be installed and the bit location to be wired.

11. ERROR TEST

Besides the error conditions that are normally detected by the systems software which are considered standard for the 7000 System, the following special error checks are made for the locomotive system. These error checks are primarily aimed at catching discrepancies in transmitted functions that could occur due to a defective switch in the transmitter or, in some cases, by misuse of the controls by the operator.

a. Directional Test



Should both directional commands be transmitted at the same time, both of them will be ignored by the software and no directional outputs will take place. However, if a valid directional signal had been sent and locked into memory and the system is in a condition where new directional information would not be accepted, then this error condition will be ignored until such time that the new directional information would normally be accepted. When this error condition exists, a directional error software flag will be set and will only be cleared if the error condition goes away within a second and a half, at which time the system will shut down.

b. Brake Apply - Brake Release Test

Should both of these commands occur at the same time, and they can since these commands are on separate switches on the transmitter, the software will acknowledge the brake apply command applying full brakes to the locomotive and will ignore the brake release command. A brake error flag will be set and system shut down will occur in one and a half seconds. Under the brake apply command, two bits are sent for this function. If for any reason only one of the bits are received due to a defect in the TX motherboard, an error flag will be set for the brakes; however, the brakes will not be applied for a second and a half interval, at which time, the entire system will shut down and the brakes will be applied.

c. Throttle and Brake Apply

Since both of these commands are on the same motion switch, a defective switch can conceivably ask for both commands at the same time. If this should happen, the throttle command will be ignored and the brake command will be accepted applying full brake pressure to the system and at the same time, a throttle error flag will be set. When the throttle's first step is sent, two bits of data are used and if for some reason only one of the bits is transmitted due to a defect on the transmitter motherboard, then the throttle command will be ignored and a throttle error flag will be set with system shut down occurring in one and a half seconds. A throttle error will also occur if first speed is not transmitted when any of the other four



speed steps are transmitted.

When any one of the three above mentioned error flags are set, an error counter will be started and if all error conditions are not cleared up within a second and a half, the entire system will shut down applying brakes. The error flags will be permanently stored in memory so long as the power to the system is not interrupted or a reset command is applied to the computer. Therefore, if a diagnostic module is plugged into the standard BUS rack even after the error has occurred, you can read out on the diagnostic board which function caused the shut down.

12. Pneumatic Self-Check

The pneumatic self-check is made once each time the start button is pressed to start the system after it has been shut down. This self-check takes about 5 to 7 seconds, however, it can extend to approximately 20 seconds if the condition of the pneumatics are marginal. While the tests are in progress all transmitted commands, except horn, will be blocked. When the pneumatics have passed the test the horn will sound for 2 seconds, if the operator is not himself sounding the horn at this time, indicating that the commands are no longer blocked and the system is ready to go. If the pneumatics fail the test, the receiver system will shut down without the 2 second sounding of the horn.

The pneumatic self-check consists of the following:

- a. Block all transmitted signals except horn.
- b. Check initial output status of control pressure switches.
- c. Release brake pressure.
 - (1) Monitor brake pressure switches. If switches do not change from original state within 5 seconds, system will shut down. If switches change within time limit, proceed with next test.
- d. Reapply brake pressure.
 - (1) Monitor brake pressure switches. If switches do not return to original state within 5 seconds, system will shut down. If switches change within time limit, proceed with next



test.

e. Energize 2nd step throttle.

(1) Monitor throttle pressure switch. If switch does not change from original state within 5 seconds system will shut down. If switch changes within the time limit, proceed with next test.

f. Release 2nd step throttle.

(1) Monitor throttle pressure switch. If switch does not return to original state within 5 seconds, system will shut down in 1-1/2 seconds and no other test or operations will be made. If switch changes, proceed with next step.

g. Energize horn for 2 seconds.

h. Release control to operator.

B. PNEUMATIC AND MECHANICAL DESCRIPTION

1. Air Supplied

- a. Five micron filter regulator set at 90 PSI with automatic water rejection.
- b. Pressure switch monitor which will cut-out radio system at 70 PSI.
- c. Three way shut-off valve in cabinet to isolate pneumatics.

2. Control Regulators

- a. Set point regulators for brake and pneumatic throttle. These are field adjustable for optimum control.
- b. Output gages for brake and pneumatic throttle pressures.

3. Combo Rack

- a. Combined 19" receiver and interface control module rack.



- b. Power switch for rack isolation.
- c. All modules are plug-in boards which plug into a common motherboard.
- d. All outputs are from the front of the plug-in card edge for ease of maintenance and troubleshooting.
- e. Two part hinged control panel for total access to system.
- f. Separate power supplies for receiver and computer boards and output modules, thereby isolating the output modules from the rest of the system.
- g. All receiver and control modules have LED indicators which are used the same as they are in the 7000 system crane control. The pneumatic output boards have four LEDs to show when the pneumatic valves have been energized. In addition to this, there are two more LEDs which will indicate that the pressure switches, if so equipped, have been activated by pressure in the lines they are monitoring.

4. Cabinet

The one cabinet houses the total system which includes the radio receiver, the electrical and pneumatic controls with circuit breakers, power supplies, power relays, output terminals, pneumatic filters and control valves. This cabinet is a two-part hinged control cabinet measuring 19" high, 24" wide and 16" deep.

5. Receiver Rack PC Board Accompaniment

- a. One Receiver.
- b. One Frequency Support Board or Datacom Board. Datacom Board is required if diversity antenna system is used in system to reduce multi-path.
- c. One 8/IO Board.
- d. One 16/O Board.
- e. One Computer Board.
- f. Four Pneumatic Output Boards.



- g. One EMR Board (two boards are required if head lamps are used).

Locomotive Transmitter Word Assignment

Word 1 - Aux Function

BIT	FUNCTION
7	Horn
6	Bell
5	* Brake Release

10/10/10

10/10/10

10/10/10

10/10/10



4	FWD
3	REV
2	Head Lamps
1	Drag Brake
0	Sand

Word 2 - Stepped Function

BIT	FUNCTION
7-5	* Brake Apply
6-4	* 1st Step Throttle
3	* 2nd Step Throttle
2	* 3rd Step Throttle
1	* 4th Step Throttle
0	* 5th Step Throttle

Word 3 - Aux Function

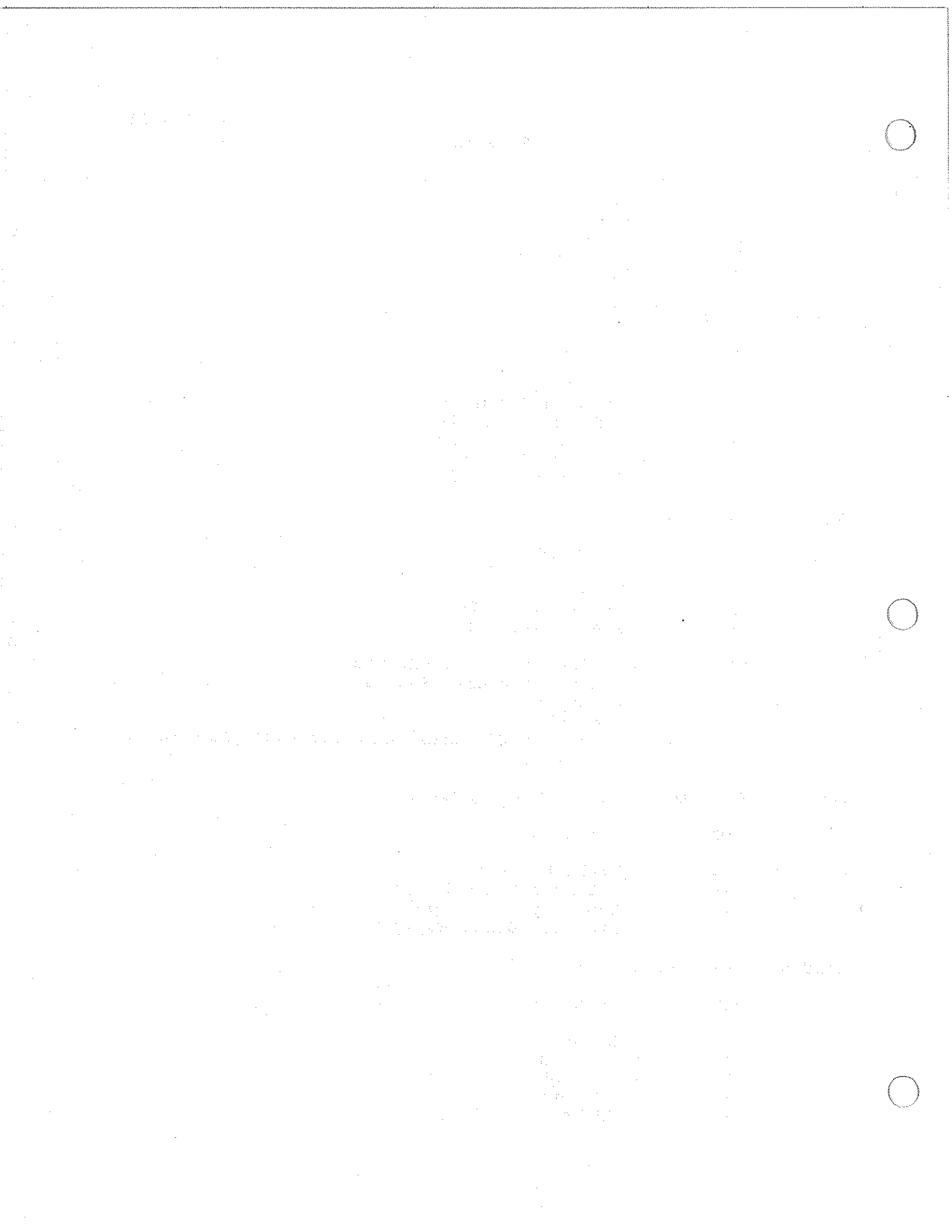
BIT	FUNCTION
7	Transmission 1st
6	Transmission 2nd
5	Transmission 3rd
4	NU
3	* Gradual Throttle Advance
2	* Gradual Throttle Retard
1	* Uncouple Rear
0	* Uncouple Front (Use this Bit when only one uncouple command is used.)

