SERVICE MANUAL

HP M1403A

DIGITAL UHF TELEMETRY SYSTEM

SERIAL NUMBERS

This manual applies to units with the following serial number prefixes. For serial numbers prefixed higher or lower than the number indicated, refer to Section 1. Antenna system components are not serialized.

HP M1400A Transmitter Serial Prefix: **3032A**

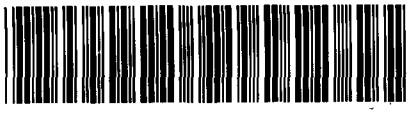
HP M1400B Transmitter Serial Prefix: **XXXXX**

HP M1401A Receiver Mainframe Serial Prefix: **3148A**

HP M1402A Receiver Module Serial Prefix: **3148A**

HP Part No. M1403-90030
Printed in U.S.A. **June 1997**

Second Edition



Printing History

First Edition ..... January 1997

Warning **FCC WARNING:**

This equipment generates, uses, and can radiate radio-frequency energy, and if not installed and used in accordance with this manual, may cause interference to radio communications.

Operation of this equipment in a residential area may cause interference, in which case the users, at their own expense, must take whatever measures may be required to correct the interference.

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B. HP Viridia Digital Transmitter Detailed Functional Description

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General

1.1 Description

This manual contains site planning and installation information for the Hewlett-Packard M1403A Digital UHF Telemetry System, which includes the Model M1400A\M1400B Transmitters and Model M1401A Receiver Mainframe (including option CO3) which houses up to eight HP M1402A Receiver Modules, and the HP M1413B/M1414B/M1415B Dynamic UHF Antenna System options (Figure 1-1).

Refer to the Operating Guide for your Central Station for detailed operating instructions. If maintenance is required, contact your Hewlett-Packard Sales Office.

The Service Manual contains the following sections:

Section 1 describes the manual and the equipment. In addition, it provides general information (options, accessories, UHF channel frequency assignments, controls and indicators, and use with other HP products), specifications, system configurations and cabling, and instrument installation instructions.

INSTALLATION NOTES M1403-90032, M1403-90031 and M1403-91891 are inserted in the manual. They contain, in the order listed, installation procedures for the Antenna System, the Analog Output option, and the ST Segment Analysis/Two-Channel Delayed Recording option.

Section 2, Theory of Operation, describes principles of operation for each instrument and subsystem to a pc board level.

Section 3, Maintenance, contains performance assurance procedures, specification checks, safety checks, and cleaning and disinfection procedures. The telemetry system has no calibration procedures.

Section 4, Troubleshooting, provides procedures to isolate system failures to the pc board level.

Section 5, Service, provides information and procedures to service the telemetry system.

Section 6, Replaceable Parts, contains parts identification and ordering information.

1.1.1 Instrument Identification

Ten-digit serial numbers are located as follows:

Receiver Mainframe, right side panel of top cover (as you face the instrument), and front on receiver mainframe behind the front (dress) cover.

Receiver Module, right side of casting.

Transmitter, inside of the battery compartment.

The first four digits of the serial number are a prefix code (XXXXA-00000) that identifies manufacturing modifications to the instrument. The last five digits represent the sequential production number. The letter that separates the serial prefix and production number identifies the country of manufacture, for instance, A=USA, G=Germany.

1.1.2 Manual Changes

As a result of instrument design improvements and changes, newer instruments may have higher serial prefix numbers assigned after the manual is printed. The updated information usually is supplied in a Document Update inserted at the front of the book. These Document Updates are keyed to a new instrument serial prefix number, manual edition, and print date, all of which appear on the title page.

For instruments with lower serial prefixes than that shown on the title page, outdated information might be deleted when this manual is reprinted.

1.1.3 Inquiries

Refer any questions about this manual or the telemetry system to your Hewlett-Packard Sales Office, identifying the affected instrument model and serial number and the UHF channel option number.

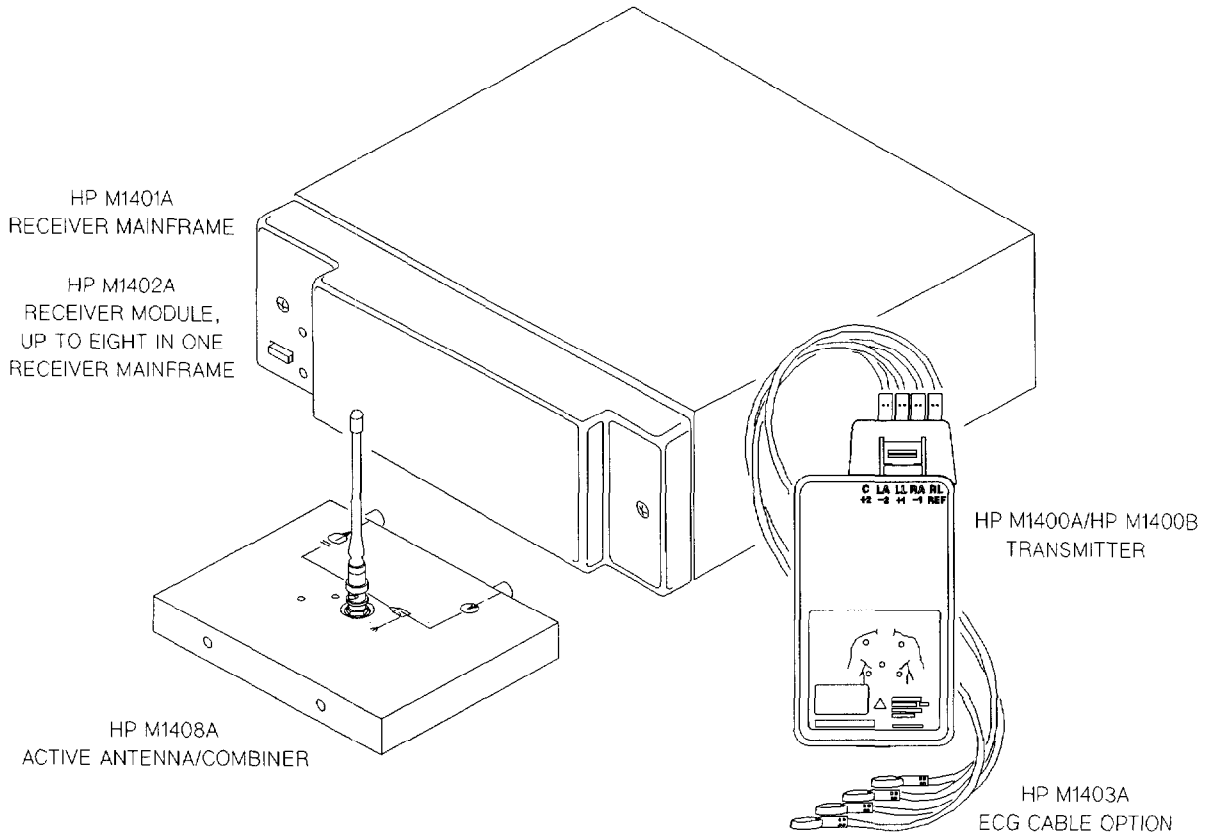


Figure 1-1. HP Digital UHF Telemetry System

1.1.4 Unpacking and Inspection

Open the shipping container and examine the instrument for visible damage such as dents or scratches on the front panel surfaces. If the shipping carton is undamaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. Inspecting the packaging material may be necessary to support claims for hidden damage that may become apparent only during subsequent testing. Retain the packaging material for possible re-use.

Check the electrical performance of the instrument as soon as possible after installation. Performance checks are given later in this section, to verify that the instruments are operating within the specifications listed in Section 2.

1.1.5 Claims and Repackaging

If physical damage is evident or if the instruments do not meet specified operating requirements when received, notify the carrier and the nearest Hewlett-Packard Sales Office. Hewlett-Packard will arrange for immediate repair or replacement of the unit without waiting for claim settlement by the carrier.

If the defective unit is to be shipped to a Hewlett-Packard Sales Office, securely attach a tag showing the name and address of the owner, the instrument model and serial numbers, and the repair required (or symptoms of fault). If available and reusable, the original HP shipping container will provide proper protection to the unit in transit. If the original container is not reusable or repairable, the Hewlett-Packard Sales Office will provide information about proper packaging materials and methods.

1.1.6 Functional Description

The Hewlett-Packard HP M1403A Digital UHF Telemetry System consists of a pocket-sized transmitter with removable lead set, a modular receiver, and a mainframe that accommodates up to eight receiver channels.

System Functions. The HP M1403A provides ECG information, alarms, inoperative indications (INOPs) and status information for up to eight patients. Installed on a Serial Distribution Network (SDN), the HP M1403A functions like eight individual bedside monitors with patient data appearing either at an HP Central Monitor or at an HP 78508A Patient Information Center (PIC). A receiver mainframe with eight receiver modules is equivalent to eight patient bedside stations, and a maximum of 24 patient bedsides may reside on one SDN system. Displays, control functions (such as gain), recordings and alarms are controlled from the central station. Recordings also may be initiated from the transmitter. Extended system functions such as bedside overview, remote arrhythmia monitoring, remote data management, and remote clinical data access is provided by some central stations.

Operation. Using UHF radio waves, the transmitter sends two digitized ECG signals to a receiver module in the associated mainframe. These signals (ECG 1 and ECG 2) can either be passed on directly for display over the SDN, or can be used to derive other cardiac vectors (reconstructed leads).

The transmitter supports a three-electrode set for single lead operation, and a four- or five-electrode set for dual-lead operation. Both ECG leads have pace-pulse detection in the transmitter, which improves detection of pacemaker signals. Each channel has user-selectable bandwidth and gain setting to optimize display and cardiotach monitoring, and minimize false alarms.

When the system is monitoring two leads at the same time, either of these signals may be displayed and used for heart rate. When the four-wire cable is used with standard electrode placement, any two of the following leads can be selected for display or used for heart rate: Leads I, II, III, aVF, aVR or aVL.

Transmitter. Both the HP M1400A and HP M1400B transmitters are enclosed in a molded plastic case and can be powered by any standard nine-volt battery, subject to the life-expectancy limits listed in Table 1-3, Specifications, for different types of batteries.

The transmitters' button may be configured at installation to transmit a nurse-call request and/or generate a strip recording, or may be permanently disabled. The button functions can be disabled by the user with the button on-off key at the central station on a per-patient basis. Because no other controls are patient-accessible, the transmitter cannot be turned off inadvertently.

To eliminate the potential confusion of displaying incorrect patient data due to crosstalk or malfunction, each transmitter transmits a unique identity (ID) code. The transmitter button is used during installation to set up the transmitter ID code with a companion receiver.

The diference between the HP M1400A and HP M1400B is in output power only. The HP M1400A transmits at 2 milliwatts; the HP M1400B transmits at 4 milliwatts.

Receiver Mainframe. The HP M1401A Receiver Mainframe contains up to eight HP M1402A Receiver Modules, each of which is frequency-matched to the corresponding transmitter.

The mainframe provides indicators to identify hardware and software failures. It calculates the heart rate from ECG A for each receiver module, and transmits the result with the ECG wave information and any alarms, INOPs, and status information over the SDN.

In the event of an electrode INOP condition in multi-lead configurations, the receiver mainframe can be configured for fallback mode so it will switch automatically from the inoperative lead (normally ECG A) to a secondary lead (normally ECG B), if available. Under extended monitoring, with the four-electrode lead set, if both the ECG A and ECG B leads are inoperative, the cardiotach will switch to another lead, if available.

The mainframe also initiates a recording and/or nurse call alarm at the central station if the transmitter button is pressed. These functions are enabled or disabled during configuration.

A BNC connector on the mainframe is used to connect with the antenna system output. The BNC connector is connected to a network that distributes the combined RF signal to each receiver module.

Patient Monitor/Holter Recorder Interface (Analog Output) Option. The Patient Monitor/Holter Recorder Interface option (hereafter referred to as the Analog Output option) increases the capability of the HP M1403A by providing an analog version of ECG waveforms to bedside monitors and Holter recorders. The option also provides synthesized pace pulse waveforms, and a Leads Off INOP when leads-off, battery-dead, invalid data and system malfunctions are detected.

ST Segment Analysis and Two-Channel Delayed Recording Option. The ST Segment Analysis provides the capability to calculate ST segment depression or elevation simultaneously on two channels of ECG. The two measurements are updated every 15 seconds and are continuously displayed. In addition, the user can enable and disable individual ST channels, and is notified of INOP due to artifact.

With the Two-Channel Delayed Recording option, the user can initiate two-channel manual or automatic delayed recordings through a PIC—manually by pressing the nurse call button, or automatically by patient alarm. The recorder strip contains data beginning 10 seconds prior to the initiation and ending 5 seconds after the initiation, for a total run time of 15 seconds. Delayed recordings may be preempted by recordings of a higher priority and saved as superseded data. Delayed recordings can be cancelled entirely by pressing the STOP button on the recorder faceplate.

Antenna System. The Dynamic UHF Antenna System minimizes signal-to-noise degradation by using high-performance, active antenna/combiners with integrated amplifiers to ensure uniform performance throughout the covered area.

1.1.7 Ordering Information

HP M1403A System Options

Note: HP M1403A frequency options are listed in Tables 1-1 and 1-2.

The standard system is specified by HP M1403A and one option between A01 and A08. Each system consists of one or more transmitters with matched receiver modules and one mainframe with SDN system output. Order ECG cables separately.

A01	1 Channel System, includes 1 transmitter, 1 receiver module, and 1 mainframe.
A02	2 Channel System, includes 2 transmitters, 2 receiver modules, and 1 mainframe.
A03	3 Channel System, includes 3 transmitters, 3 receiver modules, and 1 mainframe.
A04	4 Channel System, includes 4 transmitters, 4 receiver modules, and 1 mainframe.
A05	5 Channel System, includes 5 transmitters, 5 receiver modules, and 1 mainframe.
A06	6 Channel System, includes 6 transmitters, 6 receiver modules, and 1 mainframe.
A07	7 Channel System, includes 7 transmitters, 7 receiver modules, and 1 mainframe.
A08	8 Channel System, includes 8 transmitters, 8 receiver modules, and 1 mainframe.

Separate Instrument Options

A10	Replacement transmitter
A11	Additional transmitter with receiver module, matched pair
A12	Additional receiver module
A13	Additional mainframe only, standard SDN output
C03	Receiver Mainframe with 40 Mhz CPC card

Output Options

C01	ST Segment Analysis/Two-Channel Delayed Recording
J01	Patient Monitor/Holter Recorder Interface

ECG Cable Options

K01	Disposable pouch accessory kit
K20	3-lead patient cable with snap connector (USA)
K21	3-lead patient cable with grabber connector (USA)
K22	4-lead patient cable with snap connector (USA)
K23	4-lead patient cable with grabber connector (USA)
K24	5-lead patient cable with snap connector (USA)
K25	5-lead patient cable with grabber connector (USA)
K30	3-lead patient cable with snap connector (IEC)
K31	3-lead patient cable with grabber connector (IEC)
K32	4-lead patient cable with snap connector (IEC)
K33	4-lead patient cable with grabber connector (IEC)
K34	5-lead patient cable with snap connector (IEC)
K35	5-lead patient cable with grabber connector (IEC)

HP M1440A Upgrade Kit Options

C01	ST Segment Analysis/Two-Channel Delayed Recording upgrade kit
C03	M1401A Receiver Mainframe upgrade kit
J01	Patient Monitor/Holter Recorder Interface upgrade kit

HP 78000AI Receiver Mainframe Mounting Hardware Options

R86	Flush Wall Mount
R90	Rack Mount

Patient Monitor/Holter Recorder Interface Cable Options

HP 78599AI Cable Installation Kits

K67	Analog output cable, non-plenum, 50 ft
K68	Analog output cable, non-plenum, 100 ft
K69	Analog output cable, non-plenum, 250 ft
K70	Analog output cable, non-plenum, 500 ft
K77	Analog output cable, plenum, 50 ft
K78	Analog output cable, plenum, 100 ft
K79	Analog output cable, plenum, 250 ft
K80	Analog output cable, plenum, 500 ft
K71	Bedside cable 3/4 lead, 8-pin
K72	Bedside cable 3/4 lead, 12-pin
K73	Bedside cable 5 lead, 8-pin
K74	Bedside cable 5 lead, 12-pin
K75	Bedside Attenuator
K76	Holter Attenuator
K81	Bedside/SDN Attenuator

Antenna System Options

HP M1406A	**Line Amplifier**
HP M1407A	**Multiple Unit Power Supply**
HP M1408A	**Active Antenna/Combiner**
HP M1409B	**Attenuator Box (0 dB)**
A02	2 dB Attenuator
A02	3 dB Attenuator
A04	4 dB Attenuator
A05	5 dB Attenuator
A06	6 dB Attenuator
A07	7 dB Attenuator
A08	8 dB Attenuator
HP M1410A	**75-Ohm Terminator with DC Block**

HP M1413B Standard Non-Plenum Antenna System Options

A02	2-Antenna String
A03	3-Antenna String
A04	4-Antenna String
A05	5-Antenna String
A06	6-Antenna String

HP M1414B Standard Plenum Antenna System Options

A02	2-Antenna String
A03	3-Antenna String
A04	4-Antenna String
A05	5-Antenna String
A06	6-Antenna String

HP 78000AI Antenna Mounting Hardware Options

R89	Antenna Wall Mount

HP M1415B Receiver Mainframe Combining Network Options

A11	Interfaces 1 antenna string to 1 receiver mainframe
A12	Interfaces 1 antenna string to 2 receiver mainframes
A14	Interfaces 1 antenna string to 3–4 receiver mainframes
A21	Interfaces 2 antenna strings to 1 receiver mainframe
A22	Interfaces 2 antenna strings to 2 receiver mainframes
A24	Interfaces 2 antenna strings to 3–4 receiver mainframes
A28	Interfaces 2 antenna strings to 5–8 receiver mainframes
A41	Interfaces 3–4 antenna strings to 1 receiver mainframe
A42	Interfaces 3–4 antenna strings to 2 receiver mainframes
A44	Interfaces 3–4 antenna strings to 3–4 receiver mainframes
A48	Interfaces 3–4 antenna strings to 5–8 receiver mainframes
A82	Interfaces 5–8 antenna strings to 1–2 receiver mainframes
A84	Interfaces 5–8 antenna strings to 3–4 receiver mainframes
A88	Interfaces 5–8 antenna strings to 5–8 receiver mainframes
J01	75-Ohm Terminator with DC Block
J02	DC Blocking Capacitor

HP M1403A Telemetry System Frequency Options

Order UHF telemetry channels starting at the beginning of a block of sequential channels, for example, (12) or (11 to 19). Proceed through consecutive channel numbers unless there is a specific reason not to do so. Avoid using Channels 1–10 because they are heavily used frequencies.

Note

Only the frequencies listed for each country have been approved, or are pending approval. However, transmitter HP M1400B—with 4 milliwatt output—is authorized for use in the USA only, regardless of frequency.

Channels legal in the United States of America, including service channels, are listed in Table 1-1. Channels 11 through 28 are used for U.S. Government institutions (Veterans Administration, US Army, US Navy, US Public Health Service, and others). These institutions do not require an FCC license, but U.S. Government use of these channels outside of the range of 11–28 requires Federal Communications Commission (FCC) approval.

Unassigned non-USA frequencies (Table 1-2) require local agency approval. For non-USA servicing, only use a locally approved channel.