Word 4 - Stepped Function (Train Brake)

BIT	FUNCTION
6-4	* Brake Release
7-5	* 1st Step Brake Apply
3	* 2nd Step Brake Apply
2	* 3rd Step Brake Apply

Word 5 - Aux Function (Knuckel)

BIT	FUNCTION
7	* KF Up
6	* KF Down
5	* KF Right
4	* KF Left
3	* KR Up



2	* KR Down
1	* KR Right
0	* KR Left

Word 6 - Aux Function

BIT	FUNCTION
7	Front Extended Head Up
6	Front Extended Head Down
5	NU
4	NU
3	NU
2	NU
1	NU
0	NU

Word 7 - Personality Module

BIT	SW	FUNCTION
7	1	Bell Timer (10 Sec.)
6	2	Brake Release
5	3	Loco Brake controlled by Train Brake
4	4	Cont. Bell Timer
3	5	No Horn after self-check
2	6	Throttle with Train Brake
1	7	NU
0	8	NU

***NOTE:** The system will not start if these functions are activated when the system is started.

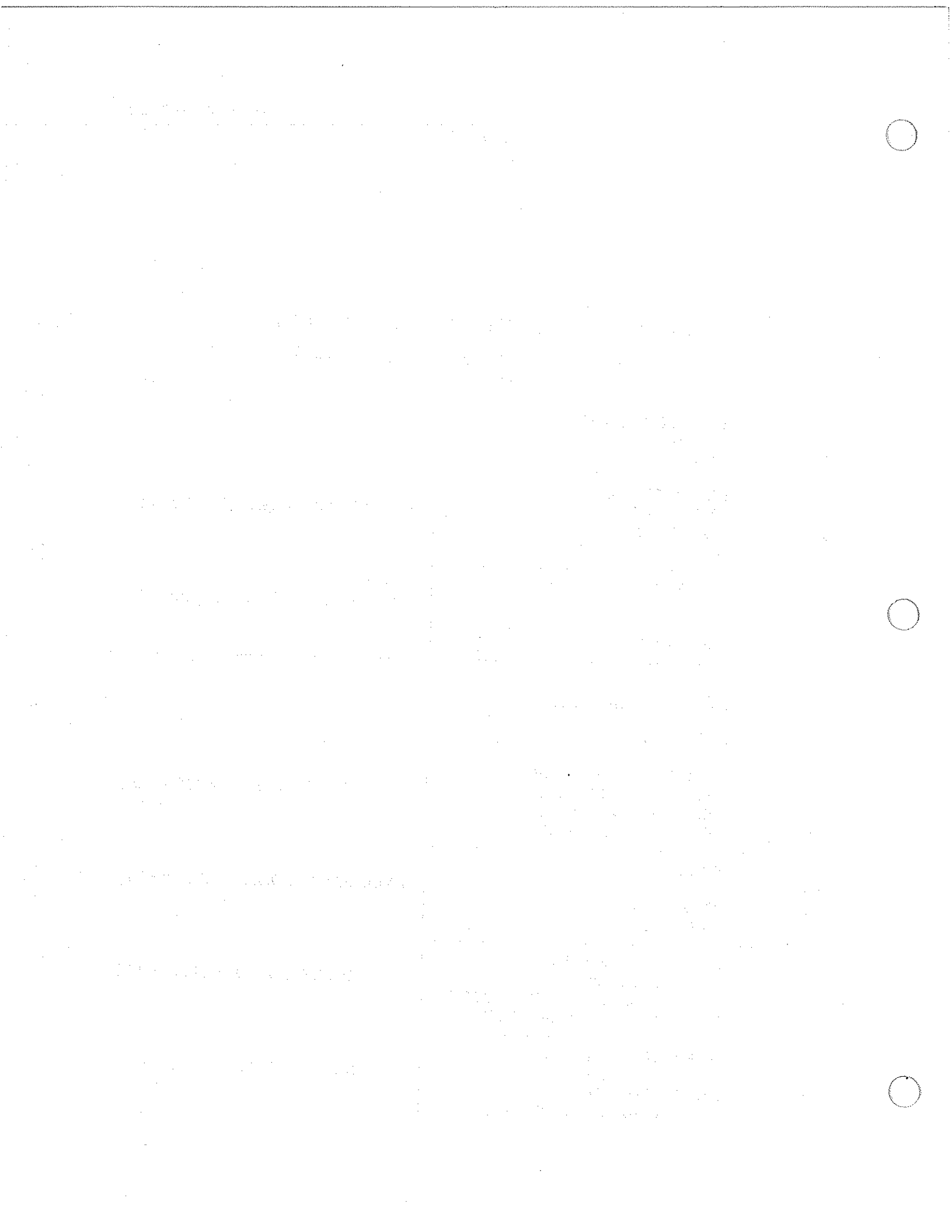


LOCOMOTIVE RECEIVER OUTPUT ASSIGNMENT**PNEUMATIC THROTTLE & DIRECTIONAL****8/IO (Location 7F)**

BIT #	FUNCTION	
7	BRAKE RELEASE	PNEUMATIC BOARD (E7208-1)
6	BRAKE APPLY	
5	DRAG BRAKE	
4	EMERGENCY BRAKE	
3	THROTTLE 1ST STEP	PNEUMATIC BOARD (E7208-8)
2	DIR FWD	
1	DIR REV	
0	UNCOUPLE	

16/O (Location 7E)

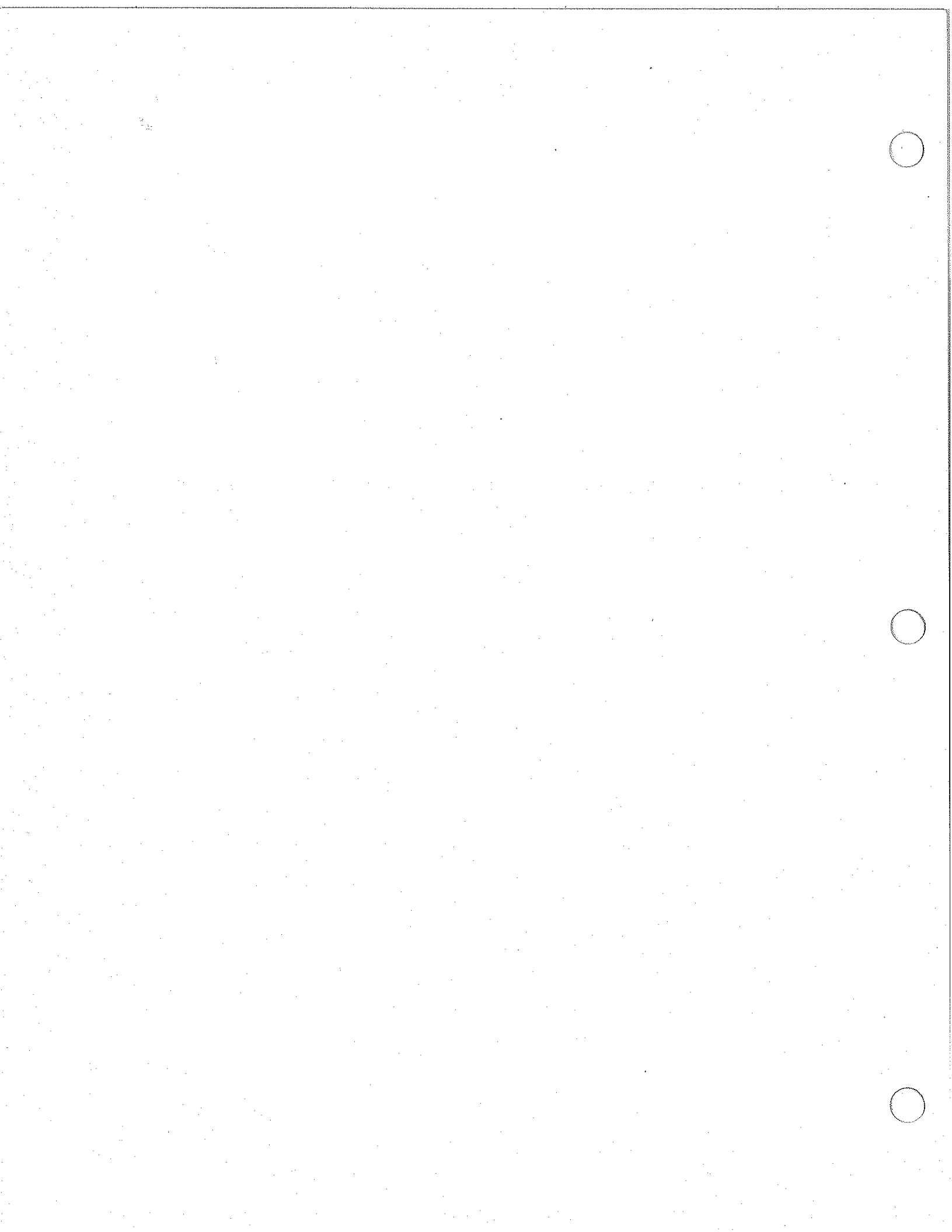
BIT #	FUNCTION	
15	THROTTLE 2ND STEP	PNEUMATIC BOARD (E7208-13)
14	THROTTLE 3RD STEP	
13	THROTTLE 4TH STEP	
12	THROTTLE 5TH STEP	
11	HORN	PNEUMATIC BOARD (E7208-10)
10	BELL	
9	SAND FWD	
8	SAND REV	
7	STATUS LIGHT FWD	RELAY BOARD (E7207-19)
6	STATUS LIGHT REV	
5	STATUS LIGHT BRAKE APPLY	
4	STATUS LIGHT THROTTLE	
3	HEAD LAMP DIM FWD	RELAY BOARD (E7207-19)
2	HEAD LAMP DIM REV	
1	HEAD LAMP BRIGHT FWD	
0	HEAD LAMP BRIGHT REV	





SERIES 8000 VHF TDMA USER/INSTALLATION MANUAL SUPPLEMENT

TC8000-4-0.0A



SERIES 8000 VHF TDMA USER/INSTALLATION MANUAL SUPPLEMENT

Table Of Contents

GENERAL

TDMA System Description
TDMA Theory of Operation
TDMA Specifications

RECEIVER

Description
Theory of Operation
E7150-X Receiver Module
E8001-X Microcomputer (uC) Module
Software
Installation
Diagnostics and Troubleshooting

TRANSMITTER(S)

Description
Theory of Operation
LTX Transmitter Model
SLTX Transmitter Model
Access Code Plugs
Batteries

SYSTEM

TDMA System Components
Unique TDMA Features
Unique TDMA Options
Access Code Plug Operation
Operating Characteristics
Rack Charts

GENERAL

The **Series 8000 VHF TDMA User/Installation Manual Supplement** covers the unique features of the Series 8000 VHF TDMA System. The transmitter and receiver/control unit portions of the **System Description** in the **User/Installation Manual** are superseded by the information in this Supplement. This Supplement also contains a new section covering the **SLTX Transmitter Model**, and the **E7632 Transmitter Microcomputer (uC)** and the **E7650 RF Modules**. The Membrane Transmitter (MTx) is not available with Series 8000 VHF TDMA systems.

TDMA System Description

The **TDMA (Time Division Multiple Access)** system allows for the use of several systems on the same frequency in the same area. This is accomplished by a proprietary (patent pending) system which compresses data and transmits it in a predetermined burst pattern. Each transmitter operates independently; there is no need for complex frequency coordination of equipment. The independent operation allows for overlap of data from different transmitters; because of the burst pattern there is no chance of several data packets in a row overlapping, and with a transmission every 100 ms on average (50 ms when a switch is moved), these infrequent overlaps have no noticeable effect on system performance. The packet data is protected against corruption by several layers of error checking and redundancy. This makes data corruption virtually impossible.

TDMA Theory of Operation

TDMA operation involves intermittent, "packet" transmissions. A TDMA transmitter transmits on average, only 10% of the time, versus 100% for a standard "continuous carrier" Series 8000 transmitter model. This allows other systems to use the open time that the packet system frees up to operate on the same channel, something that is impossible on a conventional system.

A TDMA transmitter is similar to the standard Series 8000 transmitters except for the software. The software protocol has been significantly advanced to a) compress the control information, b) increase the data rate, c) add more data protection, d) transmit data in intermittent packets, and e) store and use the transmitter access code of the transmitter that starts the receiver. The SLTX also has a new "turn-off" feature added whereby the transmitter sends a positive "shut-down" signal upon "turn-off". Should an operator "turn-off" the transmitter in an emergency, the system will immediately "shut-down" instead of waiting for the "time-out" feature. An emergency stop button can also be accommodated. This feature will also become standard on LTX transmitters after December 1992.

It should be noted that since the power amplifier stage in the transmitter RF module consumes over half of the battery power, changing to intermittent TDMA operation adds almost 40% to the battery life.

The receiver/control subsystem, uses the E7150-X Receiver Module. This hardware has been optimized for packet data transmission and can recover the first data bit from an intermittent packet eliminating the need for the long preamble needed to settle other receivers. In addition, the software has been significantly updated allowing the E8001-X uC module to handle the new packet data format and still retain the usual Series 8000 operating characteristics. The back plane and output relay systems are unchanged, although a new E8003 output board has been developed for interface to programmable logic controllers and other electronic interfaces.

TDMA Specifications

<u>PARAMETER</u>	<u>SPECIFICATION</u>
FCC REQUIREMENTS:	Part 90/ End-User License Required
AUTHORIZED FREQUENCIES:	VHF: 72-76 MHz
NUMBER OF CHANNELS:	200
CHANNEL SPACING:	20 KHz
FREQUENCY GENERATION:	Rx: Synthesized Tx: Crystal Controlled
FREQUENCY STABILITY:	10 PPM
MODULATION:	FSK: +/- 3 KHz Deviation
DATA RATE:	4800 Baud
OPERATING TEMPERATURE:	-30°C to +70°C
STORAGE TEMPERATURE:	-40°C to +100°C
HUMIDITY:	0-95% Non-Condensing
OPERATING VOLTAGES:	Rx: 120/240 VAC, 60 Hz, 0.25 A Tx: Battery Powered

RECEIVER

Description

The Series 8000 VHF TDMA Receiver Model is an "Engineered System", customized for your particular application. However, there are several common modules. The E8001-X Microcomputer (uC) Module is common to all Series 8000 systems, although it has several variants. The variants that are usually used in Series 8000 VHF TDMA systems either have the typical manual frequency control as shown in the **Radio System Operating Principles** of this manual, or cause the receiver to scan several RF channels under computer control for the multibox option. Note that the software used for a Series 8000 VHF TDMA system is quite different from standard Series 8000 software. Also note that the output board module configurations are virtually identical to standard 8000 product.

The E7150-X Receiver Module RF, however, is significantly different. It is optimized for high efficiency packet data reception. While it receives direct FSK like other Series 8000 products, it uses a 4800 baud data rate instead of the 2400 baud rate employed in standard Series 8000 systems.

Theory of Operation

The Receiver Model is comprised of several sub-assemblies. Operation of the E7150-X Receiver and E8001-X Microcomputer (uC) Modules follows:

E7150-X Receiver Module

The E7150-X Receiver Module is a dual conversion "superhet", with a synthesized first local oscillator. The final conversion and quadrature detection are built around the Motorola MC3362 multi-function IC. The uniqueness of this module lies in the data processing which preserves the level of the audio from the beginning to the end of a data packet regardless of length. This insures that the data conversion is valid throughout the duration of the packet. Data conversion simply becomes a straightforward level detection.

The synthesized first local oscillator allows for computer control of the radio control carrier frequency. The TDMA data format and software is set-up so that several channels can be scanned without missing a "turn-on" signal on any of the scanned channels. This function is identical to the multibox function of standard Series 8000 systems and is similarly transparent to the user.

E8001-X Microcomputer (uC) Module

The standard E8001-X Microcomputer (uC) module used in Series 8000 VHF TDMA systems is the version with manual frequency selection described elsewhere (**Radio System Operating Principles**) in this manual. If the multibox option is selected, an electronically scanning version of the E8001-X is provided. Note that with this option, the channels are programmed in an EPROM and cannot be manually set to any channel in the band. The uC module controls all relay actions, as well as processing incoming data from the receiver and controlling channel operation. The software, along with the wiring and output board selections made for your system, determines how your system will respond to commands from the transmitter.