Table 1-1. System Frequency Options (USA)

Option Number	Channel Frequency	Country of Use	Option Number	Channel Frequency	Country of Use
1	467.7750	USA	29	468.3125	USA
2	467.8250	USA	30	468.3625	USA
3	467.9000	USA	31	468.4375	USA
4	467.8500	USA	32	468.3875	USA
5	457.5500	USA	33	466.2125	USA
6	457.5750	USA	34	466.2625	USA
7	467.9250	USA	35	466.3375	USA
8	467.8000	USA	36	466.2875	USA
9	467.8750	USA	37	468.7625	USA
10	467.7500	USA	38	468.8125	USA
11	465.6875	USA	39	468.8875	USA
12	465.7375	USA	40	468.8375	USA
13	465.8375	USA	41	469.0875	USA
14	465.6625	USA	42	469.1375	USA
15	465.8625	USA	43	469.2125	USA
16	465.7875	USA	44	469.1625	USA
17	465.7125	USA	45	466.6625	USA
18	465.7625	USA	46	466.7125	USA
19	465.8125	USA	47	466.7875	USA
20	460.6875	USA	48	466.7375	USA
21	460.7375	USA	49	468.2875	USA
22	460.8375	USA	50	468.3375	USA
23	460.6625	USA	51	468.4125	USA
24	460.8625	USA	52	468.4625	USA
25	460.7875	USA	53	466.1875	USA
26	460.7125	USA	54	469.9625	USA
27	460.7625	USA	55	469.9375	USA
28	460.8125	USA	56	468.9125	USA

Table 1-1. System Frequency Options (USA) (continued)

Option Number	Channel Frequency	Country of Use	Option Number	Channel Frequency	Country of Use
57	468.7375	USA	99	466.9625	USA
58	469.2375	USA	100	467.0375	USA
59	469.0625	USA	101	467.1125	USA
60	466.8125	USA	102	468.2125	USA
61	466.6375	USA	103	468.4875	USA
62	466.0375	USA	104	467.1375	USA
63	466.0875	USA	105	467.0625	USA
64	468.7875	USA	106	468.2375	USA
65	468.8625	USA	107	467.1625	USA
66	469.1125	USA	108	467.0875	USA
67	469.1875	USA	109	468.2625	USA
68	466.6875	USA	110	468.5125	USA
69	466.7625	USA	111	468.5875	USA
70	469.3625	USA	112	468.6625	USA
71	469.4125	USA	113	468.5375	USA
72	469.6375	USA	114	468.6125	USA
73	466.0625	USA	115	468.6875	USA
74	464.9625	USA	116	468.5625	USA
75	466.1125	USA	117	468.6375	USA
76	469.3375	USA	118	468.7125	USA
77	469.2875	USA	119	468.9375	USA
78	469.3125	USA	120	469.0125	USA
79	469.8625	USA	121	469.2625	USA
80	466.1375	USA	122	468.9625	USA
81	466.3625	USA	123	469.0375	USA
82	466.4375	USA	124	469.4625	USA
83	466.5125	USA	125	469.5375	USA
84	466.3875	USA	126	468.9875	USA
85	466.4625	USA	127	469.4875	USA
86	466.5375	USA	128	469.5625	USA
87	466.4125	USA	129	469.5125	USA
88	466.4875	USA	130	469.8375	USA
89	466.5625	USA	131	461.8125	USA
90	466.8375	USA	132	461.8625	USA
91	466.9125	USA	133	461.8875	USA
92	466.5875	USA	134	462.0125	USA
93	466.9875	USA	135	461.0125	USA
94	466.8625	USA	136	461.0375	USA
95	466.6125	USA	137	461.0625	USA
96	466.9375	USA	138	461.0875	USA
97	467.0125	USA	139	461.1125	USA
98	466.8875	USA	140	461.1375	USA

Table 1-1. System Frequency Options (USA) (continued)

Option Number	Channel Frequency	Country of Use	Option Number	Channel Frequency	Country of Use
141	461.1625	USA	183	463.5625	USA
142	461.1875	USA	184	463.5875	USA
143	461.2125	USA	185	463.6125	USA
144	461.2375	USA	186	463.6375	USA
145	461.2625	USA	187	463.6625	USA
146	461.3875	USA	188	463.6875	USA
147	461.4125	USA	189	463.7125	USA
148	461.4375	USA	190	463.7375	USA
149	461.4625	USA	191	463.7625	USA
150	461.4875	USA	192	463.7875	USA
151	461.5125	USA	193	463.8125	USA
152	461.5375	USA	194	463.8375	USA
153	461.5625	USA	195	463.8625	USA
154	461.5875	USA	196	463.8875	USA
155	461.6125	USA	197	463.9125	USA
156	461.6375	USA	198	463.9375	USA
157	461.6625	USA	199	463.9625	USA
158	461.6875	USA	200	463.9875	USA
159	461.7125	USA	201	464.0125	USA
160	461.7375	USA	202	464.0375	USA
161	461.7625	USA	203	464.0625	USA
162	461.7875	USA	204	464.0875	USA
163	462.0375	USA	205	464.1125	USA
164	462.0625	USA	206	464.1375	USA
165	462.0875	USA	207	464.1625	USA
166	462.1125	USA	208	464.1875	USA
167	462.1375	USA	209	464.2125	USA
168	462.1625	USA	210	464.2375	USA
169	463.2125	USA	211	464.2625	USA
170	463.2375	USA	212	464.2875	USA
171	463.2625	USA	213	464.3125	USA
172	463.2875	USA	214	464.3375	USA
173	463.3125	USA	215	464.3625	USA
174	463.3375	USA	216	464.3875	USA
175	463.3625	USA	217	464.4125	USA
176	463.3875	USA	218	464.4375	USA
177	463.4125	USA	219	464.4625	USA
178	463.4375	USA	220	464.4875	USA
179	463.4625	USA	221	464.5125	USA
180	463.4875	USA	222	464.5375	USA
181	463.5125	USA	223	464.5625	USA
182	463.5375	USA	224	464.5875	USA

Table 1-1. System Frequency Options (USA) (continued)

Option Number	Channel Frequency	Country of Use
225	464.6125	USA
226	464.6375	USA
227	464.6625	USA
228	460.8875	USA
229	461.2875	USA
230	461.3125	USA
231	461.3625	USA
232	461.8375	USA
233	462.1875	USA
234	462.7875	USA
235	462.7625	USA
236	461.3375	USA
237	462.8125	USA
238	464.8125	USA
239	462.8625	USA
240	464.8625	USA
241	462.9125	USA
242	464.6875	USA
243	464.9125	USA
244	464.7375	USA
245	462.8375	USA
246	464.7875	USA
247	462.8875	USA
248	464.8375	USA
249	464.7125	USA
250	464.8875	USA
251	464.7625	USA
252	464.9375	USA
253	469.8125	USA
254	464.9875	USA
255	465.8875	USA
256	469.6875	USA
257	467.1875	USA
258	469.8875	USA
259	469.6125	USA
260	469.7375	USA
261	466.0125	USA
262	469.6625	USA
263	469.7875	USA
264	469.7125	USA
265	469.5875	USA
266	469.7625	USA
267	469.9125	USA
391	457.5250	Service
392	457.6000	Service
393	466.2375	Service
394	466.3125	Service
395	466.1625	Service
396	469.3875	Service
397	469.4375	Service

Table 1-2. System Frequency Options (Non-USA)

Option Number	Channel Frequency	Country of Use
1	467.7750	Spain - Taiwan - Italy
2	467.8250	Spain - Taiwan - Italy
3	467.9000	Spain - Taiwan - Italy
4	467.8500	Spain - Taiwan - Italy
5	457.5500	Spain - Taiwan - Italy
6	457.5750	Spain - Taiwan - Italy
7	467.9250	Spain - Taiwan - Italy
8	467.8000	Spain - Taiwan - Italy
9	467.8750	Spain - Taiwan - Italy
10	467.7500	Spain - Taiwan - Italy
11	465.6875	Spain - Taiwan - Italy
12	465.7375	Spain - Taiwan - Italy
13	465.8375	Spain - Taiwan - Italy
14	465.6625	Spain - Taiwan - Italy
15	465.8625	Spain - Taiwan - Italy
16	465.7875	Spain - Taiwan - Italy
17	465.7125	Spain - Taiwan - Italy
18	465.7625	Spain - Taiwan - Italy
19	465.8125	Spain - Taiwan - Italy
20	460.6875	Spain - Taiwan - Italy
21	460.7375	Spain - Taiwan - Italy
22	460.8375	Spain - Taiwan - Italy
23	460.6625	Spain - Taiwan - Italy
24	460.8625	Spain - Taiwan - Italy
25	460.7875	Spain - Taiwan - Italy
26	460.7125	Spain - Taiwan - Italy
27	460.7625	Spain - Taiwan - Italy
28	460.8125	Spain - Taiwan - Italy
29	468.3125	Spain - Taiwan - Italy
30	468.3625	Spain - Taiwan - Italy
31	468.4375	Spain - Taiwan - Italy
32	468.3875	Spain - Taiwan - Italy
33	466.2125	Spain - Taiwan - Italy
34	466.2625	Spain - Taiwan - Italy
35	466.3375	Spain - Taiwan - Italy
36	466.2875	Spain - Taiwan - Italy
37	468.7625	Spain - Taiwan - Italy
38	468.8125	Spain - Taiwan - Italy
39	468.8875	Spain - Taiwan - Italy
40	468.8375	Spain - Taiwan - Italy
41	469.0875	Spain - Taiwan - Italy
42	469.1375	Spain - Taiwan - Italy

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
43	469.2125	Spain - Taiwan - Italy
44	469.1625	Spain - Taiwan - Italy
45	466.6625	Spain - Taiwan - Italy
46	466.7125	Spain - Taiwan - Italy
47	466.7875	Spain - Taiwan - Italy
48	466.7375	Spain - Taiwan - Italy
49	468.2875	Spain - Taiwan - Italy
50	468.3375	Spain - Taiwan - Italy
51	468.4125	Spain - Taiwan - Italy
52	468.4625	Spain - Taiwan - Italy
53	466.1875	Spain - Taiwan - Italy
54	469.9625	Spain - Taiwan - Italy
55	469.9375	Spain - Taiwan - Italy
56	468.9125	Spain - Taiwan - Italy
57	468.7375	Spain - Taiwan - Italy
58	469.2375	Spain - Taiwan - Italy
59	469.0625	Spain - Taiwan - Italy
60	466.8125	Spain - Taiwan - Italy
61	466.6375	Spain - Taiwan - Italy
62	466.0375	Spain - Taiwan - Italy
63	466.0875	Spain - Taiwan - Italy
64	468.7875	Spain - Taiwan - Italy
65	468.8625	Spain - Taiwan - Italy
66	469.1125	Spain - Taiwan - Italy
67	469.1875	Spain - Taiwan - Italy
68	466.6875	Spain - Taiwan - Italy
69	466.7625	Spain - Taiwan - Italy
70	469.3625	Spain - Taiwan - Italy
71	469.4125	Spain - Taiwan - Italy
72	469.6375	Spain - Taiwan - Italy
73	466.0625	Spain - Taiwan - Italy
74	464.9625	Spain - Taiwan - Italy
75	466.1125	Spain - Taiwan - Italy
76	469.3375	Spain - Taiwan - Italy
77	469.2875	Spain - Taiwan - Italy
78	469.3125	Spain - Taiwan - Italy
79	469.8625	Spain - Taiwan - Italy
80	466.1375	Spain - Taiwan - Italy
81	466.3625	Spain - Taiwan - Italy
82	466.4375	Spain - Taiwan - Italy
83	466.5125	Spain - Taiwan - Italy
84	466.3875	Spain - Taiwan - Italy

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
85	466.4625	Spain - Taiwan - Italy
86	466.5375	Spain - Taiwan - Italy
87	466.4125	Spain - Taiwan - Italy
88	466.4875	Spain - Taiwan - Italy
89	466.5625	Spain - Taiwan - Italy
90	466.8375	Spain - Taiwan - Italy
91	466.9125	Spain - Taiwan - Italy
92	466.5875	Spain - Taiwan - Italy
93	466.9875	Spain - Taiwan - Italy
94	466.8625	Spain - Taiwan - Italy
95	466.6125	Spain - Taiwan - Italy
96	466.9375	Spain - Taiwan - Italy
97	467.0125	Spain - Taiwan - Italy
98	466.8875	Spain - Taiwan - Italy
99	466.9625	Spain - Taiwan - Italy
100	467.0375	Spain - Taiwan - Italy
101	467.1125	Spain - Taiwan - Italy
102	468.2125	Spain - Taiwan - Italy
103	468.4875	Spain - Taiwan - Italy
104	467.1375	Spain - Taiwan - Italy
105	467.0625	Spain - Taiwan - Italy
106	468.2375	Spain - Taiwan - Italy
107	467.1625	Spain - Taiwan - Italy
108	467.0875	Spain - Taiwan - Italy
109	468.2625	Spain - Taiwan - Italy - Qatar
110	468.5125	Spain - Taiwan - Italy - Qatar
111	468.5875	Spain - Taiwan - Italy - Qatar
112	468.6625	Spain - Taiwan - Italy - Qatar
113	468.5375	Spain - Taiwan - Italy
114	468.6125	Spain - Taiwan - Italy
115	468.6875	Spain - Taiwan - Italy
116	468.5625	Spain - Taiwan - Italy
117	468.6375	Spain - Taiwan - Italy
118	468.7125	Spain - Taiwan - Italy
119	468.9375	Spain - Taiwan - Italy
120	469.0125	Spain - Taiwan - Italy
121	469.2625	Spain - Taiwan - Italy
122	468.9625	Spain - Taiwan - Italy
123	469.0375	Spain - Taiwan - Italy
124	469.4625	Spain - Taiwan - Italy
125	469.5375	Spain - Taiwan - Italy
126	468.9875	Spain - Taiwan - Italy

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
127	469.4875	Spain - Taiwan - Italy
128	469.5625	Spain - Taiwan - Italy
129	469.5125	Spain - Taiwan - Italy
130	469.8375	Spain - Taiwan - Italy
131	461.8125	Spain - Taiwan - Italy
132	461.8625	Spain - Taiwan - Italy
133	461.8875	Spain - Taiwan - Italy
134	462.0125	Spain - Taiwan - Italy
135	461.0125	Spain - Taiwan - Italy
136	461.0375	Spain - Taiwan - Italy
137	461.0625	Spain - Taiwan - Italy
138	461.0875	Spain - Taiwan - Italy
139	461.1125	Spain - Taiwan - Italy
140	461.1375	Spain - Taiwan - Italy
141	461.1625	Spain - Taiwan - Italy
142	461.1875	Spain - Taiwan - Italy
143	461.2125	Spain - Taiwan - Italy
144	461.2375	Spain - Taiwan - Italy
145	461.2625	Spain - Taiwan - Italy
146	461.3875	Spain - Taiwan - Italy
147	461.4125	Spain - Taiwan - Italy
148	461.4375	Spain - Taiwan - Italy
149	461.4625	Spain - Taiwan - Italy
150	461.4875	Spain - Taiwan - Italy
151	461.5125	Spain - Taiwan - Italy
152	461.5375	Spain - Taiwan - Italy
153	461.5625	Spain - Taiwan - Italy
154	461.5875	Spain - Taiwan - Italy
155	461.6125	Spain - Taiwan - Italy
156	461.6375	Spain - Taiwan - Italy
157	461.6625	Spain - Taiwan - Italy
158	461.6875	Spain - Taiwan - Italy
159	461.7125	Spain - Taiwan - Italy
160	461.7375	Spain - Taiwan - Italy
161	461.7625	Spain - Taiwan - Italy
162	461.7875	Spain - Taiwan - Italy
163	462.0375	Spain - Taiwan - Italy
164	462.0625	Spain - Taiwan - Italy
165	462.0875	Spain - Taiwan - Italy
166	462.1125	Spain - Taiwan - Italy
167	462.1375	Spain - Taiwan - Italy
168	462.1625	Spain - Taiwan - Italy

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
169	463.2125	Spain - Taiwan - Italy
170	463.2375	Spain - Taiwan - Italy
171	463.2625	Spain - Taiwan - Italy
172	463.2875	Spain - Taiwan - Italy
173	463.3125	Spain - Taiwan - Italy
174	463.3375	Spain - Taiwan - Italy
175	463.3625	Spain - Taiwan - Italy
176	463.3875	Spain - Taiwan - Italy
177	463.4125	Spain - Taiwan - Italy
178	463.4375	Spain - Taiwan - Italy
179	463.4625	Spain - Taiwan - Italy
180	463.4875	Spain - Taiwan - Italy
181	463.5125	Spain - Taiwan - Italy
182	463.5375	Spain - Taiwan - Italy
183	463.5625	Spain - Taiwan - Italy
184	463.5875	Spain - Taiwan - Italy
185	463.6125	Spain - Taiwan - Italy
186	463.6375	Spain - Taiwan - Italy
187	463.6625	Spain - Taiwan - Italy
188	463.6875	Spain - Taiwan - Italy
189	463.7125	Spain - Taiwan - Italy
190	463.7375	Spain - Taiwan - Italy
191	463.7625	Spain - Taiwan - Italy
192	463.7875	Spain - Taiwan - Italy
193	463.8125	Spain - Taiwan - Italy
194	463.8375	Spain - Taiwan - Italy
195	463.8625	Spain - Taiwan - Italy
196	463.8875	Spain - Taiwan - Italy
197	463.9125	Spain - Taiwan - Italy
198	463.9375	Spain - Taiwan - Italy
199	463.9625	Spain - Taiwan - Italy
200	463.9875	Spain - Taiwan - Italy
201	464.0125	Spain - Taiwan - Italy
202	464.0375	Spain - Taiwan - Italy
203	464.0625	Spain - Taiwan - Italy
204	464.0875	Spain - Taiwan - Italy
205	464.1125	Spain - Taiwan - Italy
206	464.1375	Spain - Taiwan - Italy
207	464.1625	Spain - Taiwan - Italy
208	464.1875	Spain - Taiwan - Italy
209	464.2125	Spain - Taiwan - Italy
210	464.2375	Spain - Taiwan - Italy

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
211	464.2625	Spain - Taiwan - Italy
212	464.2875	Spain - Taiwan - Italy
213	464.3125	Spain - Taiwan - Italy
214	464.3375	Spain - Taiwan - Italy
215	464.3625	Spain - Taiwan - Italy
216	464.3875	Spain - Taiwan - Italy
217	464.4125	Spain - Taiwan - Italy
218	464.4375	Spain - Taiwan - Italy
219	464.4625	Spain - Taiwan - Italy
220	464.4875	Spain - Taiwan - Italy
221	464.5125	Spain - Taiwan - Italy
222	464.5375	Spain - Taiwan - Italy
223	464.5625	Spain - Taiwan - Italy
224	464.5875	Spain - Taiwan - Italy
225	464.6125	Spain - Taiwan - Italy
226	464.6375	Spain - Taiwan - Italy
227	464.6625	Spain - Taiwan - Italy
228	460.8875	Spain - Taiwan - Italy
229	461.2875	Spain - Taiwan - Italy
230	461.3125	Spain - Taiwan - Italy
231	461.3625	Spain - Taiwan - Italy
232	461.8375	Spain - Taiwan - Italy
233	462.1875	Spain - Taiwan - Italy
234	462.7875	Spain - Taiwan - Italy
235	462.7625	Spain - Taiwan - Italy
236	461.3375	Spain - Taiwan - Italy
237	462.8125	Spain - Taiwan - Italy
238	464.8125	Spain - Taiwan - Italy
239	462.8625	Spain - Taiwan - Italy
240	464.8625	Spain - Taiwan - Italy
241	462.9125	Spain - Taiwan - Italy
242	464.6875	Spain - Taiwan - Italy
243	464.9125	Spain - Taiwan - Italy
244	464.7375	Spain - Taiwan - Italy
245	462.8375	Spain - Taiwan - Italy
246	464.7875	Spain - Taiwan - Italy
247	462.8875	Spain - Taiwan - Italy
248	464.8375	Spain - Taiwan - Italy
249	464.7125	Spain - Taiwan - Italy
250	464.8875	Spain - Taiwan - Italy
251	464.7625	Spain - Taiwan - Italy
252	464.9375	Spain - Taiwan - Italy

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
253	469.8125	Spain - Taiwan - Italy
254	464.9875	Spain - Taiwan - Italy
255	465.8875	Spain - Taiwan - Italy
256	469.6875	Spain - Taiwan - Italy
257	467.1875	Spain - Taiwan - Italy
258	469.8875	Spain - Taiwan - Italy
259	469.6125	Spain - Taiwan - Italy
260	469.7375	Spain - Taiwan - Italy
261	466.0125	Spain - Taiwan - Italy
262	469.6625	Spain - Taiwan - Italy
263	469.7875	Spain - Taiwan - Italy
264	469.7125	Spain - Taiwan - Italy
265	469.5875	Spain - Taiwan - Italy
266	469.7625	Spain - Taiwan - Italy
267	469.9125	Spain - Taiwan - Italy
501	412.6250	Australia - Spain
502	412.6750	Australia - Spain
503	412.7250	Australia - Spain
504	412.7750	Australia - Spain
505	412.8250	Australia - Spain
506	412.7000	Australia - Spain
507	412.6500	Australia - Spain
508	412.7500	Australia - Spain
509	412.8000	Australia - Spain
510	469.5000	Australia - Italy - Spain
511	469.5250	Australia - Italy - Spain
512	469.5500	Australia - Italy - Spain
513	469.5750	Australia - Italy - Spain
514	469.6000	Australia - Italy - Spain
515	469.6250	Australia - Italy - Spain
516	469.6500	Australia - Italy - Spain
517	469.6750	Australia - Italy - Spain
518	469.7000	Australia - Italy - Spain
519	469.7250	Australia - Italy - Spain
520	412.6000	Australia - Spain
521	412.4750	Australia - Spain
522	412.5000	Australia - Spain
523	412.5250	Australia - Spain
524	412.5500	Australia - Spain
525	412.5750	Australia - Spain
526	412.8500	Australia - Spain
527	412.8750	Australia - Spain

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
528	412.9000	Australia - Spain
529	412.9250	Australia - Spain
530	412.9500	Australia - Spain
531	456.2100	Canada* - Germany - Turkey - Italy - Spain
532	456.2500	Canada* - Germany - Turkey - Italy - Spain
533	456.3300	Canada* - Germany - Turkey - Italy - Spain
534	466.2100	Canada* - Germany - Turkey - Italy - Spain
535	466.2500	Canada* - Germany - Turkey - Italy - Spain
536	466.3300	Canada* - Germany - Turkey - Italy - Spain
537	433.1000	Switzerland - Spain
538	434.7000	Switzerland - Spain
539	433.1250	Germany - Turkey
540	433.1500	Germany - Turkey
541	433.1750	Germany - Turkey
542	433.2000	Germany - Turkey
543	433.2250	Germany - Turkey
544	433.2500	Germany - Turkey
545	433.2750	Germany - Turkey
546	433.3000	Germany - Turkey
547	433.3250	Germany - Turkey
548	433.3500	Germany - Turkey
549	433.3750	Germany - Turkey
550	433.4000	Germany - Turkey
551	466.8125	Netherlands - Italy - Spain
552	466.8375	Netherlands - Italy - Spain
553	466.8625	Netherlands - Italy - Spain
554	466.8875	Netherlands - Italy - Spain
555	470.0250	Netherlands - New Zealand - Spain
556	470.0500	Netherlands - New Zealand - Spain
557	470.0750	Netherlands - New Zealand - Spain
558	470.1000	Netherlands - New Zealand - Spain
559	470.1250	Netherlands - New Zealand - Spain
560	470.1500	Netherlands - New Zealand - Spain
561	470.1750	Netherlands - New Zealand - Spain
562	470.2000	Netherlands - New Zealand - Spain
563	470.2250	New Zealand - Spain
564	470.2500	New Zealand - Spain
565	470.2750	New Zealand - Spain
566	470.3000	New Zealand - Spain
567	470.3250	New Zealand - Spain
568	470.3500	New Zealand - Spain
569	470.3750	New Zealand - Spain
570	470.4000	New Zealand - Spain

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
571	450.7650	Canada* - Netherlands - Italy - Spain
572	450.7900	Canada* - Netherlands - Italy - Spain
573	450.8150	Canada* - Netherlands - Italy - Spain
574	450.8400	Canada* - Netherlands - Italy - Spain
575	450.8650	Canada* - Netherlands - Italy - Spain
576	450.8900	Canada* - Netherlands - Italy - Spain
577	450.9300	Canada* - Italy - Spain
578	450.9700	Canada* - Italy - Spain
579	451.0100	Canada* - Italy - Spain
580	451.0500	Canada* - Italy - Spain
581	451.0900	Canada* - Netherlands - Italy - Spain
582	450.9150	Netherlands - Italy - Spain
583	450.9400	Netherlands - Italy - Spain
584	450.9650	Netherlands - Italy - Spain
585	451.0150	Netherlands - Italy - Spain
586	451.0400	Netherlands - Italy - Spain
587	451.0650	Netherlands - Italy - Spain
588	433.6750	Switzerland - Spain
589	433.7250	Switzerland - Spain
590	450.9900	Netherlands - Spain
591	433.4250	Germany - Turkey
592	433.4500	Germany - Turkey
593	433.4750	Germany - Turkey
594	433.5000	Germany - Turkey
595	433.5250	Germany - Turkey
596	433.5500	Germany - Turkey
597	433.5750	Germany - Turkey
598	433.6250	Germany - Turkey
599	433.6500	Germany - Turkey
600	433.7000	Germany - Turkey
601	448.0000	Denmark - Italy - Spain
602	448.0250	Denmark - Italy - Spain
603	448.0750	Denmark - Italy - Spain
604	448.1000	Denmark - Italy - Spain
605	448.2500	Denmark - Belgium - Luxembourg - Italy - Spain
606	448.2750	Denmark - Belgium - Luxembourg - Italy - Spain
607	448.0500	Denmark - Italy - Spain
608	448.1250	Denmark - Belgium - Luxembourg - Italy - Spain
609	448.1500	Denmark - Belgium - Luxembourg - Italy - Spain
610	448.1750	Denmark - Belgium - Luxembourg - Italy - Spain
611	448.2000	Denmark - Belgium - Luxembourg - Italy - Spain
612	448.2250	Denmark - Belgium - Luxembourg - Italy - Spain

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
621	446.0500	Italy - Spain
622	446.1000	Italy - Spain
623	446.3500	Italy - Spain
624	446.4000	Italy - Spain
625	446.5000	Italy - Spain
626	446.5500	Italy - Spain
627	446.8000	Italy - Spain
628	446.8500	Italy - Spain
629	446.0000	Italy - Spain
630	446.1500	Italy - Spain
631	446.2000	Italy - Spain
632	446.4500	Italy - Spain
633	446.6000	Italy - Spain
634	446.6500	Italy - Spain
635	446.9000	Italy - Spain
636	446.9500	Italy - Spain
637	446.2500	Italy - Spain
638	446.3000	Italy - Spain
639	446.7000	Italy - Spain
640	446.7500	Italy - Spain
641	406.8125	
642	406.8375	
643	406.8625	
644	406.8875	
645	407.1625	
646	407.1875	
647	407.4125	
648	407.4375	
649	407.5000	
650	407.5125	
651	407.5375	
652	407.5500	
653	407.5625	
654	407.5750	
655	407.5875	
656	407.6125	
657	407.7000	
658	407.7125	
659	407.8000	
660	407.8125	
661	407.8250	

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
662	407.8500	
663	407.8625	
664	407.9000	
665	407.9125	
666	407.9250	
667	407.9375	
668	407.9500	
669	407.9625	
670	407.9750	
671	433.7500	Germany - Turkey
672	433.7750	Germany - Turkey
673	433.8000	Germany - Turkey
674	433.8250	Germany - Turkey
675	433.8500	Germany - Turkey
676	433.8750	Germany - Turkey
677	433.9000	Germany - Turkey
678	433.9250	Germany - Turkey
679	433.9500	Germany - Turkey
680	433.9750	Germany - Turkey
681	434.0000	Germany - Turkey
682	434.0250	Germany - Turkey
683	434.0500	Germany - Turkey
684	434.0750	Germany - Turkey
685	434.1000	Germany - Turkey
686	434.1250	Germany - Turkey
687	434.1500	Germany - Turkey
688	434.1750	Germany - Turkey
689	434.2000	Germany - Turkey
690	434.2250	Germany - Turkey
691	434.2500	Germany - Turkey
692	434.2750	Germany - Turkey
693	434.3000	Germany - Turkey
694	434.3250	Germany - Turkey
695	434.3500	Germany - Turkey
696	434.3750	Germany - Turkey
697	434.4000	Germany - Turkey
698	434.4250	Germany - Turkey
699	434.4500	Germany - Turkey
700	434.4750	Germany - Turkey

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
701	458.5000	Canada* - UK - Ireland - Italy - Spain
702	458.5250	Canada* - UK - Ireland - Italy - Spain
703	458.5625	Canada* - UK - Italy - Spain
704	458.5875	Canada* - UK - Italy - Spain
705	458.7000	Canada* - UK - Ireland - Italy - Spain
706	458.7250	Canada* - UK - Ireland - Italy - Spain
707	458.7750	Canada* - UK - Ireland - Italy - Spain
708	458.8000	Canada* - UK - Ireland - Italy - Spain
709	458.6250	UK - Ireland - Italy - Spain
710	458.6500	UK - Ireland - Italy - Spain
711	458.6750	UK - Ireland - Italy - Spain
712	458.7500	UK - Ireland - Italy - Spain
713	458.9750	Italy - Spain
721	441.9750	Norway - Italy - Spain
722	441.9250	Norway - Italy - Spain
723	441.9850	Italy - Spain
724	441.9000	Norway - Italy - Spain
725	441.8750	Norway - Italy - Spain
726	441.9500	Norway - Italy - Spain
727	441.8000	Norway - Italy - Spain
728	441.8250	Norway - Italy - Spain
729	441.7500	Norway - Italy - Spain
730	441.7750	Norway - Italy - Spain
731	441.8500	Norway - Italy - Spain
732	434.5000	Germany - Turkey
733	434.5250	Germany - Turkey
734	434.5500	Germany - Turkey
735	434.5750	Germany - Turkey
736	434.6000	Germany - Turkey
737	434.6250	Germany - Turkey
738	434.6500	Germany - Turkey
739	434.6750	Germany - Turkey
740	434.7250	Germany - Turkey
741	468.5250	Finland - Italy - Spain
742	468.5750	Finland - Italy - Spain
743	468.6250	Finland - Italy - Spain
744	468.6500	Finland - Italy - Spain
745	468.6750	Finland - Italy - Spain
751	439.7500	Sweden - Italy - Spain
752	439.7750	Sweden - Italy - Spain
753	439.8000	Sweden - Italy - Spain

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
754	439.8250	Sweden - Italy - Spain
755	439.8500	Sweden - Italy - Spain
756	439.8750	Sweden - Italy - Spain
757	439.9500	Sweden - Italy - Spain
758	439.9750	Sweden - Italy - Spain
759	439.9000	Sweden - Italy - Spain
760	439.9250	Sweden - Italy - Spain
761	439.7000	Sweden - Italy - Spain
762	439.7250	Sweden - Italy - Spain
763	438.0500	Sweden - Italy - Spain
764	438.0750	Sweden - Italy - Spain
765	438.1000	Sweden - Italy - Spain
766	438.1500	Sweden - Italy - Spain
767	438.1750	Sweden - Italy - Spain
768	438.2000	Sweden - Italy - Spain
769	438.2250	Sweden - Italy - Spain
770	438.2500	Sweden - Italy - Spain
771	438.3000	Sweden - Italy - Spain
772	438.3250	Sweden - Italy - Spain
773	438.3500	Sweden - Italy - Spain
774	438.3750	Sweden - Italy - Spain
775	438.4000	Sweden - Italy - Spain
776	438.4250	Sweden - Italy - Spain
777	438.4500	Sweden - Italy - Spain
778	438.5000	Sweden - Italy - Spain
779	438.5250	Sweden - Italy - Spain
780	438.5500	Sweden - Italy - Spain
781	438.6000	Sweden - Italy - Spain
782	434.7500	Germany - Turkey
791	433.6000	Switzerland - Italy - Spain
801	449.7750	Canada* - Italy - Spain
802	449.8000	Canada* - Italy - Spain
803	449.8500	Canada* - Italy - Spain
804	449.8250	Italy - Spain
805	440.5250	Italy - Spain
806	440.5500	Italy - Spain
807	440.6250	Italy - Spain
808	440.7750	Italy - Spain
809	440.8250	Italy - Spain
810	445.0000	Italy - Spain

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
811	467.7750	Canada* - Belgium - Luxembourg - Italy - Spain
812	467.8250	Italy - Spain - Canada* - Belgium - Luxembourg
813	467.9000	Italy - Spain - Canada* - Belgium - Luxembourg
814	467.8500	Italy - Spain - Canada* - Belgium - Luxembourg
815	457.5500	Italy - Spain - Canada* - Belgium - Luxembourg
816	457.5750	Italy - Spain - Canada* - Belgium - Luxembourg
817	467.9250	Italy - Spain - Canada* - Belgium - Luxembourg
818	467.8000	Italy - Spain - Canada* - Belgium - Luxembourg
819	467.8750	Italy - Spain - Canada* - Belgium - Luxembourg
820	467.7500	Italy - Spain - Canada* - Belgium - Luxembourg
821	450.9500	Italy - Spain - Canada*
822	451.0300	Italy - Spain - Canada*
823	451.0700	Italy - Spain - Canada*
850	465.8375	Italy - Spain - Belgium - Luxembourg
851	465.8625	Italy - Spain - Belgium - Luxembourg
852	465.7875	Italy - Spain - Belgium - Luxembourg
853	465.7625	Italy - Spain - Belgium - Luxembourg
854	457.5250	Italy - Spain - Belgium - Luxembourg
855	457.6000	Italy - Spain - Belgium - Luxembourg
856	448.3000	Italy - Spain - Belgium - Luxembourg - Denmark
857	448.3250	Italy - Spain - Belgium - Luxembourg - Denmark
858	448.3500	Italy - Spain - Belgium - Luxembourg - Denmark
859	448.3750	Italy - Spain - Belgium - Luxembourg - Denmark
860	448.4000	Italy - Spain - Belgium - Luxembourg - Denmark
861	469.3750	Australia - Italy - Spain
862	469.4000	Australia - Italy - Spain
863	469.4250	Australia - Italy - Spain
864	469.4500	Australia - Italy - Spain
865	469.4750	Australia - Italy - Spain
866	469.7500	Australia - Italy - Spain
867	469.7750	Australia - Italy - Spain
868	469.8000	Australia - Italy - Spain
869	469.8250	Australia - Italy - Spain
870	469.8500	Australia - Italy - Spain
871	410.9500	Finland
872	410.9750	Finland
873	411.0000	Finland
874	411.0250	Finland
875	411.0500	Finland
876	411.0750	Finland
877	448.4250	Denmark
878	448.4500	Denmark

Table 1-2. System Frequency Options (Non-USA) (continued)

Option Number	Channel Frequency	Country of Use
879	448.4750	Denmark
880	448.5000	Denmark
881	458.5500	Ireland
882	458.5750	Ireland
883	458.6000	Ireland
884	458.8250	Ireland
885	458.8500	Ireland
886	458.8750	Ireland
887	458.9000	Ireland
888	458.9250	Ireland
889	458.9500	Ireland
890	472.0250	Australia
891	472.0500	Australia
892	472.0750	Australia
893	472.1000	Australia

Note

* Local frequencies are authorized by the provincial Department of Communication.

1.1.8 Accessories

Accessories supplied with the standard HP M1403A Digital UHF Telemetry System are listed below.

Description	HP Part Number
One for each HP M1400A/M1400B Transmitter:	
Battery, 8.4-volt Zinc air	1420-0340
Box of 12 Zinc air batteries	40455
Electrode set, disposable	14445A
Pouch, Transmitter	9300-0825
One for each HP M1401A Receiver Mainframe:	
Power Cord	8120-1992
One for each HP M1403A Digital UHF Telemetry System:	
Operating Guide for HP 78508A Patient Information Center	M1403-91903
Operating Guide for HP 78560A Central Monitor	M1403-91904
Operating Guide for HP 2300A Component Central Monitor	M2300-91901
Service Manual	M1403-90030
Service Quick Reference Guide	M1403-90029
Installation Note, Antenna system (included in Service Manual)	M1403-90032
Installation Note, Analog Output Option (included in Service Manual)	M1403-90031
Installation Note, ST Segment Analysis and Two-Channel Delayed Recording Option (included in Service Manual)	M1403-91891

1.1.9 Controls and Indicators

For information on using the controls to operate the telemetry system, refer to the Central Station Operating Guide.

In addition to malfunction and power LED indicators, INOP (inoperative) messages will be useful as indicators in setting up the telemetry system during installation. These messages, with a list of alarms, are described in "1.1.10 System INOPs and Alarms".

Transmitter Controls and Indicators:

The transmitter button can be configured for nurse call and/or recorder start; in addition, the button can be disabled. Transmitter status messages are presented as inoperative indications (INOPS), described in "1.1.10 System INOPs and Alarms".

Receiver Mainframe External Controls and Indicators:

The receiver mainframe has a power on/off switch on the front panel, and a line-voltage selector on the rear panel.

For each receiver mainframe, one malfunction LED on the outside of the case indicates a fatal error in the mainframe.

Central Station Control Displays:

Displayed at the central station are lead selection, size control, alarm limits, suspend alarm, bed on/off and ECG bandwidth controls.

1.1.10 System INOPs and Alarms

The HP M1403A displays three types of status messages designed to alert the user to actual or impending problems. The status messages may concern the system, portions of the system, or the patient. The three types of status messages are hard inoperative conditions (hard INOPs), soft inoperative conditions (soft INOPS), and alarm conditions.

Hard INOP messages warn the user that the ECG signal cannot be processed, and that the patient is therefore not being monitored.

Soft INOP messages warn the user of impending hardware problems, such as a weak transmitter battery.

Alarm messages warn the user of problems relating to the patient, such as a high heart rate.

All INOP status messages disappear automatically after the inoperative condition is remedied. No operator intervention at the central station is required.

The three types of status messages are prioritized so that the more serious problems will override others at the display. Hard INOPs have the highest priority, followed by alarms, and then soft INOPs.

The various status messages within the three categories are described below in their order of precedence.

Hard INOPs:

Since one INOP condition may generate more than one INOP indicator, the following INOPs are based on severity. Hard INOPs result in HR -?- on the central station display and a continuous gong sound. The baseline setting of the waves is represented by a flat line at the bottom of the SDN sector display, except for the Tel Cannot Analyze INOP.

No Receiver. This INOP indicates that no receiver module is plugged into a slot in the receiver mainframe. If the user enables a bed that is not supported by a receiver module, the mainframe generates this INOP at the central station. This INOP also indicates a non-functional receiver at cold start. See Receiver Malfunction.

Receiver Malfunction. This INOP indicates a hardware malfunction that requires corrective action from an HP customer engineer. The mainframe front panel LED will stay lit until the INOP is removed.

No Signal. This INOP indicates that a receiver module is not receiving a signal from the corresponding transmitter. The cause can be a transmitter out of range, a removed battery, or defective equipment.

Tel Cannot Analyze. This INOP indicates the radio frequency (RF) signal is too noisy for a heart-rate count. The condition can be caused by intermittent RF interference or a low signal level. The noisy signal INOP cycles on for at least 12 seconds; the cardiotach is disabled and causes HR -?- to appear on the central station display. This INOP also results in a flat ECG baseline on the display (mixed with intermittent sections of ECG waveform), which is unlike the usual hard INOP. It does cause the hard INOP continuous gong tone to sound, however.

Replace Battery. When the transmitter battery reaches a 6.6-volt level, the transmitter sends a replace battery signal to the receiver mainframe, which latches this INOP and sends it over the SDN until the battery is replaced. The transmitter will be inoperative after the replace battery signal is sent. If the battery is removed before the "replace battery" signal is sent, the "no signal" INOP will be displayed.

Interference. This hard INOP indicates that the receiver is no longer getting valid data from the transmitter. This INOP will occur if the receiver is experiencing interference from an RF source that is not another HP M1400A/M1400B Transmitter. Also, this INOP may occur if the transmitter is in a "no signal" state with a weak RF source present.

Invalid Signal E01. This INOP is used to indicate loss of monitoring due to interference from another HP M1400A/M1400B Transmitter at the same frequency. This INOP also is present before a new transmitter is identity-matched to the receiver module. The INOP will be reset when the crosstalk source is removed.

Leads Off. This INOP identifies the loss of one or both of the two ECG leads, depending on the lead set in use and the affected channel(s). The INOP sent over the SDN is LEADS OFF (xx), where xx is the lead label for the lead that is in INOP. If both transmitted leads are in INOP, then only the message LEADS OFF is sent.

Leads Off (Wave Label ECG A). This hard INOP reports the loss of ECG A, which runs the cardiotach. No heart rate or alarms will be available until this INOP is cleared, or until a fallback mode is established so ECG B appears (or another lead, in extended monitoring).

Alarms:

Although alarms are not used as indicators, they are listed here for completeness. Alarms have higher priority than soft INOPs. Alarms are latched during monitoring, so if an INOP occurs, the alarm text remains until the alarm has been reset. The existence of INOP text is indicated by an up-arrow preceding the alarm text.

If an alarm is preempted by an alarm or a higher priority INOP, the old alarm is cleared and will not be re-displayed after the new alarm is cleared, with the exception of nurse call.

The nurse call alarm will be preempted by another incoming alarm; upon clearing of the alarm condition, the nurse call message will be re-displayed. If an alarm condition exists and a nurse call is generated, the nurse call message will be displayed when the alarm condition is cleared, except for asystole and ventricular fibrillation (vfib) alarms.

Alarms are listed here and described in the Operating Guide and the installation checkout procedures:

Asystole
Ventricular Fibrillation (Vfib)
HR < Limit
HR > Limit
Nurse Call

Soft INOPs:

These INOPs have the lowest priority and result in a warning message on the display screen. Each soft INOP is removed automatically when the condition is corrected.

Leads Off (Wave Label ECG B). This soft INOP for ECG B does not affect the heart rate or alarms.

Weak Signal. This transmitter range warning clears automatically when the transmitter signal level increases.

Battery Weak. This INOP is sent from the transmitter when the battery reaches 7.0 volts, which signals that the transmitter battery is almost discharged (see "1.2.1 Specifications"). This INOP is reset automatically when the battery is changed.

1.1.11 Use with Other HP Products

The following Hewlett-Packard products are used with the HP M1403A Digital UHF Telemetry System:

The HP 78508A Patient Information Center (PIC), which must be used with a Serial Distribution Network (SDN) subsystem. Software revision 6.0 or greater is a prerequisite.

The HP 78560A Central Monitor. Software revision 8.0 or greater is a prerequisite. Arrhythmia capabilities are included with HP 78560A/AU Options G21 through G29, with arrhythmia software revision 7.0.

The HP M2300A Component Central Monitor. The M1403A works with the CCM as follows:

- If you have the earlier releases of the CCM software (before Release C), your CCM works with the standard configuration of the M1401A Receiver Mainframe.
- If you have Release C or higher of the CCM software, your CCM requires the M1401A to have been upgraded to include the 40 MHz CPC Card in place of the Turbo Processor. This upgrade is available in all new versions of the M1401A Receiver Mainframe ordered from the factory (and covered in this manual). You can also upgrade your exisiting mainframe to the 40 MHz CPC Card by ordering and installing the M1440A-#C03 Upgrade option. See your HP sales or service representative for details.

1.2 Specifications and Site Requirements

1.2.1 Specifications

Electrical and mechanical specifications of the telemetry system are listed in Table 1-3.

Table 1-3. Specifications

HP M1400A Transmitter	
RF Power Output	+3 dBm (2 milliwatts) nominal.
Carrier Frequency Range	406 to 512 MHz (exact frequency fixed by option).
Radio Channel Spacing	25 kHz
Modulation Type	Digital, frequency-shift keying.
Power	Zinc air battery supplied with transmitter (any standard-size 9-volt battery may be used). Multi-level battery condition indication at central station: Weak battery indication: Occurs at 7.0 V, nominal. Replace battery indication: Occurs at 6.6 V, nominal.
Battery Current	4.5 mA, nominal.
Battery Types and Typical Life Expectancy	Zinc air (supplied): 8 days Lithium: 5 days Mercury: 4.5[1] Alkaline: 3 days Carbon-zinc: 1.5 days
Weak Battery Warning Time	At least one hour.
Dimensions (H x W x D)	4.65 x 2.62 x 1.09 in (118 x 67 x 28 mm).
Weight	6.9 oz (195 g), with battery.
Case Material	High-impact ABS/polycarbonate and polypropylene.
Color	Parchment White.
Operating Temperature Range	32 to 113°F (0 to 45°C).
Storage Temperature	−40 to +158°F (−40 to +70°C).
Altitude	*Operating*, up to 15,000 ft (4,570 m); *Storage*, up to 50,000 ft (15,220 m).
Defibrillator Protection	Transmitter ECG input protected against 400 joules discharge into a 50-ohm load.
Shock Resistance	Withstands a 4 ft (1.2 m) drop to vinyl-covered concrete surface with only possible cosmetic damage.