Software

The software version used for TDMA operation is unique and interprets the TDMA protocol and adapts the intermittent TDMA system so that it operates like a standard Series 8000 system. Relay operation is similar to normal Series 8000 system.

In addition, TDMA software is specifically designed to allow control of multiple receivers via access code plugs. The transmitter sends its master code and the receiver access code at start up; the receiver stores the transmitter master code in RAM upon recognizing its code in a good packet.

Much effort goes into insuring the integrity of the data. The data has a unique format. First, there is an access code that is unique to each system. On standard Series 8000 TDMA systems, only a transmitter with that access code plug can start the system. With the multibox option, several transmitters are capable of starting a receiver, but only the transmitter that starts the receiver can operate it. This allows the use of "universal spare transmitters" while insuring that normal operation is not disrupted. There also is an error checking system (Cyclic Redundancy Count, or CRC) which protects against corrupted data. Corruption is further protected against by a four bit double redundant direction command for each direction; only half of the possible combinations are valid. It is virtually impossible to get a sequence of proper commands, proper access code, and correct CRC word from noise or other undesired transmissions.

Installation

A Series 8000 VHF TDMA system is installed in a similar manner to standard Series 8000 systems. However, there are certain issues that should be addressed for best performance:

- 1) Never mount the antenna on the receiver cabinet.
- 2) If there is a problem with receive noise, remove or re-route the excess coaxial cable out of the receiver cabinet.
- 3) The antenna should be able to be seen from most operating positions on the ground. The antenna should not be obstructed by the crane.
- 4) Do not attach the receiver to a case for a variable frequency drive. Do not use the same power line for the receiver as for a variable frequency drive. Make sure that the receiver power feed is separate from the variable frequency drive feed, at least to the pickup shoe. If a separate line is not available, install a line conditioner before the receiver.

Diagnostics and Troubleshooting

NOTE: If you should change the E8001 uC module, MAKE SURE THAT THE SWITCHES ARE SET TO THE FACTORY SETTINGS AND THAT THE CORRECT SOFTWARE FOR YOUR SYSTEM IS INSTALLED.

The receiver RF has an LED to indicate synthesizer lock similar to other radios. It works identically to the LED on standard Series 8000 receivers. It also has a signal output, again similar to standard Series 8000 receivers.

The various output modules are common to all Series 8000 systems.

The Microcomputer Module has two (2) rows of LEDs, similar to most E8001-X uC modules. However, the operation of some of the diagnostics are different. The following lists the differences in operation of the LED diagnostics of a Series 8000 TDMA system versus the standard Series 8000 diagnostics:

Table 1: System Frequency Code Settings - The frequency selection of Series 8000 TDMA multibox systems is under computer control; SW2, SW3, and SW4 do not exist on the E8001 version used in multibox TDMA. Single frequency TDMA systems have manual selection identical to standard Series 8000, and Table 1 applies.

Table 2: Access Code Settings - The main receiver access code is set in SW10. The transmitter master code that started the system is stored in RAM as described in the Software portion of the Receiver section, earlier in this Supplement.

The decimal to binary access code translation contained in Table 2 is applicable. However, the access codes are assigned differently; refer to your rack chart (at the end of this supplement, or supplied with the receiver) for the correct access code(s) for your system. Access codes should not be changed from the factory setting. Any spare or substitute uC modules should be set to the factory setting.

Maximum Range Control Setting - This is preset at the factory. Incorrect setting can disable your Series 8000 VHF TDMA system.

System Troubleshooting Changes:

AGC Level - AGC does not operate normally in TDMA due to the intermittent nature of the radio signal. This reading (SW9 in positions 2, 3, 4, and 5) described in the **Microcomputer Board Checks** 5c should be ignored. This check appears in two places, **Completely Inoperative System**, and **Partially Operative System**. The same applies to the **Receiver Signal Strength Checks** in the **Erratically Operating System** section, and this check should also be ignored.

Squelch - The squelch is held open all the time in a TDMA system; therefore this light should always be on.

The following functions and procedures remain unchanged from the **Series 8000 User/Installation Manual**:

- o Alarm Auxiliary Function
- o Main Relay (MR) Function
- o Manual-Radio Switching Procedure (if applicable)
- o Radio System Starting Procedure
- o Radio System Shut Down Procedure
- o Radio System Restarting Procedure

TRANSMITTER(S)

Description

There are two transmitter models currently available for the Series 8000 VHF TDMA system. They are; 1) the Lever Transmitter (**LTX**), and 2) the Small Lever Transmitter (**SLTX**). Both transmitter models contain an RF, a Microcomputer and an Antenna Module. They also contain a battery and lever switches. However, only the lever switches are common between them, so each transmitter will be described separately.

Theory of Operation

The Series 8000 VHF TDMA system is available with either the LTX or SLTX transmitter models. A Series 8000 VHF TDMA transmitter is electrically very similar to a standard Series 8000 transmitter. The SLTX has a new electronic "shut-off" switch that will be described in detail in the SLTX section. As with the receiver, the transmitter software is significantly different. The software generates the unique data packets and keys the transmitter for intermittent RF carrier operation. As with standard Series 8000 and other Telemotive equipment, the software reads the switches and interprets their positions to the desired signals to be sent to the receiver.

LTX Transmitter Model

The LTX transmitter is the standard Series 8000 transmitter. It has been adapted to TDMA operation by the inclusion of special TDMA software. The E7630 Microcomputer (uC) and E7123 RF Modules are quite similar to their standard Series 8000 counterparts. Some small changes have been made to the E7123 RF Module that improve its performance with TDMA; these improvements are reflected in current standard Series 8000 product. The electronic "shut-off" switch will become standard on LTX transmitters after December 1992.

SLTX Transmitter Model

The SLTX transmitter model contains a different uC module, the E7632 which does the same job as the E7630 except for different dimensions and the new electronic "shut-off" switch. The SLTX also has a different RF Module, namely the E7650 which performs the same function as the LTX RF Module. The SLTX has an electronic "shut-off" switch that replaces the usual physical switch on standard Series 8000 and most other Telemotive equipment. This change was made so that

turning off the transmitter would cause a shut-down command to be sent, resulting in an immediate system shutdown.

Access Code Plugs

The Series 8000 VHF TDMA System was developed specifically to allow the ultimate flexibility in controlling different combinations of hoists/trolleys and/or bridges. The selection of a particular combination of hoists/trolleys and bridge is accomplished by the use of the correct combination of access code plugs. By changing access code plugs, an operator can determine which receivers are controlled, even though several receivers are within range of the transmitter.

The access code plug is a military style connector (for ruggedness) which is hard wired for a particular code. When an access code plug is inserted into an appropriate transmitter, the transmitter sends that code along with its master code when the start button is depressed. The receiver writes the transmitter master code into memory and only responds to that transmitter until it shuts-down.

To operate a different receiver, the access code plug should be changed and the new receiver started. **NOTE:** If you remove the access code plug while operating a system, the system will "shut-down" and will need to be restarted. This prevents any possibility of two transmitters trying to operate the receiver with the same access code plug.

TDMA systems are usually configured to operate one selectable bridge and several selectable trolleys. The number of selectable trolleys is a function of the engineering of your particular system. If a need arises for a configuration different from what is possible with your system, please contact the factory.

Batteries

Battery life is increased for a TDMA system due to the intermittent transmission of data. A standard Series 8000 transmitter continuously sends data when turned on (except for the 16 minute time-out). However, a TDMA transmitter intermittently sends data and is "on-the-air" only 10 - 20 percent of the time. This provides a 40% increase in battery life.

It should also be noted that the SLTX case has a different battery arrangement. Access is through the side plate that has the thumbscrews and the battery compartment is smaller than the LTX battery compartment. Thus, many of the batteries used with the LTX cannot be used with the SLTX.

SYSTEM

TDMA System Components

A single Series 8000 TDMA system consists of several receivers and one or more transmitters. Because of the combinations possible and the unique engineering required to allow all of the desired modes of operation, Series 8000 VHF TDMA receiver/transmitter systems must be configured in a coordinated fashion across the entire building in which they are installed. Please consult the factory for any additions to your systems.

Unique TDMA Features

The Series 8000 VHF TDMA system offers as one unique feature the ability to operate several systems independently on one channel without the systems interfering with each other. The other unique feature is the ability to control different combinations of bridges and trolleys with one transmitter using access code plugs. Both are inherent in TDMA.

Unique TDMA Options

The Series 8000 VHF TDMA system is available with most of the options available on standard Series 8000 systems. In addition, the following TDMA options are available:

- o Electronic Turn-Off with Positive Stop (standard on SLTX)

For control of multiple single trolleys or bridges from different transmitters on the same frequency, please inquire about the Telemotive Series 8000 VHF TMS (Time Multiple Shared) system.

Access Code Plug Operation

Use of the access code plug is very simple. Each receiver will have an associated access code plug. If the correct plug for a given receiver is not in place already, remove any plug that is in place by twisting and pulling it out, then insert the correct plug by pushing it into the desired socket and twist it in. The operating sockets will be on top of the transmitter; any storage sockets will be on back. Once the correct plug(s) is inserted, make sure that you are in range, and start the system. Operate the system as usual. Remember not to remove any plugs while you are operating a system, or the system will shut-down.

NOTE: - Since Series 8000 VHF TDMA systems can control multiple combinations of trolleys, relationships between the transmitter levers and the trolleys ARE NOT fixed. A lever controls whatever trolley that has its access code plug plugged in. Be sure that you have the desired trolley order reflected in the order of inserted access code plugs.

Operating Characteristics

Operating characteristics are the same as the standard Series 8000 systems, except for some time-outs that slightly differ. Refer to the **Series 8000 VHF TMS/TDMA Technical Manual Supplement** (optional) for details.

Rack Charts

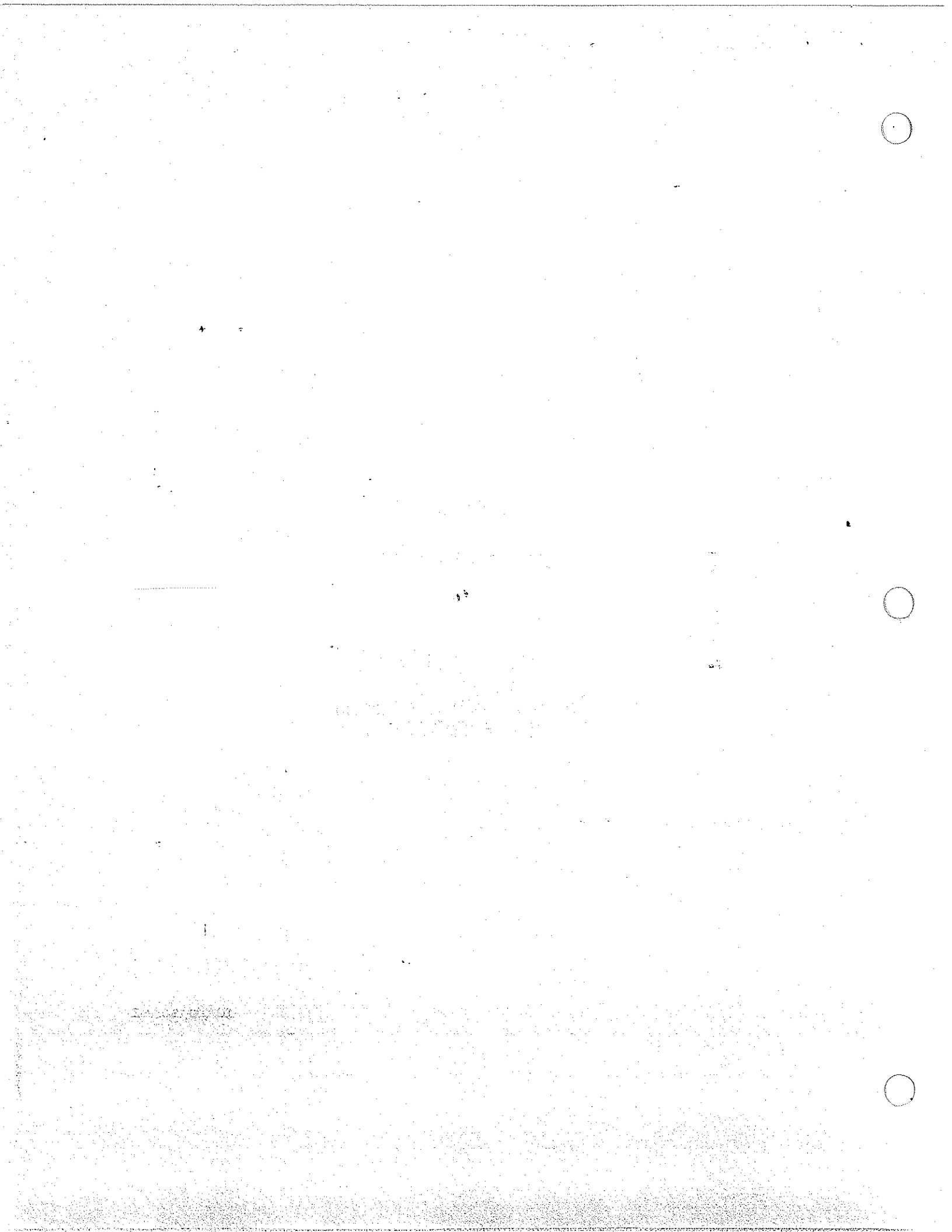
Rack charts for your system are inserted after this page.



**TELEMOTIVE
LTX TRANSMITTER**

**SUPPLEMENT TO
TELEMOTIVE
RADIO CONTROL SYSTEM
USER'S MANUAL**

TC7000-13-0.0A-Z



MAINTENANCE & GENERAL SERVICE INSTRUCTIONS: LTX

PERSONNEL SAFETY PRECAUTIONS

WARNING

The following precautions must be observed to help prevent conditions which are dangerous to persons servicing the equipment and persons in the area of the material handling equipment.

1. In all cases, turn the Transmitter Unit keyswitch to OFF position and remove the key before starting any maintenance or repairs on the Transmitter Unit.
2. Before servicing transmitter, make sure you do not inadvertently activate material handling equipment. Either turn material handling equipment off, or service transmitter in a shielded enclosure or at a far enough distance (beyond signal control of equipment).
3. When operating or testing the system, follow all SAFETY PRECAUTIONS listed in this Manual.
4. When attempting repair of physically-damaged switches, controls, or cases. While not always apparent, damaged controls can lock unexpectedly in active positions, thereby preventing normal equipment braking. Replace damaged components only with Telemotive factory authorized components.

EQUIPMENT PROTECTION PRECAUTIONS

CAUTION

The following precautions will help avoid damage to the Transmitter Unit

1. Any work performed on the RF section of the Transmitter Unit must be performed by an FCC licensed technician (or equivalent in other countries). Additionally, you may be responsible for compliance with other local regulations.
2. Certain Transmitter Unit modules contain several adjustments: Do not attempt to perform adjustments without the Technical Manual, and procedures for adjustments.

MAINTENANCE & GENERAL SERVICE INSTRUCTIONS: LTX

BATTERY REPLACEMENT

Battery Monitor Indicator (models equipped with battery monitor only)

Battery condition is indicated by the red BATTERY MONITOR LED located on the Transmitter Control Panel. When the transmitter is turned ON and the battery is sufficiently charged, the LED flashes at a 3 Hz rate. When the charge is below acceptable limits, the LED turns off.

BATTERY REMOVAL/REINSTALLATION

1. Turn keyswitch to the OFF position and remove key.
2. Battery compartment is located on right-hand side of Transmitter Unit (as viewed from normal operating position; see Fig. 1).
3. Open compartment door by rotating latch to horizontal position, as shown in Fig. 1.
4. Pull velcro-type tape strips from each other and slide battery out of compartment.
5. Disconnect battery from transmitter by grasping and unplugging battery/transmitter connector *as close to the connector as possible*. Do not disconnect connector without supporting connector leads.
6. Slide charged battery into compartment while holding tape strips away from battery.
7. Firmly reconnect battery connector (connector is polarized).
8. Push excess battery leads into compartment. Reattach velcro-type tape strips.
9. Close compartment door and rotate latch to vertical position.