1 Mercury batteries are not recommended: Hazardous waste disposal requirements.

Table 1-3. Specifications (continued)

HP M1400B Transmitter	
RF Power Output	+6 dBm (4 milliwatts) nominal.
Carrier Frequency Range	406 to 512 MHz (exact frequency fixed by option).
Radio Channel Spacing	25 kHz
Modulation Type	Digital, frequency-shift keying.
Power	Zinc air battery supplied with transmitter (any standard-size 9-volt battery may be used). Multi-level battery condition indication at central station: Weak battery indication: Occurs at 7.0 V, nominal. Replace battery indication: Occurs at 6.6 V, nominal.
Battery Current	6.0 mA, nominal.
Battery Types and Typical Life Expectancy	Zinc air (supplied): 7 days Lithium: 4 days Mercury: 3.5[1] Alkaline: 2.5 days Carbon-zinc: 1 day
Weak Battery Warning Time	At least one hour.
Dimensions (H x W x D)	4.65 x 2.62 x 1.09 in (118 x 67 x 28 mm).
Weight	6.9 oz (195 g), with battery.
Case Material	High-impact ABS/polycarbonate and polypropylene.
Color	Parchment White.
Operating Temperature Range	32 to 113°F (0 to 45°C).
Storage Temperature	−40 to +158°F (−40 to +70°C).
Altitude	*Operating*, up to 15,000 ft (4,570 m); *Storage*, up to 50,000 ft (15,220 m).
Defibrillator Protection	Transmitter ECG input protected against 400 joules discharge into a 50-ohm load.
Shock Resistance	Withstands a 4 ft (1.2 m) drop to vinyl-covered concrete surface with only possible cosmetic damage.

1 Mercury batteries are not recommended: Hazardous waste disposal requirements.

Table 1-3. Specifications (continued)

HP M1401A Receiver Mainframe	
Outputs	SDN system output standard. Analog output optional.
Input Voltage	100/120/220/230-240V ac selectable ±10%.
Frequency Range	47 to 63 Hz.
Power Consumption	100 VA maximum, 77 VA average; 85 W maximum; 61 W average with 8 receiver modules.
Dimensions (H x W x D)	5.75 x 16.73 x 17.28 in (146 x 425 x 439 mm).
Weight	45 lb (20.4 kg) with 8 receiver modules.
Operating Temperature Range	32 to 131°F (0 to 55°C).
Storage Temperature	−40 to +158° F (−40 to +70° C).
Altitude	*Operating*, up to 15,000 ft (4570 m); *Storage*, up to 50,000 ft (15 220 m).
Color	Parchment White.
Controls	Front Panel: Power ON/OFF; Rear Panel: Line voltage selector. Displayed at Central Station: Lead selection, size control, alarm limits, suspend alarm, bed on/off, ECG bandwidth and ST controls (with option).
Indicators	Power ON (indicator light and mechanical indicating lines on POWER button), Instrument Malfunction. Displayed at Central Station: *Hard INOP messages*: No Receiver, Receiver Malfunction, No Signal, Tel Cannot Analyze, Replace Battery, Invalid Signal E01, Interference, Leads Off, Leads Off (Wave Label ECG A). *Soft INOP messages*: Leads Off (Wave Label ECG B), Weak Signal, Battery Weak.
Connections (rear)	BNC Antenna connector. Downstream SDN connector. Upstream SDN connector. Power inlet (four selectable voltages). Ground lug.
Fan	Low-noise fan with filter (filter accessible from front).

Table 1-3. Specifications (continued)

Analog Output Option (J01)	
ECG Output Bandwidth	0.05 to 100 Hz (3 dB).
Input Voltage	100/120/220/230-240V ac ± 10%
Output Voltage	9 Vac nominal
Current Requirements	60 Ma
Frequency Range	47-63 Hz
Analog Output Gain (from output of receiver module)	High-level Outputs: 500 ±5%. Low-level Outputs: 1 + 7% / −6%.
Inoperative Mode (INOP) Condition	High-level Output: 10.8 ±1.2 volts.
Output Level	Low-level Output: > 100 megohms with respect to reference electrode.
Delay from Transmitter Input to Analog Output	40 milliseconds max. (Not intended for use with synchronized cardioversion due to processing delay.)
Indicators	Output Connector Box; Status and Power LEDs.
Connections	Output Connector Box: Input (50-pin jack and power module), Output (8 pairs of 9-pin D-connectors; Analog Output Card: Output (50-pin jack); Bedside Attenuator: Output (3-conductor phone jack); Holter Attenuator: Output (set of 5 button connectors).
Dimensions (H x W x D): Output Connector Box	 18.25 x 5.25 x 1.12 in (463 x 133 x 28 mm).
Weight:	24 oz (0.68 kg)

Table 1-3. Specifications (continued)

ST Segment Analysis and Two-Channel Delayed Recording Option (C01)	
ST Segment Analysis	
Leads	First and second channels selectable from I, II, III, aVR, aVF, and aVL with a 4-lead cableset, and from II and MCL with a 5-lead cableset.
Measurement Range	−9.9 mm to +9.9 mm miniumum.
ON/OFF	ST Segment is "ON" when "Diagnostic" or "ST" ECG Bandwidth is selected.
Limit Alarms	Range: −9.8 mm to +9.8 mm Adjustment: 0.2 mm Alarm Delay: Condition must produce alarm values for 1 minute before alarm occurs.
Resolution	Varies with ECG gain. x4 ± 0.1 mm (highest gain) x2 ± 0.1 mm (intermediate gain) x1 ± 0.1 mm (intermediate gain) x1/2 ± 0.2 mm (intermediate gain) x1/4 ± 0.4 mm (lowest gain)
INOP Alarm	Triggered if: Algorithm cannot generate valid value due to excessive variation between measured ST values; the algorithm recognizes an unacceptable number of ventricularly paced beats, for which it will not generate an ST value; the algorithm calculates a value ≥ 25 mm or ≤ −25 mm.
Measurement Points	Default Settings: Iso Point: R −80 ms J Point: R +48 ms ST Point: J +60 ms Adjustment Range (HP 78560A only): Iso Point: R −460 to R +460 ms J Point: R −460 to R +400 ms ST Point: J +60 or J +80 ms
ST Measurements	Median value updated every 15 seconds
Two-Channel Delayed Recording (included with option C01)	
Wave Processing	2 waves per bed.
Recordings at 78508A	Manual, by nurse call button Automatic, by patient alarm

Table 1-3. Specifications (continued)

Receiver Module HP M1402A	
Carrier Frequency Range	406 to 512 MHz (exact frequency fixed by option).
Impedance	50 ohms nominal.
Frequency Tuning	Crystal-controlled.
Channel RF Bandwidth Channel spacing	10 kHz. 25 kHz.
Image Rejection	−75dB
Built-in Test	Valid telemetry detected.
Operating Temperature Range	32 to 131°F (0 to 55°C).
Storage Temperature	−40 to +158°F (−40 to +70°C).
Altitude	*Operating*, up to 15,000 ft (4570 m); *Storage*, up to 50,000 ft (15,220 m).
ECG Channel Differential Input	 Defibrillator protected.
Input Impedance	Greater than 10 megohms (below 60 Hz).
Input Dynamic Range	±8 mV.
DC Offset Range	±400 mV
Common Mode Rejection Ratio	Greater than 80 dB (differential input).
Bandwidths (selectable) -3 dB nominal; -4 dB max	Monitoring: 0.5 to 40 Hz. Diagnostic: 0.05 to 100 Hz. Paced: 0.5 to 100 Hz. Exercise: 5.0 to 40 Hz.
Gain Accuracy	±5%, at 77°F (25°C).
ECG Amplification	Central-station selectable gain of 250, 500, 1000, 2000, 4000.
Noise at ECG Output	10 μV rms (40 μV peak-to-peak), referred to input, with each ECG lead connected to the same point through a 51 kilohm resistor in parallel with a .047 μF capacitor.
Calibration	1 mV pulse on central station recordings.
ECG Output	Compatible with Hewlett-Packard Serial Distribution Network (SDN) and Optional Analog Output.
Cardiotach Accuracy	±3 beats per minute, ±2% of heart rate for constant rate input. At fewer than 15 bpm, the heart rate indication is 0.
Alarm Range Adult	Central-station selectable, in 5 bpm increments. High: 20 - 250 bpm. Low: 15 - 245 bpm.
Alarm Accuracy	±1 bpm of displayed value.
Alarm Delay	4 seconds.
Displayed Cardiotach Update	1 second, nominal.
Display Range	15 - 300 bpm.

Table 1-3. Specifications (continued)

HP M1408A Active Antenna/Combiner	
Operating Voltage	19 - 32V dc.
Current Requirements	50 mA.
Average Power Consumption	Approximately 1.5 watts.
RF Gain at 465 MHz	Antenna: 9.7 dB typical. Line: 3.5 dB typical
Dimensions (H x W x D)	1.26 x 9.0 x 7.0 in (32 x 229 x 178 mm).
Weight	25 oz (0.78 kg).
HP M1406A Line Amplifier	
Operating Voltage	19 - 40V dc.
Current Requirements	50 mA.
Average Power Consumption	1.1 watts.
RF Gain at 465 MHz	12.5 dB typical.
Dimensions (H x W x D)	1.36 x 2.51 x 4.26 in (36 x 64 x 108 mm).
Weight	7.2 oz (0.20 kg).
HP M1407A Multiple Unit Power Supply	
Input Voltage: 0950-2038 USA Power Module: 0950-2079 VDE/IEC Power Module: 0950-3221 CE Mark Power Module:	 120V ac ±10%. 230V ac ±10%. 100-240V ac ±10%.
Frequency Range	47 - 63 Hz.
Power : 0950-2038 USA Power Module: 0950-2079 VDE/IEC Power Module: 0950-3221 CE Mark Power Module:	 36 VA maximum. 36 VA maximum. 33 VA maximum.
Output Voltage: 0950-2038 USA Power Module: 0950-2079 VDE/IEC Power Module: 0950-3221 CE Mark Power Module:	 23 V dc nominal at 1 A. 23 V dc nominal at 1 A. 24 V dc 0 to 1.4 A
Output Current 0950-2038 USA Power Module: 0950-2079 VDE/IEC Power Module: 0950-3221 CE Mark Power Module:	 1 ampere dc. 1 ampere dc. 1.4 ampere dc.
Dimensions (H x W x D): Power Tee 0950-2038 U.S.A. Power Module (with bracket) 0950-2079 VDE/IEC Power Module (with bracket) 0950-3221 CE Mark Power Module (with bracket)	 1.33 x 3.15 x 4.08 in (34 x 80 x 100 mm). 2.74 x 2.86 x 6.30 in (69.5 x 72.6 x 160 mm). 3.00 x 3.13 x 6.30 in (76.4 x 79.4 x 160 mm). 2.16 x 3.15 x 5.35 in (55.0 x 80.0 x 136 mm).

Table 1-3. Specifications (continued)

HP M1407A Multiple Unit Power Supply, Continued	
Weight:	
Power Tee	8.0 oz (0.22 kg).
0950-2038 U.S.A.Power Module (with bracket)	42 oz (1.18 kg).
0950-2079 VDE/IEC Power Module (with bracket)	44 oz (1.25 kg).
0950-3221 CE Mark Power Module (with bracket)	29.27 oz (0.83 kg)
HP M1409B Attenuator	
Voltage Rating	50 Vdc
DC Resistance	100 milliohms max
Characteristic Impedance	75 ohms
Insertion Loss	0.25 dB at 500 MHz with 0 dB equalizer and 0 dB pad
Port Connectors	Line Input—BNC; Line Output—BNC
Dimensions (H x W x D)	3.5 x 6.0 x 5.0 in (32 x 229 x 178 mm)
Weight	36 oz (0.78 kg)

System Safety Standards	
Safety Standards	UL 544. CSA C22.2 No. 125-M1984, Risk Class 3. TUEV Certification to IEC 601-1. BSI BS5724:part 1:1979.
Licensing Information	Contact your local HP Sales Office

1.2.2 Site Requirements

Environmental Considerations. The instruments should be used in an area reasonably free from vibration, dust, corrosive or explosive gases, and extremes of temperature and humidity. The instruments operate within specifications at ambient temperatures between 0 and 55 degrees Celsius for the receiver mainframe and 0 and 45 degrees Celsius for the transmitter. Temperatures exceeding these limits could affect instrument accuracy and cause damage.

Location Considerations. Place the receiver mainframe to allow room at the front and rear for servicing. For air circulation, allow eight inches clearance at the bottom and the fan intake (at the left side as you face the front), and two feet to the nearest overhead obstruction.

Power Requirements. If the central nursing station and one or more receiver mainframes are on an emergency power supply, be sure all antenna system HP M1407A Multiple Unit Power Supplies are connected to the hospital emergency power supply.

1.2.2.1 Antenna System Site Information

A site survey is required.

Site Information:	Floor plan(s) with dimensions; fire door and elevator locations are important construction details;
	Existing antenna network documentation.
	Coverage area: Present area and added areas;
	One network or several independent systems;
	Number of present and future channels.
	Frequencies: Current HP telemetry frequencies in hospital;
	Other radio frequencies currently used in hospital (paging systems, ambulances, walkie-talkies);
	Other HP telemetry systems in hospitals within one mile;
	Other Business Radio Service licenses at this site.
Receiver Mainframe Locations:	Emergency power available, number of outlets (including provision for multiple unit power supplies); Central station location
Antenna Mounting:	Flexible antennas to be added below or above ceiling; Other mounting considerations, such as whether wall mounts are needed; Ceiling obstructions lower than antennas (ductwork, for example)
Cabling:	Cable routing in air return spaces (air plenums); if cabling will be routed in cable trays, locate cable trays on floor plans.

Note

For conduit system expansion, explore all alternatives. For instance, plenum cabling may suffice, per National Electric Code. See paragraph 2 of *Antenna System Installation Note M1403-90032*, supplied following this chapter of the service manual. Local ordinances govern, in all cases.

1.3 System Configurations and Cabling

These configuration procedures supplement information in the HP 78581A (System) Communications Controller (SCC) Service Manual (78581-91909-0). In documenting the SDN system, the SCC service manual provides detailed information such as cable termination procedures and kit illustrations and descriptions. The following paragraphs apply only to the HP M1403A Digital UHF Telemetry System.

The procedures in this section cover HP M1401A Receiver Mainframe (mainframe) connection to an SDN system, and connection directly to an HP Central Monitor or an HP 78508A/S Patient Information Center (PIC). Wiring configurations for the Analog Output option are also included.

1.3.1 Serial Distribution Network (SDN) Connections

The HP M1401A Receiver Mainframe can be connected only to SDN Branches 25 to 29, which are dedicated to non patient-connected instruments (Figure 1-2). Up to three HP M1401A Receiver Mainframes may be serially connected (daisy-chained) to one branch, with a total cable length not to exceed 15.2 meters (50 feet) and a maximum number of beds not to exceed 24.

The telemetry system interconnection diagram (Figure 1-3) shows connections to the SCC via local distribution cables (LDC), which are provided in four standard lengths to fit most installations. One variable-length LDC is available for lengths up to 15.2 meters (50 feet).

Connections between HP M1401A Receiver Mainframes and the SCC can be direct (no faceplate), and SDC cable can be used. Without an SCC, LDC cable must be used.

Standard Length LDC:

The standard-length LDCs are supplied with a molded, color-coded connector at each end that mates with a color-coded receptacle on the wall box and on the HP M1401A Receiver Mainframe. Unique keying and the color-coded connectors ensure correct cable connections. The standard-length LDCs are listed below:

LDC Length	HP Part Number
0.9 meters (3 ft)	78599AI Option J03 (8120-3591)
1.8 meters (6 ft)	78599AI Option J06 (8120-3587)
3.0 meters (10 ft)	78599AI Option J10 (8120-3588)
6.1 meters (20 ft)	78599AI Option J20 (8120-3589)

The LDC connector colors are GRAY (downstream) and BROWN (upstream). The upstream cable direction is from the instrument(s) toward the wall box (SCC).

The downstream cable direction is from the wall box toward the instrument(s).

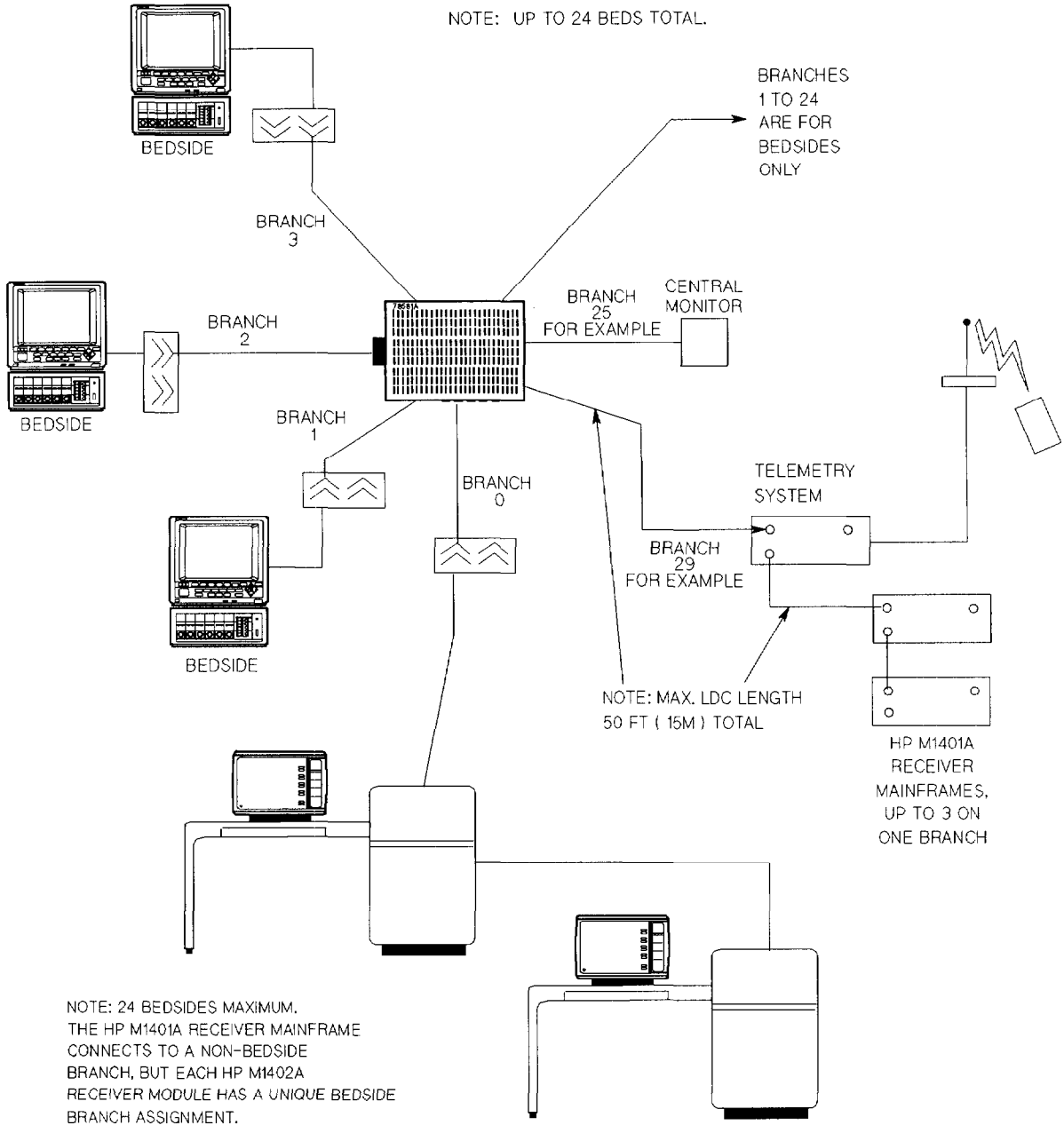
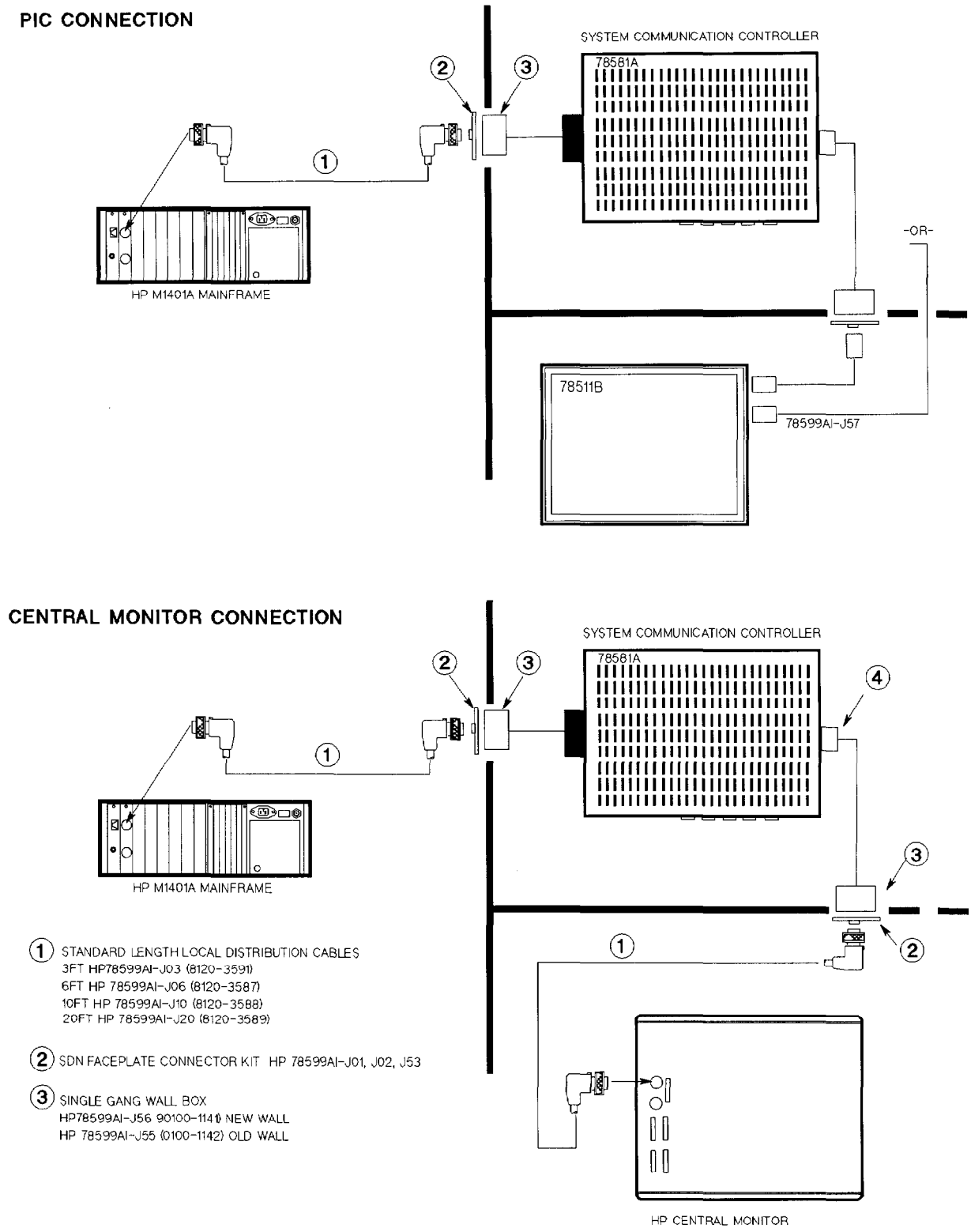
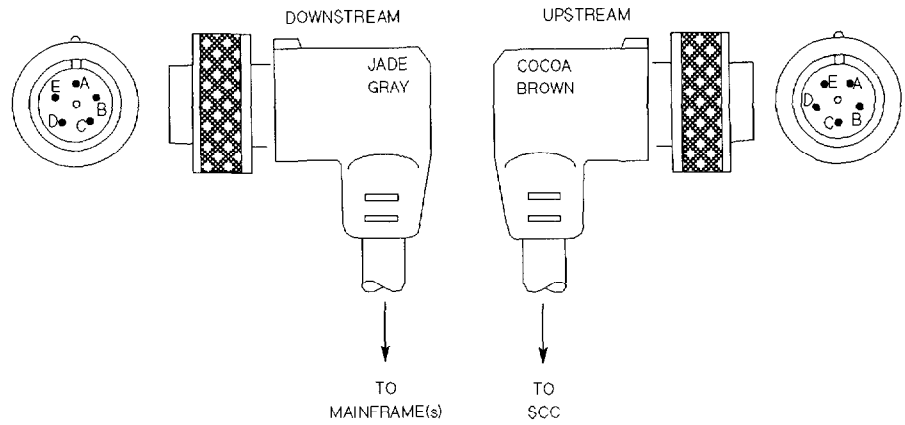