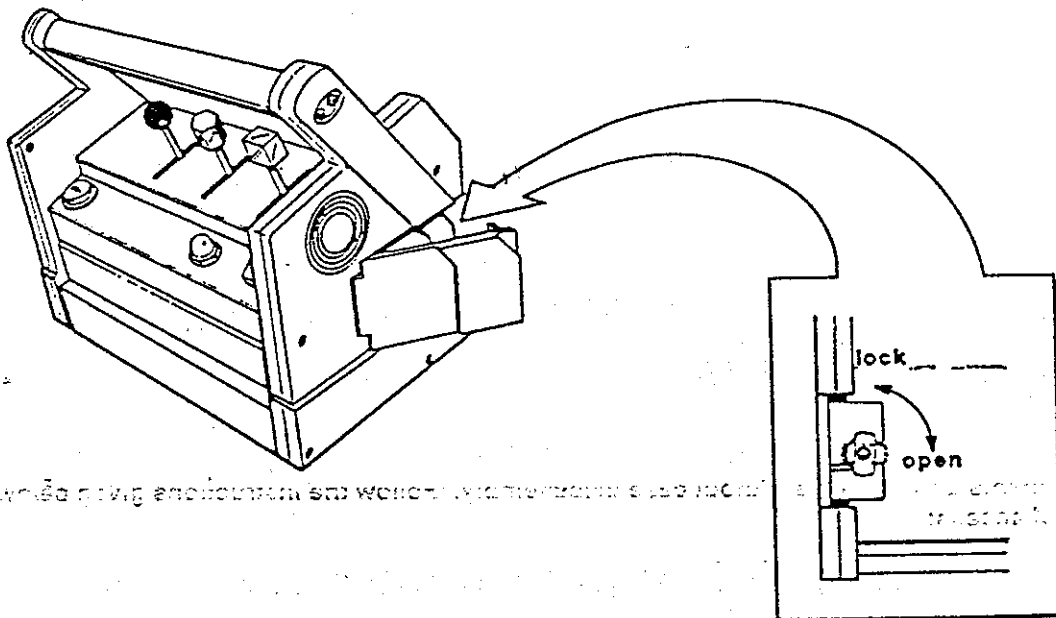


Fig 1 LTX Battery Compartment

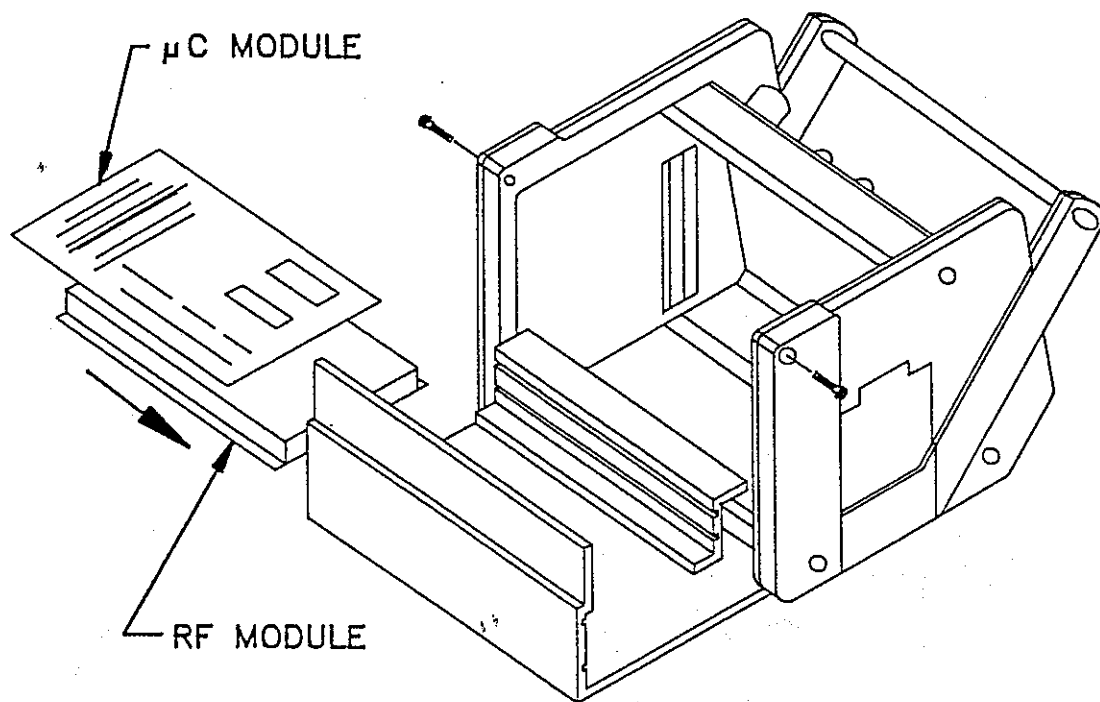


Fig 2 LTX with Access Door in Open Position

OPENING CASE FOR SERVICE

(refer to Fig 2.)

The LTX Transmitter Unit is equipped with a hinged panel which allows access to all internal components and modules without case disassembly. Follow the instructions given below for internal access:

1. Make certain keyswitch and POWER switch are in OFF position.
2. Open housing by removing the two Phillips-head screws located on the transmitter panel (black plastic) ends. These screws are located near the bottom of the transmitter near the bottom front panel.
3. Tilt front panel/card guide; away from control panel.
4. ~~μC Module slides into top guide; RF Module slides into lower guide. Remove both Modules.~~

TRANSMITTER GENERAL DESCRIPTION: LTX

The Telemotive VHF and UHF Lever-Switch Transmitter (LTX) Units are completely self-contained with controls, circuit modules, antenna, and battery housed in one hand-held case. Units are available for VHF and UHF ranges in power outputs from 50mW to 700mW.

The LTX Transmitter Unit is comprised of the following major items:

CONTROL (FRONT) PANEL EXTRUSION

In addition to serving as the top portion of the case, the Control Panel Extrusion supports all motor controls, auxiliary function and warning device switches, an ON-OFF switch, and a battery monitor indicator. The switches and motor controls are connected to the μ C Module via multiconductor ribbon ("flat-lead") cables fitted with locking connectors, thereby allowing easy separation of individual controls from the μ C Module without desoldering.

LTX Control Panel and Case (housing) Assemblies are covered on page 12.

TRANSMITTING ANTENNA

VHF Transmitters typically use an antenna which is integrated into the left hand end cap (as viewed from normal operating position).

All UHF Transmitter Units use a helical ("rubber-duckie") antenna which mounts to the Transmitter Control Panel using a BNC connector.

LTX antennas are covered on page 10.

BOTTOM EXTRUSION: END CAPS

In addition to serving as the bottom portion of the case, the bottom extrusion serves as a card guide chassis for the two transmitter electronic modules. The bottom extrusion swings away from the case with the removal of two screws, allowing access to internal components without case disassembly (refer to Transmitter MAINTENANCE & GENERAL SERVICE INSTRUCTIONS page 5)

BATTERY PACK

Several Batteries are available and are applications-matched to the transmitter electrical and environmental requirements. On Transmitters not equipped with optional charging jack, remove battery from Transmitter as described in Transmitter MAINTENANCE & GENERAL SERVICE INSTRUCTIONS page 3.

See user's Manual for battery options.

μ C (DIGITAL) MODULE

The μ C Module encodes motor control data and switch closures into serial digital data. Additionally, the serial data is encoded with system control data. The μ C Module consists of an Intel 8031 microcomputer IC and 8K x 8 EPROM memory which controls input/output functions. Briefly, the μ C Module performs the following functions:

1. Multiplexes the various motor and on-off functions onto a serial data signal.
2. Encodes the serial data with system control data such as sync, baud rate selection, selectable defeat time-out (dead-man's throttle" feature), and access code programming.

RF MODULE

The RF Module accepts serial data from the μ C and modulates the data onto an RF carrier via FSK (Frequency-Shift-Keying) modulation.