Figure 1-2. SDN Communication Diagram



NOTE: MAINFRAME MUST BE CONNECTED ONLY TO SDN BRANCHES 25 TO 29.
IF NO ARRHYTHMIA FUNCTION IS PRESENT, CENTRAL STATION MUST BE ON BRANCH 0 FOR TIME SOURCE.

Figure 1-3. HP M1401A Receiver Mainframe Connections to SDN System



STANDARD LENGTH LOCAL DISTRIBUTION CABLES (LDC)

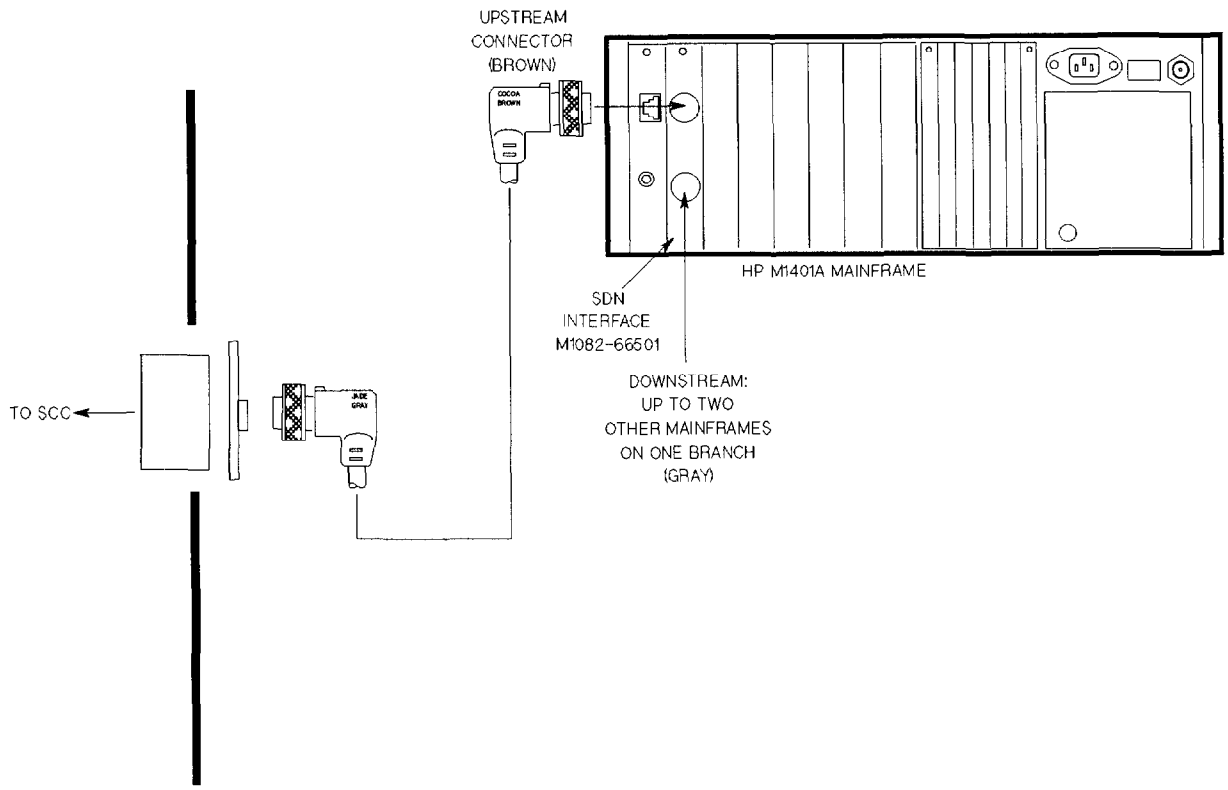


Figure 1-4. LDC Connections from Receiver Mainframe to Wall Box

The LDC connection from the mainframe is shown both to the SCC via a wall faceplate (Figure 1-4) and directly to a Central Monitor (Figure 1-7).

Variable-Length LDC:

The maximum total LDC length is not to exceed 50 feet (15.2 meters).

The variable-length LDC is available to meet the installation requirements not fulfilled by the standard-length LDCs. The variable-length LDC is terminated on one end and unterminated on the other. The unterminated end allows the cable to be cut to a desired length and terminated with the associated color-coded connector at the installation site. As listed below, loose LDC and up/downstream connectors are also available to fabricate LDCs as required:

Variable Length LDC	HP Part Number
15.2 meters (50 ft) Cable includes molded connector on one end and downstream connector to be installed on the other end.	HP 78599AI Option J50
15.2 meters (50 ft) Includes 15.2 meter (50 ft) length of unterminated LDC.	HP 78599AI Option J54
Connectors only Includes two SDN connectors — upstream and downstream.	HP 78599AI Option J52

Instructions for installing a loose SDN connector onto the unterminated end of the LDC are provided in the *Terminating Variable Length LDC* section of SCC Service Manual 78581-91909-0.

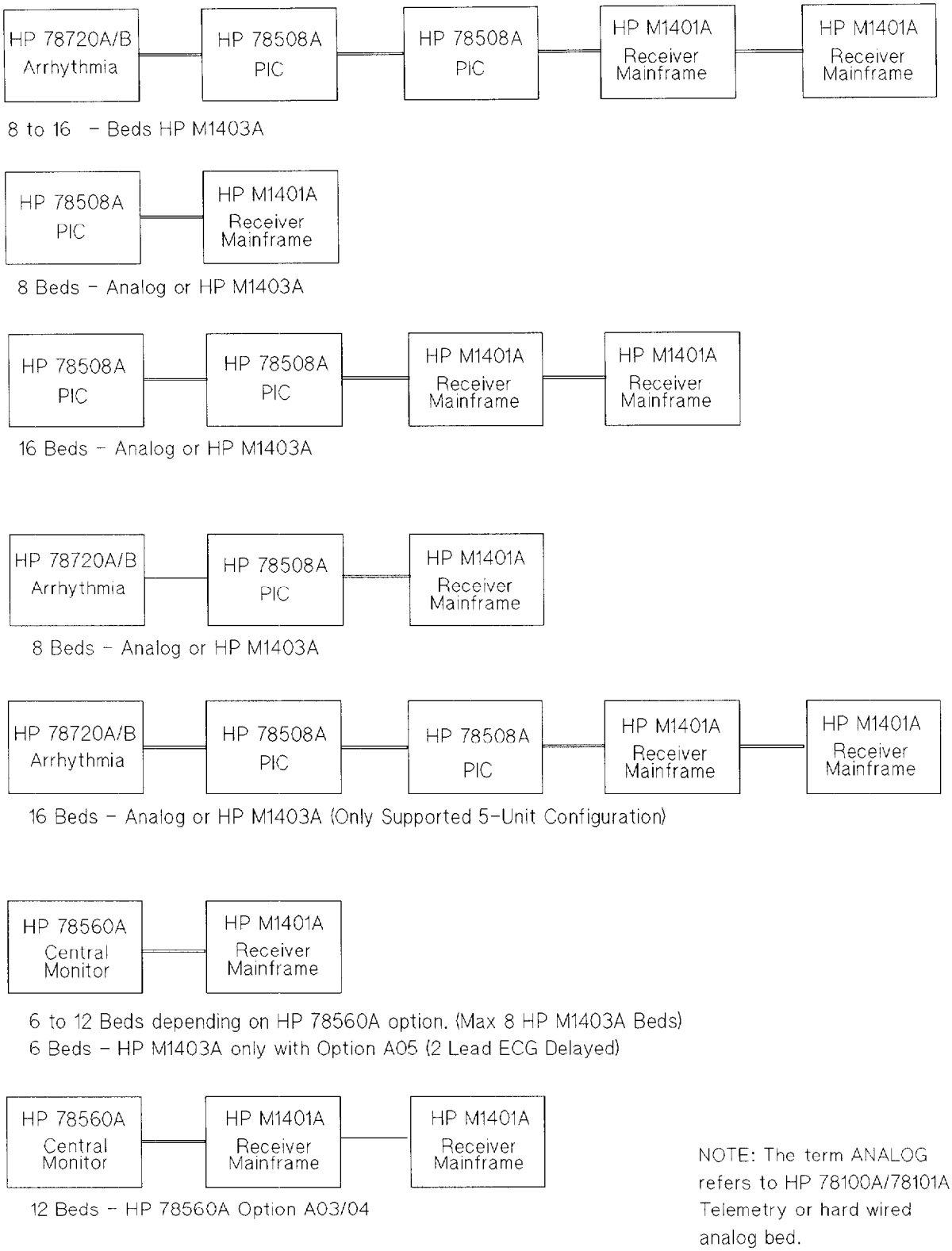


Figure 1-5. Combinations without an SCC

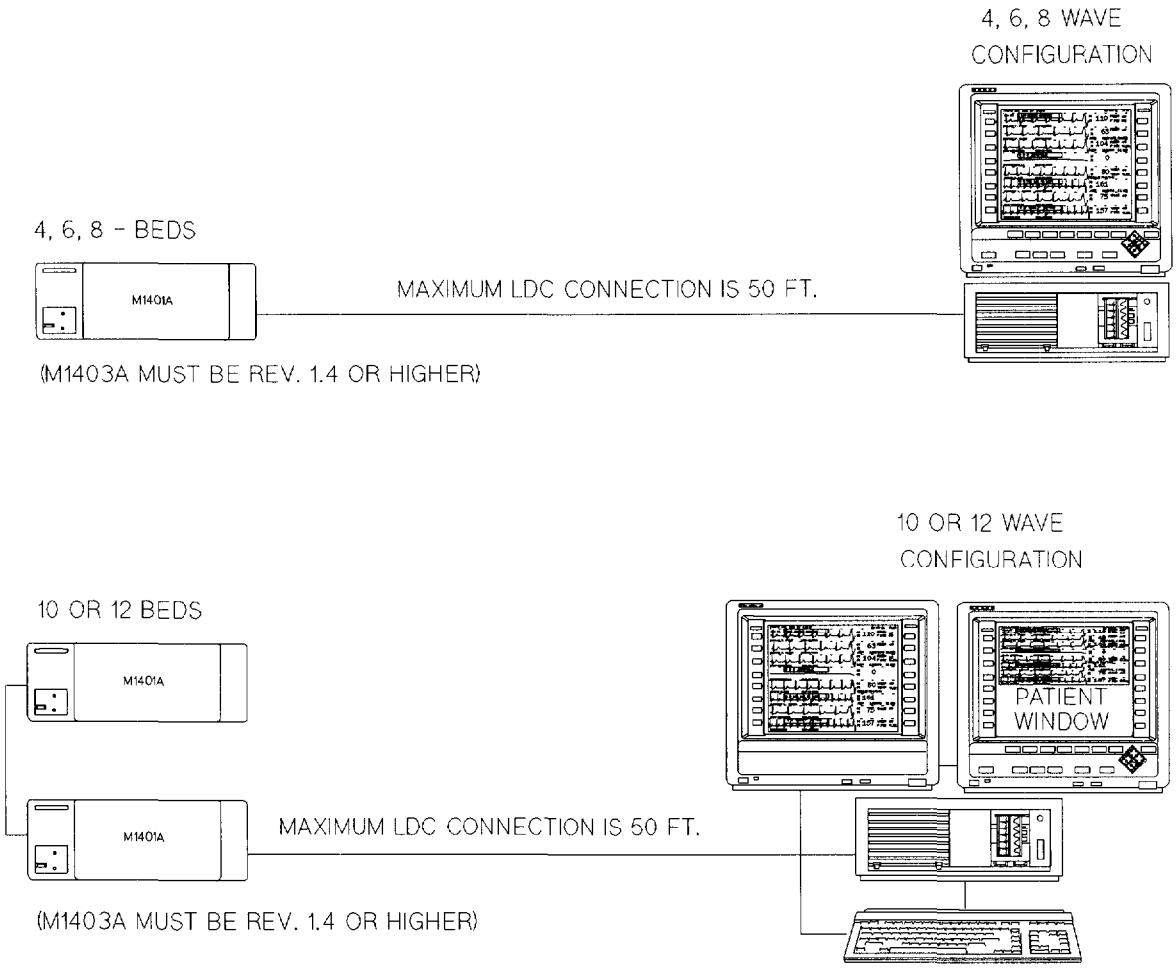


Figure 1-6. CCM Combinations without an SCC

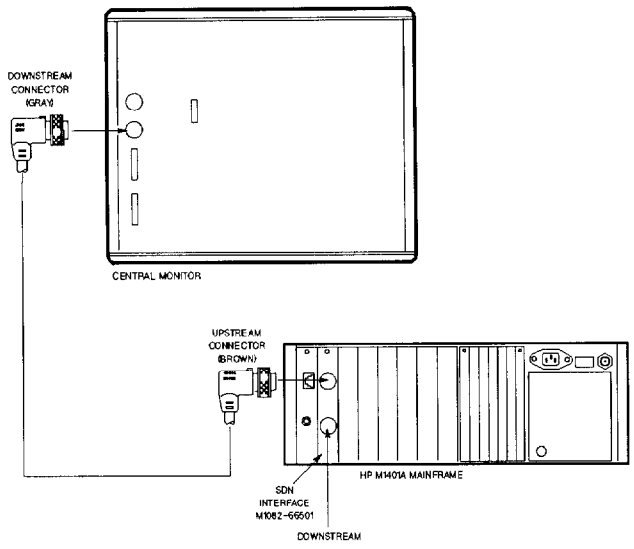


Figure 1-7. Direct Connection to an HP Central Monitor

1.3.2 Analog Output Option Wiring Configurations

Figure 1-8 shows two possible wiring configurations for users with the Analog Output option. The wiring configurations are identified as Configuration A, and Configuration B.

Configuration A connects analog output to bedside monitors and Holter recorders and routes the digital ECG over the SDN to SCC branches 25-29, or directly to a central station. When using this configuration, lead changes, hardware fallback, and extended monitoring can all be invoked at the central station, and the nurse call button will function.

Configuration B connects analog output to bedside monitors and Holter recorders, and routes the digital version from the bedside monitor to SCC branches 1-24 over the SDN. When using this configuration, lead changes are accomplished at the bedside and all hard INOP conditions will appear as LEADS OFF INOPs at bedside. The nurse call button does not function.

When using either of these configurations, users should be aware that since the central station is receiving a digital ECG and the bedside monitor is receiving the analog version, displays may appear different.

1.3.3 Non-SCC Configurations

The instruments represented in Figure 1-5 may be connected together without a System Communications Controller. Two examples are shown in the following paragraphs.

1.3.3.1 Direct Connection to an HP Central Monitor

A telemetry-only system may not require an SCC. One or two daisy-chained mainframes can be connected directly to one HP 78560A Central Monitor (Figure 1-7), or to an M2300A Component Central Monitor with two displays. Depending on the configuration, up to 12 bedsides can be connected.

Note

- For the CCM, the maximum LDC connection is 50 feet.
- For the CCM, the 10 or 12 bed configuration has different HP-HIL cable hookups. See the *Installing the Compoinents* section of this chapter>

The upstream connector of the most-upstream mainframe is connected by a local distribution cable (LDC) to the downstream connector of the Central Monitor by any of the four standard-length LDCs listed previously.

M1403A option C03 is not compatible with HP 78560A or 78508A.

1.3.3.2 Direct Connection to an HP 78508A PIC

One or two HP M1401A Receiver Mainframes can be connected directly to the HP 78511B Equipment Cabinet (Figure 1-9). The equipment cabinet can be connected to one other equipment cabinet, in this configuration. Inside the cabinet, an **HP 78599AI Option K11** cable attaches to the DOWNSTREAM connector on SDN Interface Board 78511-60480. The cable must be terminated using an AMP tool (HP 8710-1303) and connector kit HP 1251-7925 (Molex connector).

M1403A option C03 is not compatible with HP 78560A or 78508A.

Refer to "1.3.4 Pistol-grip Termination Tool" for a description of the termination tool.

Equipment Cabinet Preparation:

Withdraw Equipment Cabinet HP 78511B if it is mounted on slides, if necessary. Remove the top cover (Figure 1-9) by loosening the screw at top center of the rear panel and sliding the cover off toward the rear.

a. If the required **HP 78599AI Option K11** LDC cable is not available, a cable that is terminated at both ends may be used. Remove the GRAY (downstream) connector from the cable at the measured length plus the same service loop allowance used for other cables in the installation. Add two feet (61 cm) to permit exact trimming inside the cabinet.

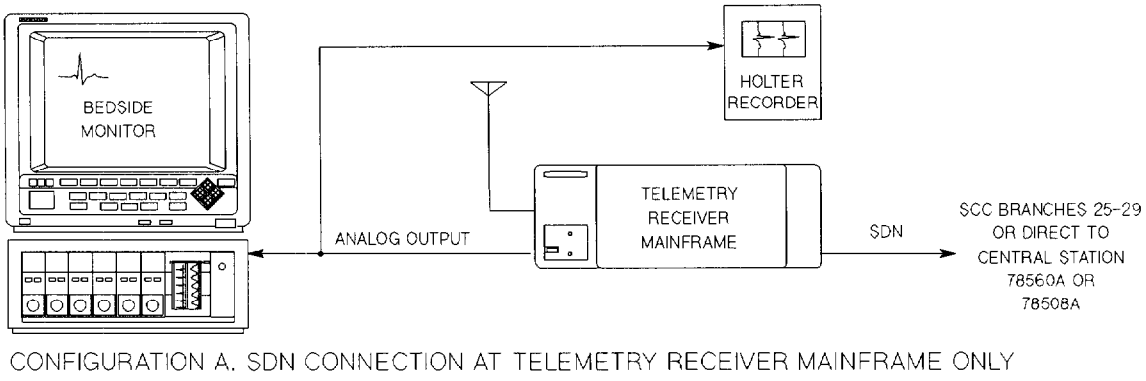


Figure 1-8. Analog Output Wiring Configurations

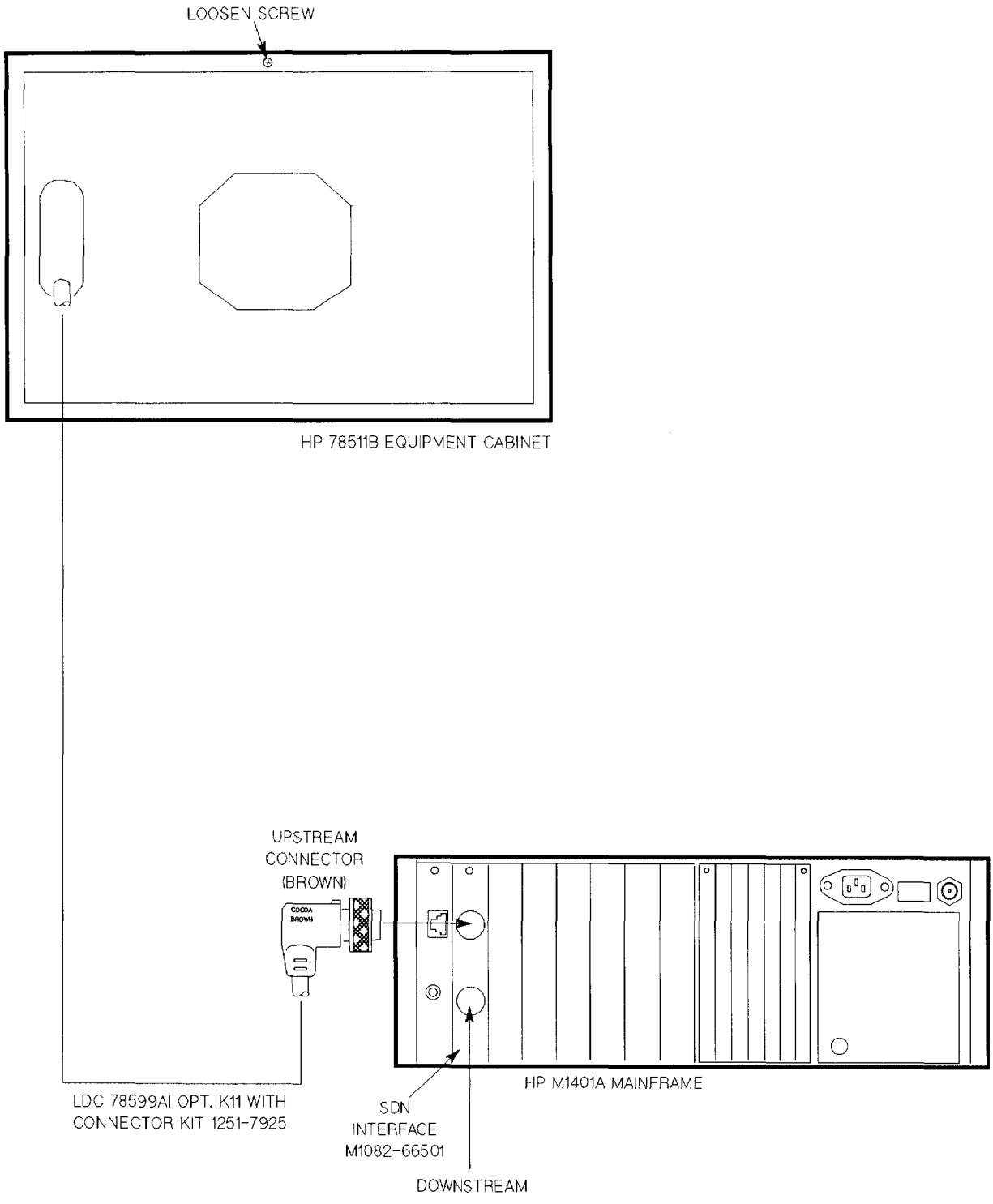


Figure 1-9. Direct Connection to HP 78508A Patient Information System

b. Remove the cable clamp plates from the least-full pair of cable clamp studs in the HP 78511B Equipment Cabinet (Figure 1-10).

c. Position the end of the cable over the SDN board, and cut it off 6 inches (16 cm) beyond the DOWNSTREAM connector.

d. At the cable clamp location, dress the cable into the clamp plate and mark the cable jacket 1.5 inches (2.5 cm) either side of the clamp (3 inches, or 7.6 cm total) to define the area in which the shield braid will be exposed.

e. Remove the cable from the cable entry.

f. Refer to Figure 1-11 and, without cutting into the shield, remove 3 inches (7.6 cm) of plastic jacketing to expose the shield braid where marked. Slide on and heat shrink two 2-inch (5 cm) pieces of shrink tubing over the cut ends of the cable jacket, over the edge of the exposed braid.

Cable End Preparation:

a. Strip off 2 inches (5 cm) of insulation from the end of the cable.

b. Unravel and push back the braided shield over the cable insulation and trim off the excess shield wire to a 1/2-inch (13 mm) cuff. Be careful to separate the drain wires from the shield.

c. Remove the filler material and foil strips.

d. Twist together the two drain wires and trim. Solder a green jumper wire (8150-0452) to the twisted drain wires close to the cuff of shield wire mesh (Figure 1-11).

e. Slide a 3-inch piece of heat-shrink tubing over the cuff.

f. Connect the five wires of the LDC cable to the loose Molex connector described in the following paragraph.

Cable Termination:

At the unterminated end of the SDN cable, apply connector kit HP 1251-7925 with AMP Mass Termination Assemblies (MTA) **pistol-grip insertion tool** HP 8710-1303 (Figure 1-12).

Note The wire size is AWG 22 (stranded), so select stuffer setting 3 on the tool (Figure 1-13).

a. Insert the connector into the left side of the tool head, as shown in Figure 1-13.

Caution The tool may be damaged if the connector is pushed into the tool from the right side.

b. Choose the contact to be terminated and align it with the stuffer. Be sure the index pawl rests between the connector index ribs.

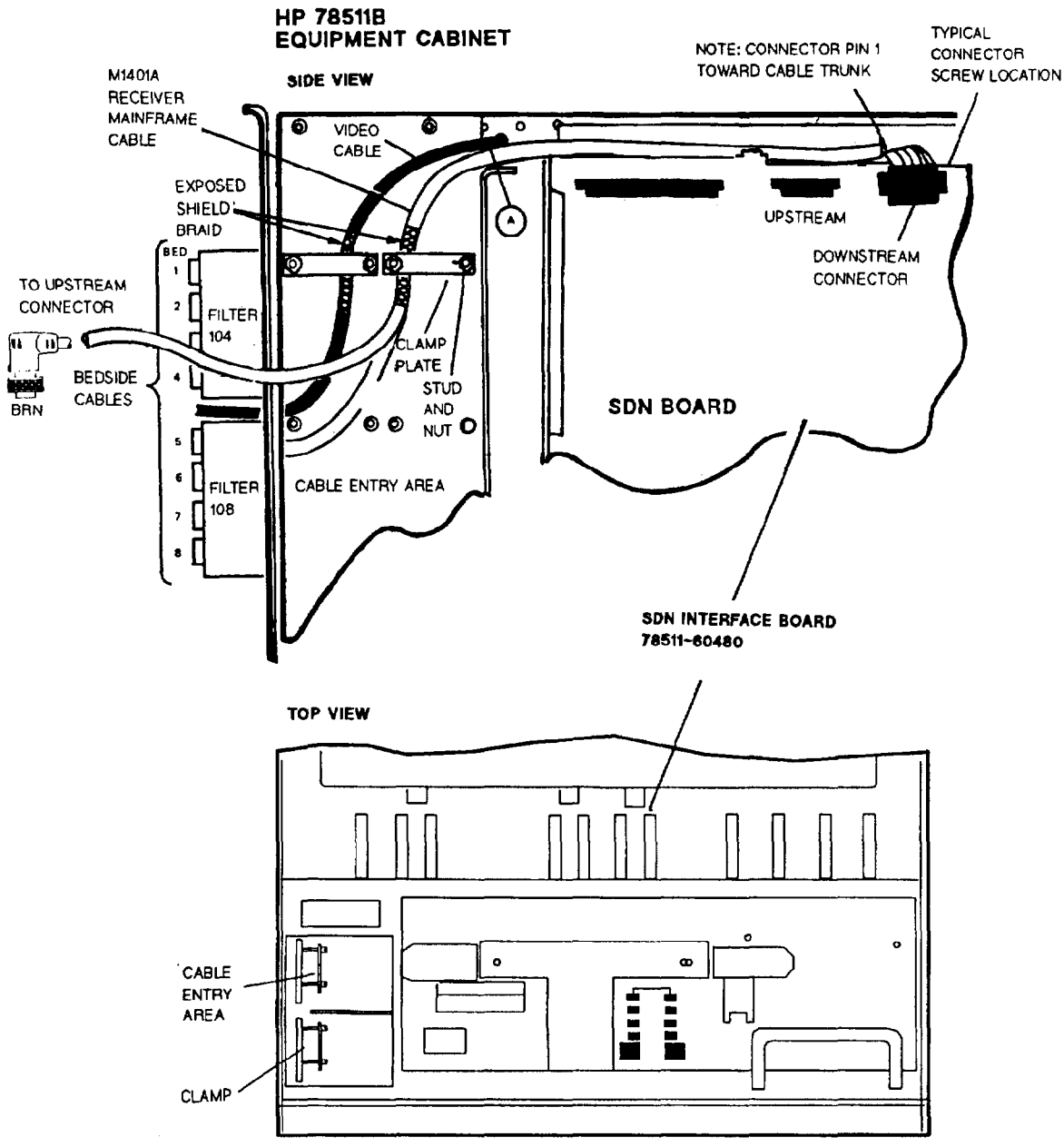
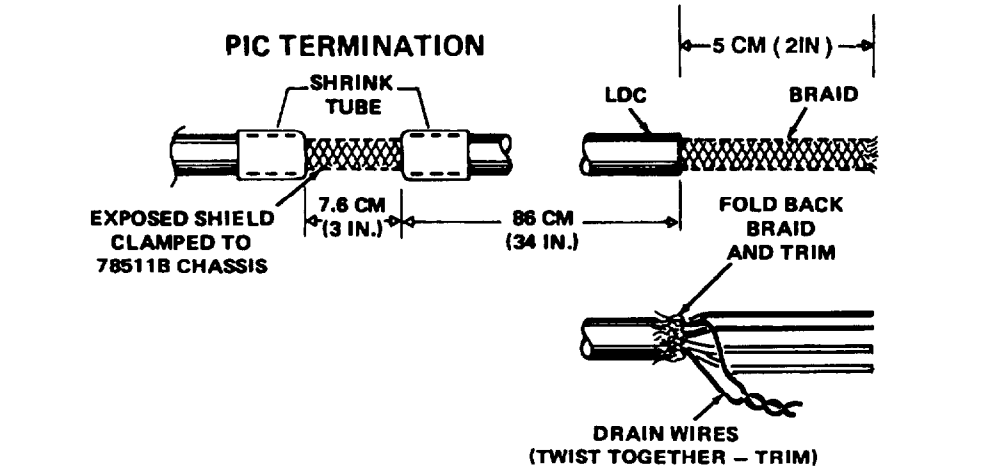


Figure 1-10. HP 78511B Equipment Cabinet Cable Installation



SIGNAL	DOWNSTREAM CONNECTOR	
	WIRE COLOR	PIN #
DATA (+)	PINK	1
DATA (–)	BLUE	2
GROUND	GREEN	3
N.C. – KEY		4
PRIORITY (+)	GRAY	5
PRIORITY (–)	BLACK	6

Figure 1-11. Termination Procedures at PIC

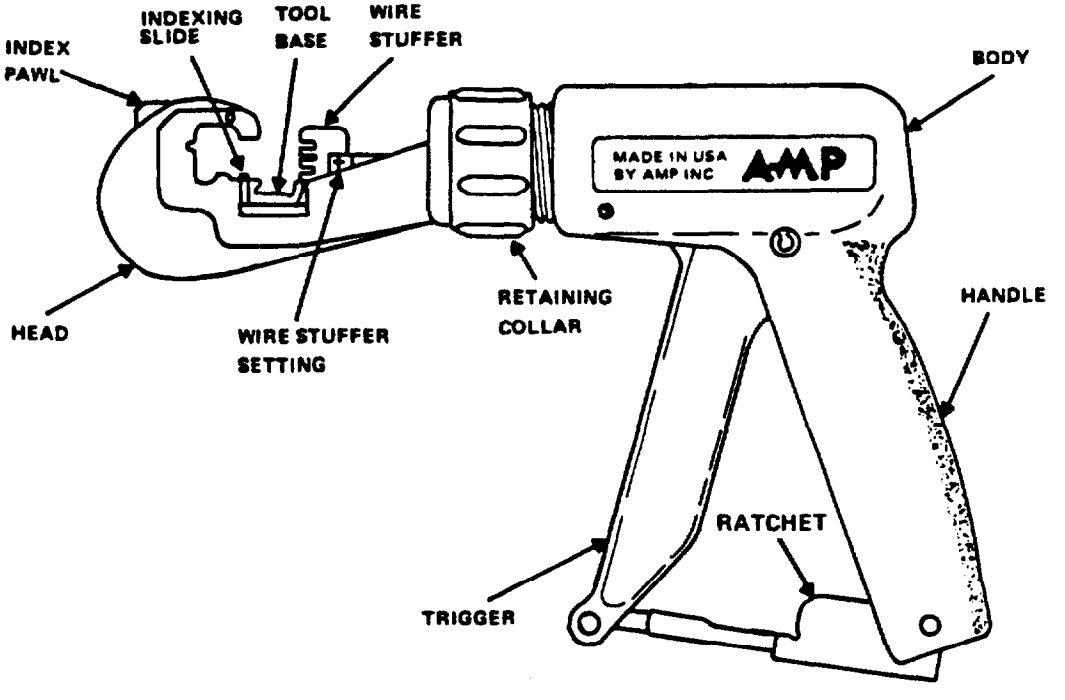
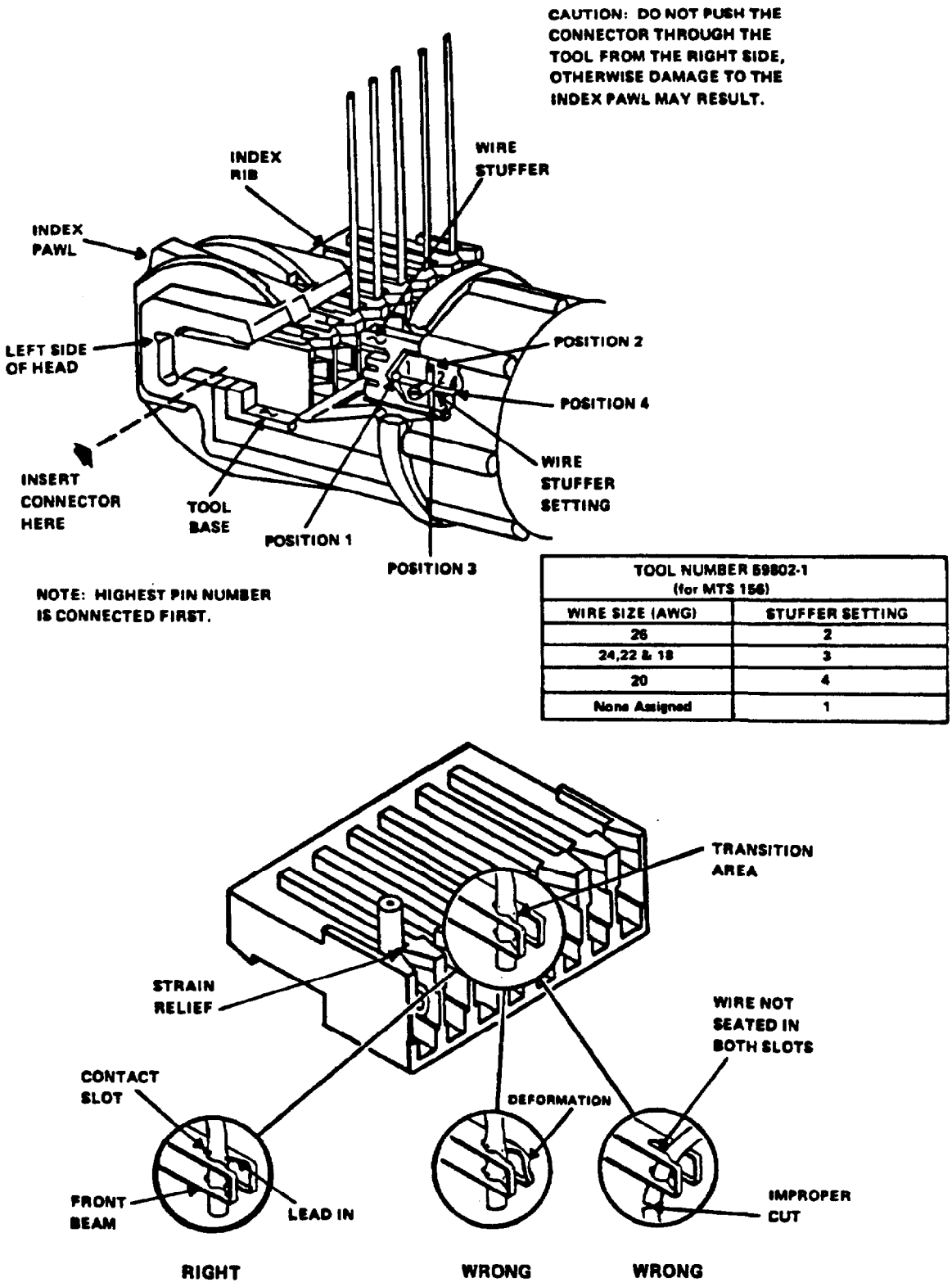


Figure 1-12. MTA Pistol Grip Tool (8710-1303)



TOOL NUMBER 59802-1 (for MTS 156)	
WIRE SIZE (AWG)	STUFFER SETTING
26	2
24,22 & 18	3
20	4
None Assigned	1

Figure 1-13. MTA Pistol Grip Tool Termination Procedure and Contact Inspection

c. Insert an unstripped wire between the connector contact and the wire stuffer until it bottoms on the tool base.

d. Center the wire in the slot of the contact and squeeze the tool trigger. (Note that the ratchet will not release until the trigger is bottomed).

e. Release the trigger. The index slide will automatically advance the connector to the next position.

f. Repeat Steps b through e until all contacts have been terminated.

Note

The connector can be pulled out of the right side of the tool head, or it can be automatically indexed out by squeezing the trigger. Also, when the last termination is made, a new connector can be inserted and the automatic indexer will pick it up and force the terminated connector out of the tool.

---

g. Inspect **each termination** using the following standards (Figure 1-13):

1. Make sure the conductor is below the transition of the lead-in and contact slot.
2. Make sure the insulation is 0.080 to 0.100 inch beyond the front contact beam.
3. Make sure the wire is not bottomed in the contact slot.
4. Make sure the contact beams are not deformed. If damage is apparent, replace the contact(s) in accordance with the instruction sheet packaged with the connector, or according to the AMP, Inc. manual.
5. Make sure the insulation of the wire is not nicked or cut in any area other than the two wire slots.
6. Make sure the wire extends below the strain relief features of the connector.

h. Install key 1251-5709 into contact hole 4 of the connector as shown in Figure 1-11.

i. Shrink the tubing and fasten tie wrap 1400-0401 onto the wire cluster close to the connector to provide strain relief.

Securing the Cable:

a. After the connector is applied to the cable, attach the cable to the downstream connector (J4) on SDN board 78511-60480 and tighten the cable clamp hold-down screws (Figure 1-10).

b. Route the cable through the cable clamp studs, and clamp it into the cable bracket with the clamp plate and nuts previously removed.

c. Reinstall the cover(s) onto the equipment cabinet and return it to the proper position.

This concludes the SDN cable installation procedures.

1.3.4 Pistol-grip Termination Tool

Tool 8710-1303 (Figure 1-12) terminates wires in connectors of the AMP Mass Termination Assemblies (MTA), using the AMP displacement terminating technique. This method is used to insert unstripped wire into a slotted contact beam to form a reliable electrical connection between the conductor and contact. Tool 8710-1303 (AMP 59802-1) is designed for connectors with 0.156 contact centers (MTA-156 system).

Tool Features and Functions:

The features of the pistol-grip tool are shown in Figure 1-12 and Figure 1-13.

Body: A plastic molding that retains the trigger and plunger mechanism.

Head: Guides and supports the connector.

Wire Stuffer: Forces wire into the two slotted beams of the contact. It supports the contact beams when insertion force is applied to the wire. The stuffer setting regulates the travel of the stuffer to provide a choice of four depths. The SDN/SDLC/LDC cabling always uses setting 3, intended for AWG 22 wire.

Ratchet: Ensures full terminating depth of the wire.

Indexing Slide: Automatically positions the connector after each termination.

Index Pawl: Aligns connector for insertion, and retains it during termination.

Tool Certification:

Briefly check the tool, daily. More detailed inspections should be scheduled to assure the quality and reliability of AMP terminating tools.