TRANSMITTER GENERAL DESCRIPTION LTX

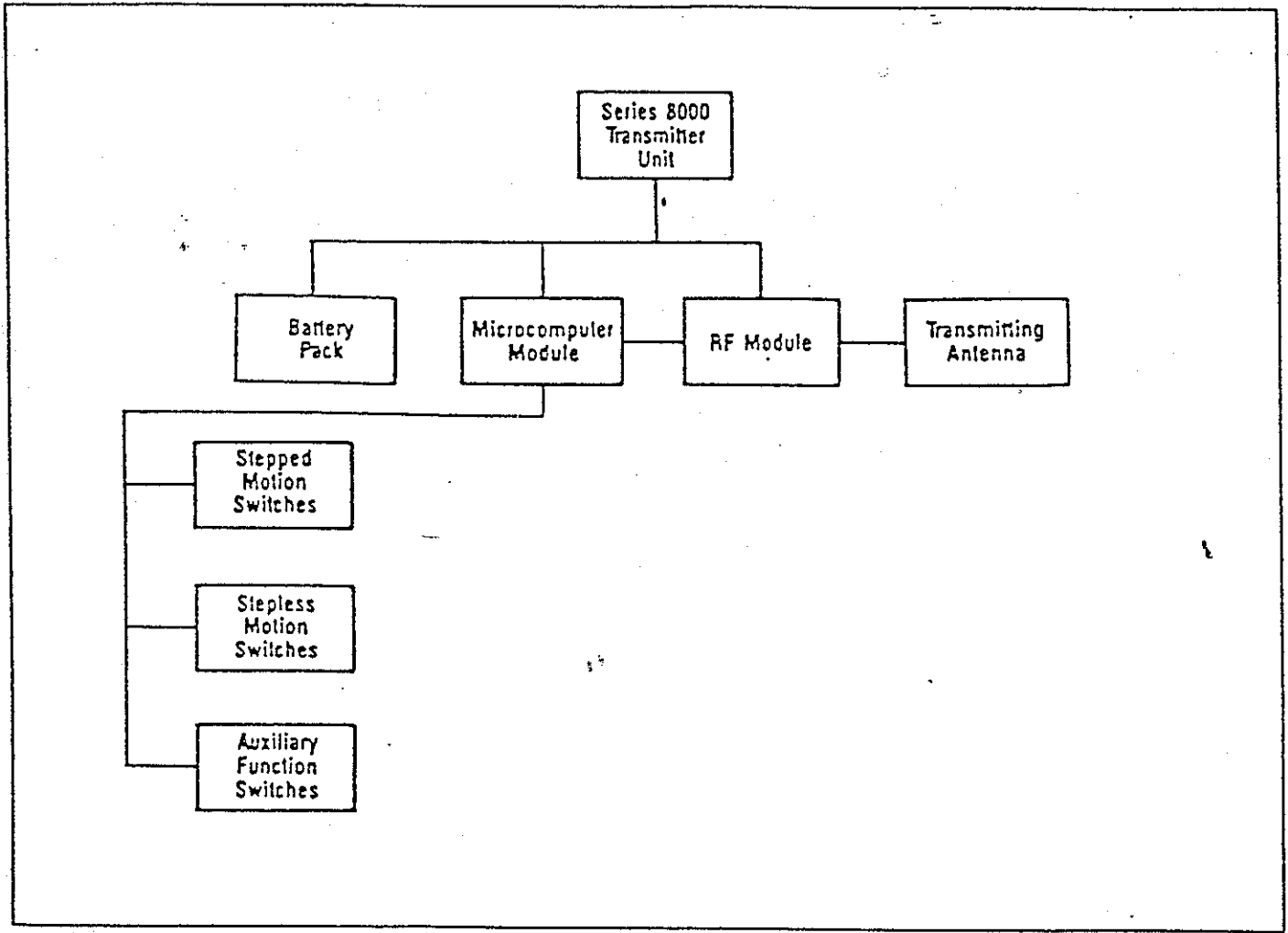


FIGURE 3 LTX TRANSMITTER BLOCK DIAGRAM



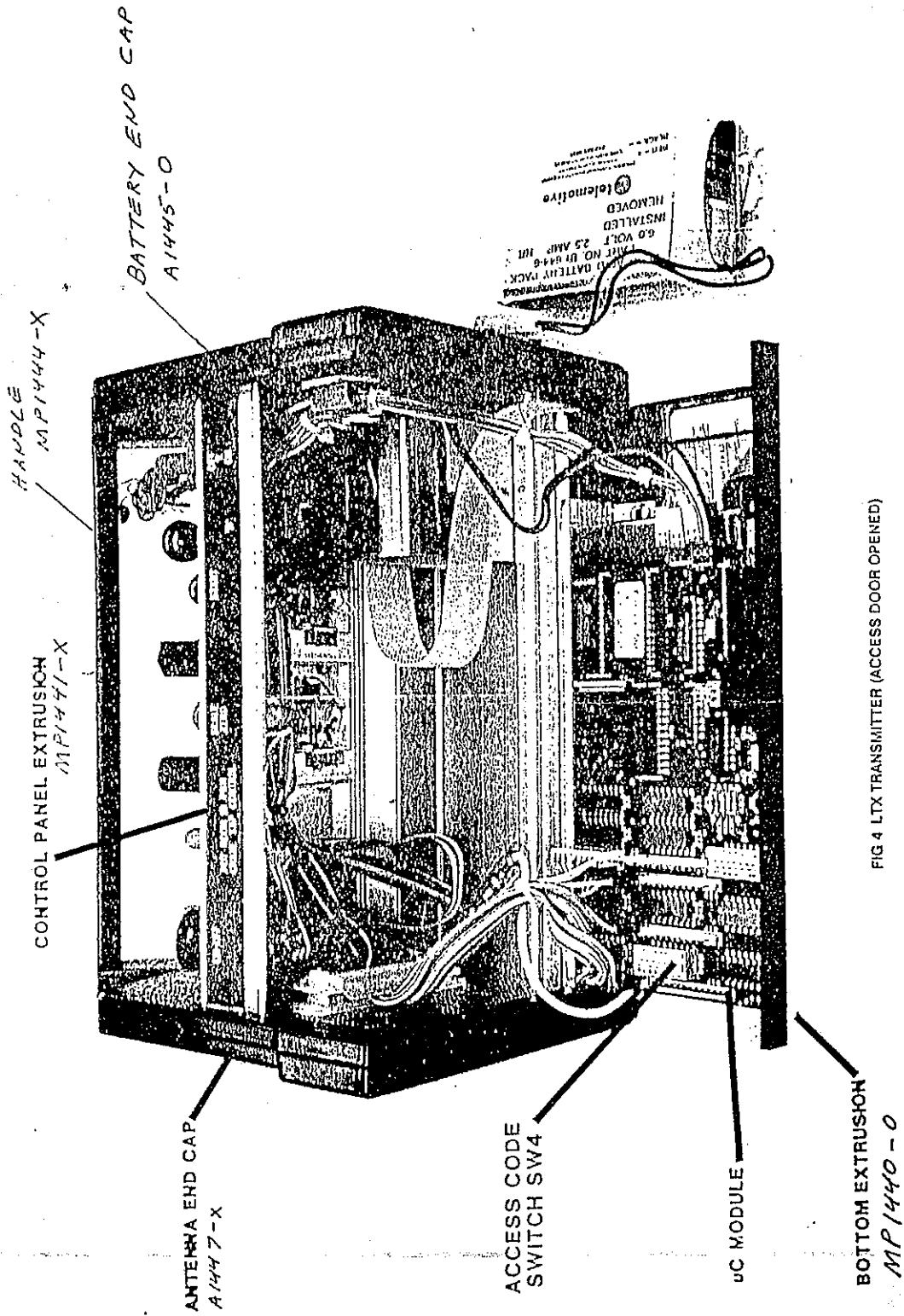
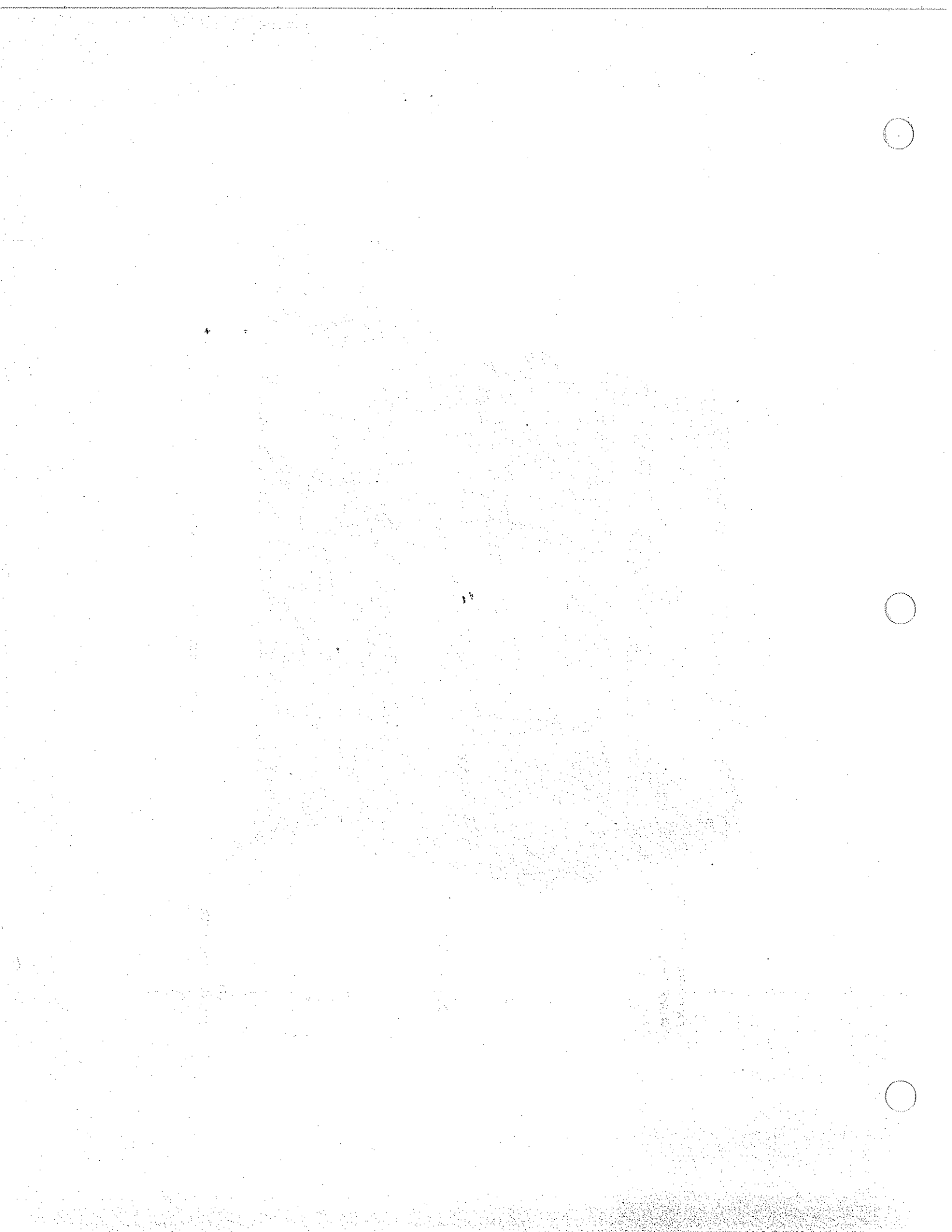


FIG 4 LTX TRANSMITTER (ACCESS DOOR OPENED)



TRANSMITTER ANTENNA: LTX

CAUTION

Replace antenna only with the Telemotive part that corresponds to the frequency and model number of the Transmitter Unit. An improper antenna will rapidly damage the Transmitter Unit.