1. Remove dust, moisture and other contaminants with a clean brush or soft, lint-free cloth.
2. Make sure all parts of the tool are in place and properly secured.
3. Press and release the button of the spring-loaded pawl to be sure the pawl moves freely.
4. Squeeze and release the trigger to be sure the plunger and the mechanism inside the body move smoothly.
5. Check that the slide spring is properly located and not deformed.

1.4 Configuration Parameters

The following parameters are set up at installation. The parameters are described below. The first setting is the factory default setting, other selections are shown in parentheses. For instance: *Lead Fallback:* ON (OFF).

In the configuration checklist table, neonatal cardiotach defaults are shown in [brackets].

1.4.1 ECG Parameters

Cardiotach:

The HP M1403A cardiotach can be selected for monitoring adult patients or for neonatal patients. The same cardiotach will be used on all patients.

This function cannot be changed by the user at the Central Station.

Cardiotach: ADULT (NEONATAL)

Alarm Limit:

The default high heart rate alarm limit can be set for any value from 20 bpm to 250 bpm, in increments of 5 bpm.

The default low heart rate alarm limit can be set for any value from 15 bpm to 245 bpm, in increments of 5 bpm.

Both the high alarm limit and the low alarm limit can be changed by the user at the Central Station on a per patient basis.

High Alarm Limit:	120 bpm (20–250 bpm, in increments of 5 bpm)
Low Alarm Limit:	50 bpm (15–245 bpm, increments of 5 bpm)

ECG Filter Bandwidth:

The default ECG filter bandwidth choices are as follows:

Monitoring: 0.5 Hz - 40 Hz

This is the setting we suggest for most ambulatory patients, and all arrhythmia monitored patients. It helps minimize muscle artifact without compromising ECG quality.

Diagnostic: 0.05 Hz - 100 Hz

This setting provides the highest-fidelity ECG signals for critical diagnostic evaluations, S-T monitoring and similar circumstances. However, it is also most sensitive to muscle artifact, which can lead to false alarms. It is best suited to temporary diagnostic evaluation on non-ambulatory patients.

Exercise: 2.5 Hz - 40 Hz

This setting allows for the most filtering of the ECG. It should be used in areas where muscle artifact makes monitoring difficult (e.g., cardiac rehabilitation). This bandwidth may mask clinically significant changes in the ECG and impede arrythmia analysis; therefore, it should be used for patients requiring only an accurate heart rate count.

DO NOT USE EXERCISE BANDWIDTH WITH ARRHYTHMIA MONITORING.

Paced: 0.5 Hz - 100 Hz

The paced bandwidth is optimum for pace pulse display and detection. It should not be used for neonates. To continue monitoring ST for paced patient, select diagnostic or ST bandwidth.

The bandwidth can be changed by the user on a per-patient basis at the Central Station.

ST: 0.05 Hz - 40 Hz

The ST bandwidth is used for ST Segment Analysis and is available with option C01 only.

ECG Filter Bandwidth:

MONITORING (DIAGNOSTIC, EXERCISE, PACED OR ST)

Lead Selection, 4-electrode Cable Set:

Lead I, II, III, aVR, aVL or aVF can be selected as the default monitoring leads.

The lead can be changed by the user on a per-patient basis at the Central Station.

ECG A (cardiotach lead): II (I, III, aVL, aVR or aVF)

ECG B (secondary lead): I (II, III, aVL, aVR, aVF or OFF)

Note ECG A and ECG B cannot be the same.

Lead Label, 5-electrode Cable Set:

The lead label I, II, III, MCL, V, or ECG can be selected as the default monitoring labels for the 5-electrode cable set. If a 3-electrode cable set is used, the ECG A label will be used.

With the 5-electrode cable set, the user can also configure the mainframe for lead swap or lead labeling. If choosing lead swap, the user must select ECG B.

ECG A (cardiotach lead): II (I, III, MCL, or V)

ECG B (secondary lead): MCL (I, II, III, V, ECG or OFF)

Note ECG A and ECG B cannot be the same.

Lead Fallback:

Lead Fallback is a feature available when using either a 4- or 5-electrode cable set. In Fallback mode, if the cardiotach lead (ECG A) becomes inoperative due to a leads off condition, an INOP message and tone will occur at the Central Station to notify the user of the leads off condition. After 10 seconds, in an attempt to continue patient monitoring and alarms, the monitor will automatically switch the cardiotach source to the secondary lead (ECG B), if operative. Ten seconds after the inoperative condition on ECG A has been removed, the cardiotach will automatically switch back to ECG A as its source.

If fallback is configured OFF, a LEADS OFF condition on ECG A will generate an INOP message and tone at the Central Station, and patient monitoring and alarms will cease until the inoperative condition has been removed.

Lead Swap:

The lead swap mode of the five electrode lead set allows the user to swap the cardiotach lead (ECG A) between either of two leads selected at configuration. ECG B will automatically receive the lead not swapped to ECG A, and will also support the OFF selection. If lead swap is selected, ECG B = OFF is not allowed.

For Arrhythmia Patients:

If the patient is being monitored by an arrhythmia system, fallback will occur at the discretion of the arrhythmia system regardless of how the telemetry system is configured.

This feature cannot be changed by the user at the Central Station.

Lead Fallback: ON (OFF)

Extended Monitoring:

Extended Monitoring is a feature which is only applicable to the 4- and 5-electrode cable set and is only available if Lead Fallback is configured "ON". It is best illustrated with an example:

The HP M1400A/M1400B Transmitter, when used with a 4-electrode cable set, will broadcast 2 ECG leads, Lead I and II. From these 2 leads, Leads III, aVR, aVL and aVF are reconstructed.

For example, the user may have selected Lead II as the cardiotach lead (ECG A) and aVR as the secondary lead (ECG B). If Lead II becomes inoperative because the LL electrode has fallen off, the monitor will try to switch to the secondary lead (ECG B) to continue patient monitoring (Lead Fallback).

When the monitor tries to use ECG B it finds that ECG B is inoperative, too. This is when Extended Monitoring occurs.

If **Extended Monitoring** is configured "ON" the monitor will switch the cardiotach source to any operative lead (in this case Lead I) and continue monitoring.

When the inoperative condition on the cardiotach lead (ECG A) has been corrected, the cardiotach source will switch back to ECG A.

When the HP M1400A/M1400B Transmitter is used with a 5-electrode cableset, leads II and MCL are broadcast.

Extended Monitoring will only occur with a 5-electrode cableset if ECG B is turned off.

If ECG A (Lead II) goes into INOP because the RA electrode has fallen off, the monitor tries to use ECG B (MCL) but finds it is turned OFF.

If Extended Monitoring is configured ON, the monitor will switch the cardiotach source to any operating lead (MCL) and continue monitoring.

When the inoperative condition on the cardiotach lead (ECG A) has been corrected, the cardiotach source will switch back to ECG A.

This feature cannot be changed by the user at the Central Station.

Extended Monitoring: ON (OFF)

ST Enable/Disable:

ST is enabled and disabled by the bandwidth selection. If ST or Diagnostic bandwidths are selected, ST will be displayed at the Central Station. If any other bandwidth is selected, ST will be disabled.

1.4.2 ST Segment Analysis/Two-Channel Delayed Recording (Option C01) Parameters

With the C01 option the following ST segment analysis parameters are effective:

Alarm Limit:

For both ECG A and ECG B, the default high and low alarm limits can be set for any value from −9.8 to +9.8 in increments of 2 mm. In both cases, the high default value is +0.6; the low default value is −1.0.

Measurements:

For both ECG A and ECG B, the Isoelectric default is −80 and can be adjusted from −460 to +460 in increments of 4 ms

For both ECG A and ECG B, the J Point default is +48 and can be adjusted from −460 to +400 in increments of 4 ms.

For both ECG A and ECG B, the ST Offset default is 60 and can be be set to either 60 or 80 ms.

INOP alarms are triggered under the following conditions:

- The algorithm cannot generate a valid value due to excessive variation between measured ST values
- The algorithm recognizes an unacceptable number of ventricularly paced beats, for which it will not generate an ST value
- The algorithm calculates a value $\geq$ 25 mm or $\leq$ −25 mm

1.4.3 Alarms

Alarm Suspend Time:

If an alarm condition exists, but the alarms have been suspended, all alarm sounds will be suppressed. Parameters, rhythm and ectopic status messages continue. If an inoperative condition exists, the audible tone will be suppressed but a message will be displayed at the Central Station.

The Alarm Suspend Time can be configured to be 3 minutes or indefinite. If the Alarm Suspend Time is configured for 3 minutes, the monitor will automatically re-enable all alarm indications 3 minutes after suspend alarms was selected. When configured to be indefinite, the suspend alarms softkey functions as an Alarms ON/OFF key.

This function cannot be changed by the user at the Central Station.

Alarm Suspend Time: 3 minutes (Indefinite)

Alarm Reset Reminder:

If an alarm condition exists, and the reset softkey at the Central Station is pressed, the alarm tone at the Central Station will be silenced, but the alarm message will remain as long as the condition exists.

Alarm Reset Reminder is a feature that will re-enable the alarm tone at the Central Station for six seconds every three minutes for as long as the alarm condition is present.

For Arrhythmia Patients:

The Alarm Reset Reminder will not occur on arrhythmia monitored patients.

This function cannot be changed by the user at the Central Station.

Alarm Reset Reminder: ON (OFF)

1.4.4 Transmitter Button

The button on the HP M1400A/M1400B Transmitter can be configured for one of four functions, Nurse Call, Record, both Nurse Call and Record or it can be disabled.

If configured for Nurse Call, when the button is pressed, a short yellow alarm tone and a Nurse Call Message will occur at the Central Station.

If configured for Record, when the button is pressed, a recording will be generated at the Central Station.

If configured for both, both of the above actions will occur.

If configured for disabled, when the button is pressed nothing will happen.

The function of the button cannot be changed by the user at the Central Station, but the button can be enabled or disabled by the user on a per patient basis at the Central Station.

Transmitter Button: Nurse Call and Record
(Button Disabled, Nurse Call Only, Record Only)

1.4.5 Languages

English, German, French, Italian, Spanish, Swedish, Dutch or Japanese may be selected as the user interface language.

Note The language selected **MUST BE THE SAME LANGUAGE AS THAT OF THE ASSOCIATED CENTRAL STATION.**

This parameter cannot be changed by the user at the Central Station.

Language: English (German, French, Italian, Spanish, Swedish, Dutch, Japanese)

1.4.6 Self-Tests

Auto Self-test:

If Auto Self-test is configured ON, when an associated Central Station goes into self-test mode, it will cause the M1401A Receiver Mainframe to also initiate a self-test.

If a single HP M1401A Receiver Mainframe is shared between more than 1 unit we suggest configuring this "OFF" such that monitoring of patients associated with the second unit are not affected.

This function cannot be changed by the user at the Central Station.

Auto Self-test: OFF (ON)

Self-test strip:

If a Receiver Mainframe Self-test is initiated, and problems are found, a recording strip with error code information will be generated at the Central Station, if this function is configured ON.

This function cannot be changed by the user at the Central Station.

Self-test strip: OFF (ON)

1.4.7 Serial Distribution Network

SDN Unit Number:

A maximum of six HP M1401A Receiver Mainframes may exist on an SCC. Each receiver mainframe must have a unique SDN Unit Number from 1–6 (see Figure 1-2).

This parameter cannot be changed by the user at the Central Station.

SDN Unit Number: 1 (2, 3, 4, 5, 6)

SDN Branch Number:

An HP M1401A Receiver Mainframe emulates up to 8 SDN beds. During installation, branch numbers must be assigned to each receiver module.

If less than 8 receiver modules are installed, the receiver module either can be configured for 0 (not assigned) or they can be configured for a branch number. If a non-existent receiver is assigned to a bed branch, a NO RECEIVER INOP will occur at the Central Station if assigned to a sector.

If a branch has been assigned to a telemetry bed, that branch may not be used by another product.

These parameters cannot be changed by the user at the Central Station.

	SDN Branch Number:
Receivers	1–8: 1–8 (9–16, 17–24)
or	1–24, 0 = not assigned
Receiver	1 :
	2 :
	3 :
	4 :
	5 :
	6 :
	7 :
	8 :

Table 1-4. HP M1403A Configuration Checklist

PARAMETER	FACTORY DEFAULT	USER DEFAULT OPTIONS
Cardiotach	Adult [Neonatal]	Adult, Neonatal
Heart Rate		(In increments of 5 bpm)
Alarm Limit:		
High	120 bpm [200 bpm]	20–250 bpm
Low	50 bpm [100 bpm]	15–245 bpm
Bandwidth (Filter)	Monitoring	Monitoring, Exercise, Diagnostic, Paced, ST (with option C01)
Lead Selection		
4-electrode:		
ECG A	II	I, II, III, aVR, aVL, aVF
ECG B	I	I, II, III, aVR, aVL, aVF, OFF
Lead Label		
3/5-electrode:		
ECG A	II	I, II, III, MCL, V
ECG B	OFF	I, II, III, MCL, V, ECG, OFF
Lead Swap	OFF	ON, OFF
Lead Fallback	ON	ON, OFF
Extended Monitoring	ON	ON, OFF
Alarm Suspend Time	3 minutes	3 minutes, indefinite
Alarm Reminder	ON	ON, OFF
Transmitter Button	Call and Record	Call and Record, Button Disabled, Nurse Call only, Record only
Language	English	English, German, French, Dutch, Italian, Spanish, Swedish, Japanese
Auto Self-test	OFF	ON, OFF
Self-test strip	OFF	ON, OFF
ST Segment Analysis (Option C01)		
ST Module	Enabled	Enabled, Disabled
ST Alarm Limits (mm)		
ECG A High	+0.6	−9.8 to +9.8, in increments of 0.2
ECG A Low	−1.0	−9.8 to +9.8, in increments of 0.2
ECG B High	+0.6	−9.8 to +9.8, in increments of 0.2
ECG B Low	−1.0	−9.8 to +9.8, in increments of 0.2
ST Measurements (ms)		
ECG A/B Isoelectric	−80	−460 to +460, in increments of 4
ECG A/B J Point	48	−460 to +400, in increments of 4
ECG A/B ST Offset	60	60 or 80

Table 1-4. HP M1403A Configuration Checklist (continued)

PARAMETER	FACTORY DEFAULT	USER DEFAULT OPTIONS
SDN Unit Number	1	1, 2, 3, 4, 5, 6
SDN Branch Number		1–24, 0 – not assigned
Receiver Number		
1–8	1–8	1–8, 9–16, 17–24
1	1	1–24, 0 not assigned
2	2	1–24, 0 not assigned
3	3	1–24, 0 not assigned
4	4	1–24, 0 not assigned
5	5	1–24, 0 not assigned
6	6	1–24, 0 not assigned
7	7	1–24, 0 not assigned
8	8	1–24, 0 not assigned

1.5 Instrument Installation

This paragraph contains mechanical and electrical installation instructions for the HP M1403A Digital UHF Telemetry System instruments. Telemetry system instrument configurations and cabling are described in "1.3 System Configurations and Cabling". Read all instructions and recommendations before installing any wall mount.

1.5.1 Wall Mount Installation

The following instructions provide installation procedures for HP M1403A optional mounts.

Caution

The mounting instructions are neither applicable in California or sanctioned by the California OSHPD for installation in the State of California, U.S.A., in conformance to that state's requirements for seismic protection.

Paragraph 1.5.1.1 describes the **HP M1403A Option 78000AI-#R86 Flush Wall Mount** installation, used to mount an HP M1401A Receiver Mainframe on a wall.

Paragraph 1.5.1.2 describes the **HP M1403A Option 78000AI-#R90 WallMount** installation, used to mount an HP M1401A Receiver Mainframe into a 19-inch Electronic Industries Association (EIA) equipment cabinet or custom enclosure.

1.5.1.1 Wall Mount Installation, HP M1403A Option #R86

The following instructions describe surface wall mount base or shelf mount shelf installation to a wall.

Before instruments have been installed, the hospital or other facility, its consultants, or its contractors shall be responsible for meeting the following conditions:

1. **That the wall is adequate to safely mount monitoring instruments, including the selection of fasteners and their proper installation,**
2. **That the installation recommendations have been followed,**
3. **That the installation has been completed in accordance with accepted standards of good workmanship.**
4. **Anchorage or support in a metal stud or wood stud wall must be verified by a registered professional engineer before installing the mounting system.**

Warning

EXISTING WALL CONSTRUCTION AND REINFORCEMENT:

THE WALL MOUNTS MUST BE CAPABLE OF SUPPORTING FOUR TIMES THE SPECIFIED WEIGHT CAPACITY AFTER THEY HAVE BEEN PROPERLY INSTALLED. TO PROVIDE THIS SUPPORT IN PLASTER, PLASTERBOARD, OR GYPSUM BOARD WALLS, THE WALL COVERING MUST BE REMOVED IN THE AREA OF WORK AND A REINFORCEMENT MUST BE PROVIDED WITHIN THE WALL STRUCTURE, AS SHOWN IN THE INSTALLATION DIAGRAMS.

DO NOT INSTALL A WALL MOUNT ONTO SOLID BRICK OR BRICK VENEER WALLS, OR ONTO CRUMBLY WALL MATERIAL SUCH AS CINDER BLOCKS OR DETERIORATED CONCRETE OR CONCRETE BLOCK.

ENSURE THAT NO ELECTRICAL WIRING, PIPING, OR OTHER UTILITIES WITHIN THE WALL INTERFERE WITH OR CAN BE DAMAGED BY THE INSTALLATION PROCESS.

FASTENINGS:

LEAD EXPANSION BOLTS OR PLASTIC EXPANSION ANCHORS SPECIFICALLY ARE NOT ADEQUATE OR SAFE. USE THE ANCHORS SPECIFIED FOR SOLID CONCRETE CONSTRUCTION.

NEVER MOUNT HEAVY INSTRUMENTATION TO PLAIN GYPSUM BOARD USING EXPANSION ANCHORS. THE WALL COVERING (PLASTERBOARD OR PLASTER) MUST BE REMOVED AND THE WALL MUST BE REINFORCED INTERNALLY, IN NEW OR EXISTING CONSTRUCTION.

CHECK THE MOUNTING HARDWARE HOLDING THE WALL MOUNT ONTO THE WALL EVERY 12 MONTHS; TIGHTEN THE HARDWARE IF NECESSARY.

IN INSTALLATION:

NO PORTION OF THE MOUNT OR MAINFRAME MAY EXTEND OVER A PATIENT'S BED.

NEVER EXCEED THE MAXIMUM RATED LOAD SPECIFIED ON THE LABEL(S) ATTACHED TO THE WALL MOUNT IN USE.

NEVER EXCEED ANY MAXIMUM INSTRUMENT STACKING HEIGHT SPECIFIED ON THE LABEL(S) ATTACHED TO THE WALL MOUNT IN USE.

DO NOT ATTEMPT TO REMOVE ANY WALL MOUNT WHILE INSTRUMENTS ARE ATTACHED.

Summary:

The wall mount is mounted directly to the wall. First, the mounting methods are described for the Option #R86 flush wall mount base because the mounting method depends on the wall type. Then the methods of attaching the HP M1401A Receiver Mainframe to the shelf and base are described.

All mountings and anchorages must conform to local building codes and regulations.

The mount is supplied with assorted hardware. Refer to individual wall type recommendations for specifications of suitable hardware, which may have to be obtained locally.

In general, the wall mounts are installed securely to the wall internal structure with number 10 sheet metal screws, 1/4-20 or 10-32 pan head machine screws, or bolts with nuts or toggle wings. The type of fastening and method depends on the wall construction. To meet your specific installation requirements, refer to the procedures in the following paragraphs.

Note

Machine screws have built-in lockwashers or other means of securing threads. All sheet-metal screws have type-A threads.

1.5.1.1.1 Location of Mount.

Recommended **minimum** height distances for wall mount (Figure 1-14) are:

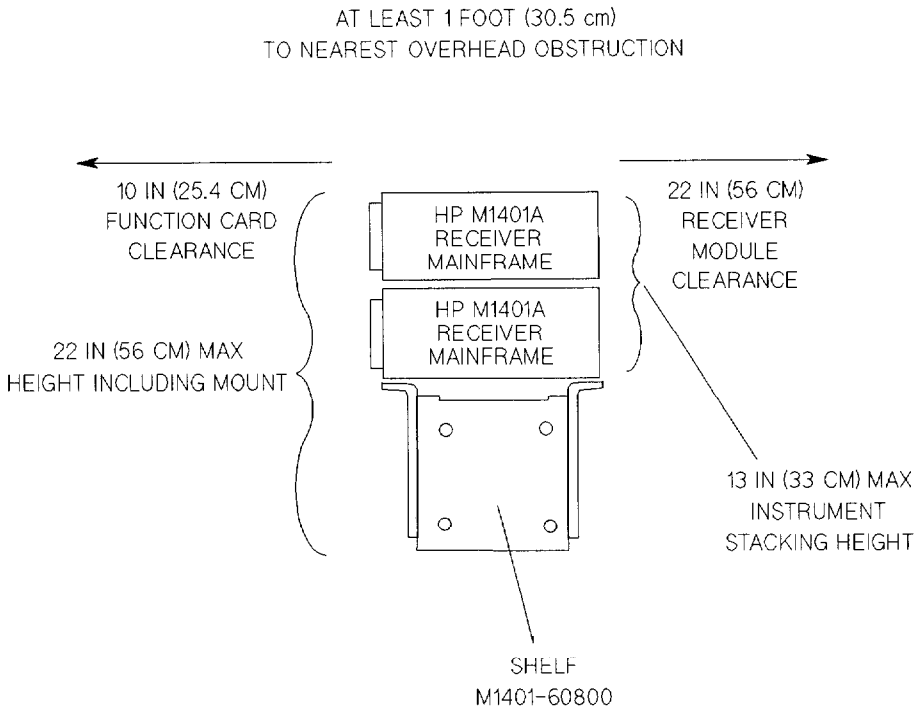
Surface wall mount: 8 inches (20.3 cm) above floor, to provide for air circulation.