The VHF LTX Transmitter Unit is available with the antenna types, discussed on the following two pages.

VHF END CAP ANTENNA

Typically, VHF Lever-Switch Transmitter Units use an integral end cap antenna which is built in to the left-hand case end cap (plastic side cover, as viewed from normal operating position).

The antenna portion of the end cap is not separable from the end cap. Therefore, if either the end cap or the antenna requires replacement, both are replaced as a single integrated part using one part number.

REMOVAL/REINSTALLATION (REFER TO FIG. 5)

1. Turn keyswitch to OFF position and remove key.
2. Remove the two Phillips-head screws that attach the end cap to the handle.
3. Remove the remaining four Phillips-head screws on the end cap panel.
4. Pull end cap away from Transmitter case. Do not attempt to completely remove at this point.
5. Disconnect antenna end cap from transmitter module by grasping and unplugging in-line coaxial connector as close to the connector as possible. Do not disconnect connector without supporting connector cable ends.
6. Perform the steps listed above in reverse order when reinstalling antenna end cap.

NOTE:

Factory-replacement end cap antennas are frequency-tuned at the factory and require no field tuning or matching in most situations. If performance is degraded (i.e. significantly reduced range) following an antenna replacement, this indicates that SWR requires further fine adjustment due to uncontrollable factors: Call Telemotive Service for further instruction.

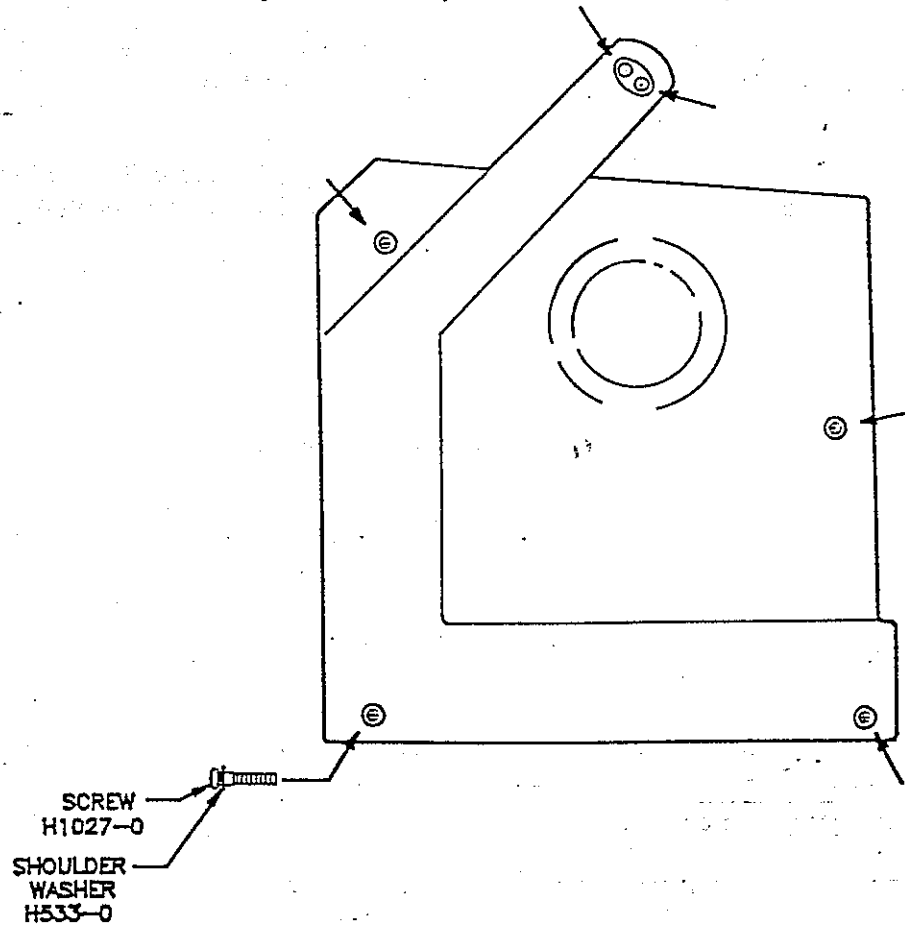
TRANSMITTER ANTENNA LTX:

VHF & UHF HELICAL ANTENNA

Certain VHF and all UHF Lever-Switch Transmitters use a helical ("rubber-duckie") antenna. The antenna is mounted to the Transmitter Control Panel using a standard BNC connector bayonet-mount. Replacement helical antennas are frequency-tuned at the factory.

CAUTION

Turn transmitter keyswitch to OFF position and remove key before removing antenna.



4 OF EACH PER SIDE

ANTENNA TYPE	FREQUENCY RANGE	ANTENNA PART NUMBER*
INTEGRAL END CAP	75-76 MHz	A1447-0
INTEGRAL END CAP	72-72.86 MHz	A1447-1
INTEGRAL END CAP	49-50 MHz	A1447-2
INTEGRAL END CAP	40-42 MHz	A1447-3
HELICAL	72-72.86 MHz	E8010-0
HELICAL	75-76 MHz	E8010-1
HELICAL	406-430 MHz	E8010-2
HELICAL	450-470 MHz	E8010-3

*When ordering, please include transmitter frequency and/or job number to insure antenna is tuned to the proper frequency.

TABLE 1 LTX TRANSMITTER-TO-ANTENNA CORRELATION

CONTROL PANEL/HOUSING: LTX

The LTX Control Panel/Housing consists of the following major items:

1. Control Panel/Chassis. The Control Panel/Chassis ("front extrusion") consists of an angle-shaped extrusion which serves both as the control panel and as the major chassis.
2. Access Door/Card Guide. The Access Door ("door extrusion") consists of a black anodized extrusion which hinges away from the control panel, thereby providing access to the transmitter circuitry without case disassembly. The access door is equipped with card guides that hold the two transmitter electronic modules.
3. End Caps. As viewed from the operator's position, the left End Cap typically contains the antenna on VHF units. The right End Cap includes the battery compartment door. Both end caps fasten to the Control Panel/Chassis.
4. Handle. The Handle fastens to the End Caps and is mounted using four Phillips-head screws.

REMOVING CONTROLS AND SWITCHES

WARNING

Do not attempt the repair of mechanically or electrically faulty controls. Faulty controls must only be replaced with factory authorized replacement parts.

1. Turn keyswitch to the OFF position and remove key.
2. Open access door. See "Opening Case for Service" instructions in MAINTENANCE & GENERAL SERVICE INSTRUCTIONS. Page 5.
3. Noting which flat-lead cable corresponds to the control being removed, disconnect the corresponding cable from the Transmitter μ C Module. Note the relative location of the connector(s) using a sketch or note; this helps avoid confusion when reinstalling a replacement part (connectors are polarized).
4. Remove lever switch knobs by unscrewing knobs counter-clockwise.
5. Remove lever control from control panel by removing the two screws from the top of the control next to the switch.

6. **ON-OFF and AUX rubber-booted switches have a hex nut molded into the boot base just above the switch mounting hex nut. Remove switch boot first by supporting switch hex nut with a low-profile open-end wrench while unscrewing switch boot, then remove switch hex nut.**
7. **Keyswitch is fastened by a hex nut located underneath control panel.**

MOTION CONTROLS & SWITCHES

The type and number of controls found on a given Transmitter depend upon the configuration of the radio remote control system. However, various combinations of the following controls and/or switches are found on all LTX Transmitters:

1. **MOTION CONTROL** These are the larger, lever-type controls; two types are available.
 - a. **STEPPED MOTION CONTROL:** This control uses a lever to operate a drum-type cam which progressively opens and closes several switches. Combined closures of the motor control's individual switch elements develop the digital code that constitutes the stepped motor-control signal.
 - b. **STEPLESS MOTION CONTROL:** This control uses a lever to operate a potentiometer which, in conjunction with Transmitter μ C A/D circuitry, develops the digitally-coded stepless motor-control signal.
2. **MOMENTARY-CONTACT PUSHBUTTON SWITCH** This switch is used as the "START" button, as well as for warning functions such as a horn.
3. **SINGLE-THROW TOGGLE SWITCH:** This switch is used as the transmitter power ON/OFF switch, as well as for AUXiliary functions such as lights, grab, etc.

All controls which connect to the Transmitter μ C Module are connected to the module via flat-lead multiconductor ("ribbon") cables fitted with Molex-type connectors. Each such control uses its own cable, thereby permitting easy removal of a control without disturbing the wiring of other controls.