Shelf wall mount: 12 inches (30.5 cm), above top instrument to provide for ventilation.

Allow clearances shown in Figure 1-14 to allow mainframe access for removal and servicing.

Warning

DO NOT PLACE ANY PORTION OF THE WALL MOUNT OR RECEIVER MAINFRAME OVER A PATIENT'S BED.



WARNING

DO NOT PLACE ANY PORTION OF THE WALL MOUNT OR MAINFRAME OVER A PATIENT'S BED.

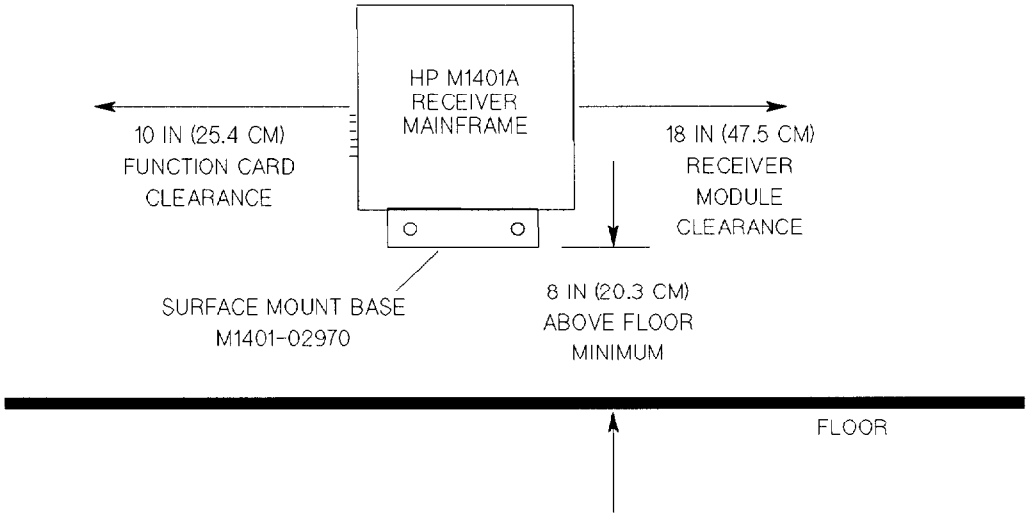


Figure 1-14. Locating the Wall Mount

1.5.1.1.2 Installing Mount Base or Shelf.

(1) On Hollow Block or Hollow Tile Walls, or

(2) On Plaster over Expanded Metal Lath on Steel Studs

Warning **DO NOT USE THIS METHOD IN SEISMIC-SENSITIVE AREAS.**

DO NOT INSTALL WALL MOUNT ONTO SOLID BRICK WALLS OR TILE VENEER WALLS, OR ONTO WEAK OR CRUMBLY WALL MATERIAL SUCH AS CINDER BLOCKS, BRICK, BRICK VENEER, CLAY OR RUBBLE CONSTRUCTION.

As shown in Figure 1-15, the base is installed using 1/4-20 pan head machine screws with toggle wings, or mount the shelf using 10-32 pan head machine screws with toggle wings.

Two people are required for this procedure. Tools are a 5/8-inch (16 mm) carbide-tipped masonry drill, a medium-sized screwdriver, and a broach or small masonry chisel and hammer. Wear eye and ear protection if necessary. "Tile" does not refer to an applied wall-surface treatment, but only to hollow construction tiles.

1. Mark wall with mounting hole locations using selected mount as a template, using the guidelines in the paragraph before this one to locate mount. Holes must be within the hollow portion of each block (Figure 1-15).

Note Hole centers should be about 3/8-inch (9.5 mm) above required mount height to allow clearance for toggle wings.

---

2. Drill 5/8-inch (16 mm) holes where marked locations according to accepted construction practices.
3. Enlarge holes in hard materials to allow toggle bolt wings to pass through. The holes must be square and lined up with the floor. Use a small masonry chisel to square off the holes.
4. Install wall mount shelf or base (Figure 1-15) as follows:
   a. Align shelf so horizontal flanges are up.
   b. Turn flush mount wall plate so flange end is up and label (not shown) is at bottom.
   c. Remove toggle wings from their machine screws.
   d. Apply a flat washer to each machine screw.
   e. Pass each screw through a mounting hole in the base or shelf and apply its toggle wing, as shown in Figure 1-15.
   f. At same time (use a helper) put all toggle wings through holes while holding shelf or base out a little from wall.

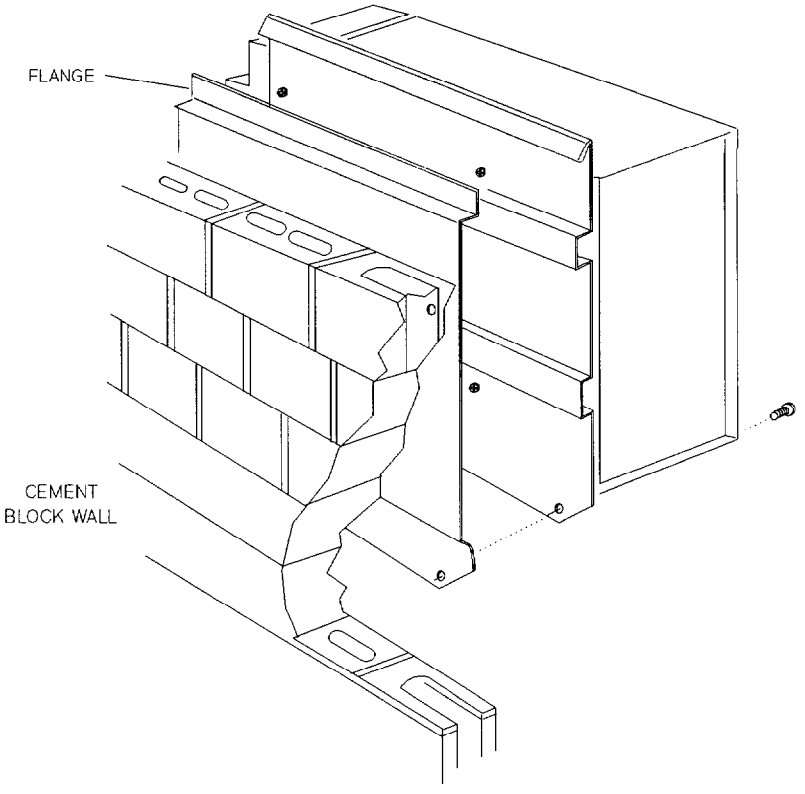


Figure 1-15. Installation on Hollow Block Wall

1.5.1.1.3 Installing Surface Wall Mount Base or Shelf on Solid Concrete or Solid Block Walls.

This type of installation is not illustrated. It must be done by a person with experience and expertise in concrete and concrete fasteners and who will follow explicit instructions of fastener manufacturer(s).

Warning

THIS TYPE OF INSTALLATION MUST NOT BE USED IN SEISMIC-SENSITIVE AREAS.

NEVER ATTEMPT TO MOUNT INTO CRUMBLY MATERIALS OR INTO IMPROPERLY PREPARED HOLES.

USE ONLY FASTENINGS SPECIFIED FOR SOLID CONCRETE CONSTRUCTION. LEAD OR PLASTIC EXPANSION ANCHORS ARE NOT ACCEPTABLE. NEVER USE WOOD SCREWS, LAG BOLTS, OR OTHER GRADE 2 FASTENERS.

Required tools and materials:

Carbide-tipped drills (must be sharp)
Roto hammer
Air bulb
Number 12 x 2-inch Rawl plugs
1/4-20 x 1.5-inch steel expansion anchor (top holes)
Number 11 x 1.15-inch Buildex combination head screws (bottom holes)

Note

Due to alignment problems of drilling holes in concrete, use fasteners specified above, only. Special fasteners are available from construction supply companies. If concrete has a plaster coat, compensate for extra hole depth by selecting a longer screw.

1. Use guidelines in Figure 1-14 to determine wall mount height.
2. Mark wall with mounting hole locations using selected mounting base or shelf as a template (Figure 1-15).
3. Center punch each location to reduce drill-bit walking, except on tile veneer.
4. Drill holes straight, with a correct diameter and depth into solid concrete. Disregard thickness of any plaster coat.
5. Apply plugs and fasteners according to standard concrete construction practices.

1.5.1.1.4 Installing Surface Wall Mount Base or Shelf on Drywall (Plasterboard) Construction.

All drywall installations (Figure 1-16) must be provided with a secure anchorage built into the wall framing.

The following paragraphs and Figure 1-17 provide a method of support backing for 5/8-inch (16 mm) gypsum board (plasterboard, blueboard) walls to comply with State of California, U.S.A., seismic requirements for wall-mounted instrumentation.

Anchorage Installation:

The anchorage method shown in Figure 1-17 represents load tests that comply with California OSHPD requirements for anchorage and installation of wall mounted instrument support systems.

Caution

Wall mounts are designed to support only maximum weight specified on labels.

Anchorage or support in stud walls of all types must be verified by project engineer.

In new construction, the anchorage can be built into the wall during construction. For remodeling, the existing wall covering (plasterboard) must be removed, the anchorage constructed, and the plasterboard re-applied, together with any overlay or veneer.

In all methods, the anchorage centerline should be marked by installing a number 10 sheet-metal screw before the wall covering is applied, so it will protrude through the plasterboard. The mount base or shelf will cover the hole made by this screw in the gypsum board.

Base or Shelf Installation:

Refer to Figure 1-14 for placement heights, and Figure 1-16 for information about installation on drywall construction.

Note

Drill all screw holes in anchorage with a 9/64-inch (3.6 mm) diameter twist drill (or number 28 drill) for number 10, 2-inch, type-A sheet metal screws. Do not substitute screws.

Screws should be started and driven with ball-handled drivers or torque-limiting screw guns not exceeding 60 inch-pounds.

1. At desired location, level base or shelf, then use base or shelf as template to mark for screw holes.
2. Remove base or shelf and drill marked holes. Do not run drill through base or shelf while producing holes.
3. Re-apply base or shelf to wall, and install number 10 pan-head sheet metal screws through holes to reinforced wall.

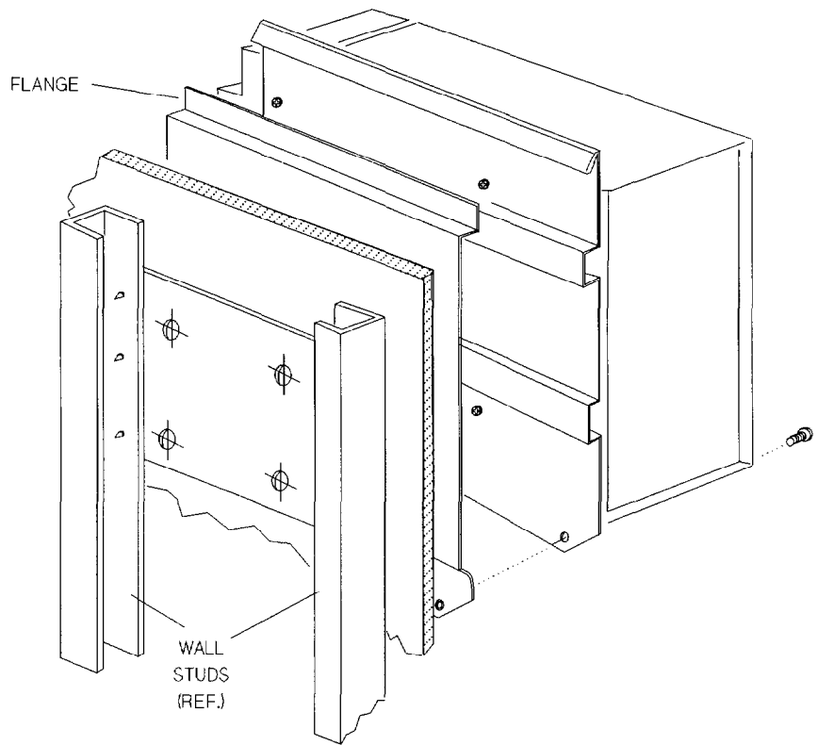


Figure 1-16. Installation on Drywall Construction

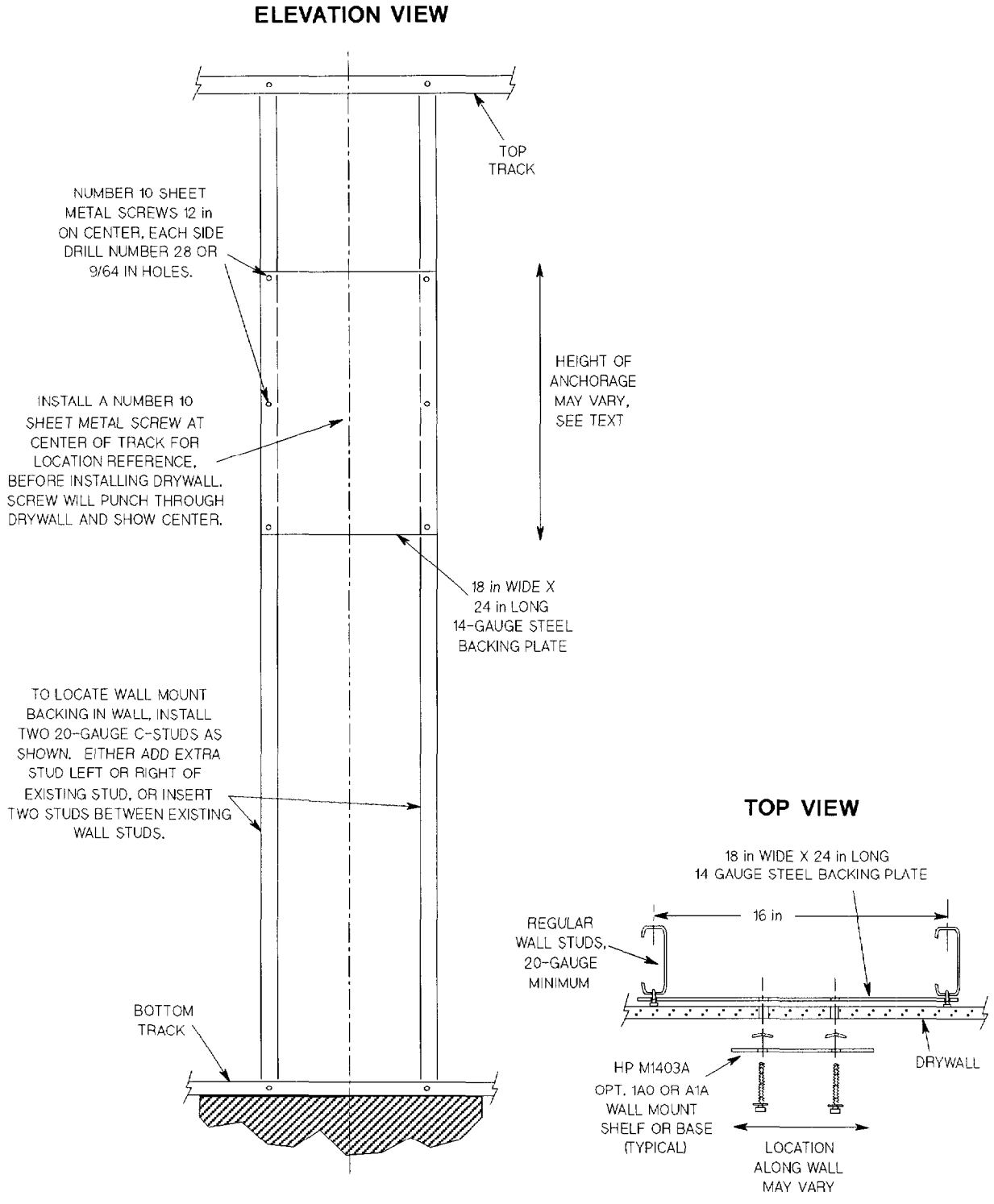


Figure 1-17. Anchorage Method for Drywall Construction

1.5.1.1.5 Installing HP M1401A Receiver Mainframe.

HP M1403A Option #R86 Flush Wall Mount Installation:

Summary:

The surface wall mount base is fastened to the wall with one of the methods just described.

The wall mount hook is a flat plate with an inverted channel at the top. This channel hooks the mounted mainframe onto the flange on top of the mount base.

The mainframe and hook are attached to the bottom of the base to complete the installation.

1. Attach M1401-02990 **hook** to HP M1401A Receiver Mainframe with four M5 x 10 mm machine screws and washers (Figure 1-15 or Figure 1-16). **The mainframe should face to right (heat-sink to left) as you face wall.**
2. Raise **hook** (with mainframe attached) to top of **base**.
3. Position inverted channel on top of hook over **flange** on top of **base**.
4. Slide **hook** so bottom holes in **hook** are over threaded holes in **base**.
5. Fasten **hook** to bottom of **base** with two M5 x 6 mm screws.

1.5.1.2 WallMount Installation, HP M1403A Option #R90

Summary:

The rack mount option fits an EIA 19-inch (48.3 cm) console or equipment cabinet.

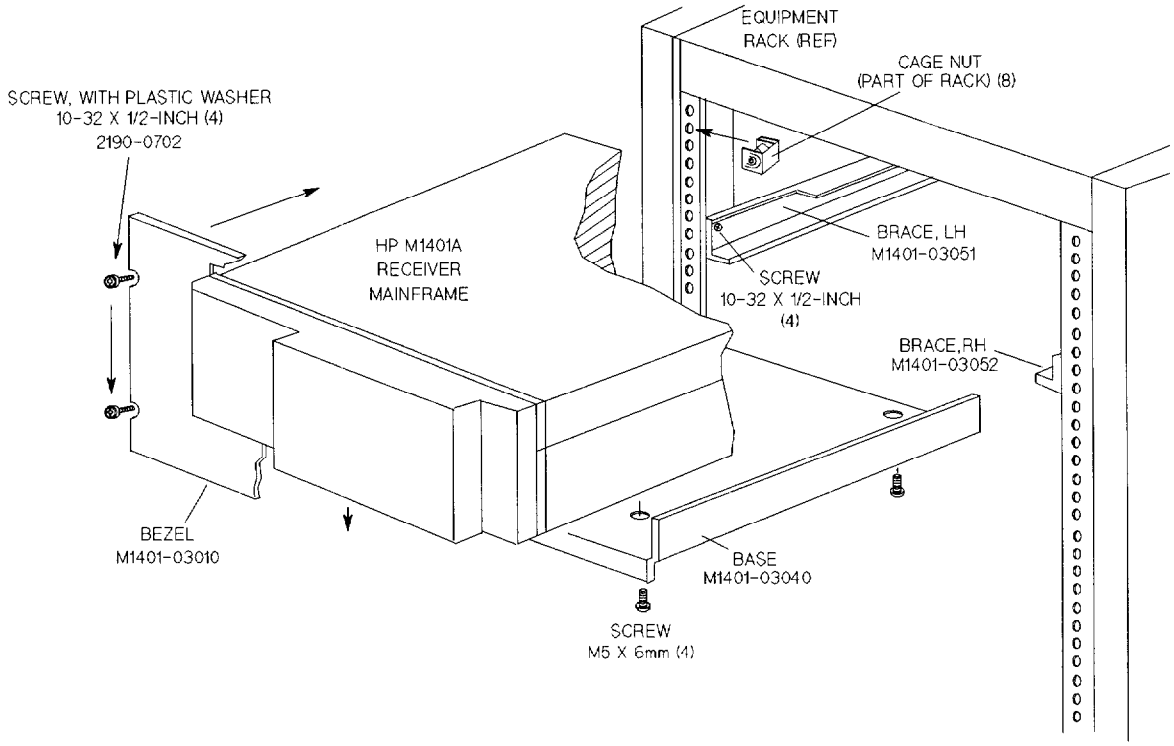
The mounting posts inside the rack are prepared with cage nuts at the location(s) desired for the HP M1401A Mainframe(s). All cage nuts should be inserted first because access will be restricted later.

A pair of braces is attached to the mounting posts.

The mainframe is installed onto the base, and moved back into the housing. Note that the mainframe protrudes from the housing.

The bezel is fastened over the front of the mainframe.

1. Prepare mounting posts in housing with 10-32 cage nuts (not supplied). Before clipping any cage nuts into holes, measure from front-to-back and mark hole locations. Refer to Figure 1-18 for basic EIA nut location pattern:
   a. Measure to locate upper bezel nuts 1.5 inches (38 mm) down from bezel top.
   b. Measure to locate lower bezel nuts 7.25 inches (184 mm) down.
   c. Check bezel nut location marking by holding bezel up to rack.
   d. Mark nut locations for the braces 7.125 inches (181 mm) down.
   e. Use carpenter's spirit level to check rear posts for correct hole selection for braces.
2. Install cage nuts in the holes previously marked.
3. Install braces on cage nuts using four 10-32 x 1/2-inch screws.
4. Install base (M1401-03040) onto HP M1401A Receiver Mainframe with four M5 x 6 mm screws. Note lower corners of base (Figure 1-18) are cut away to clear braces.
5. Place mainframe and base onto rack braces and move assembly back into cabinet.
6. Apply bezel onto mainframe. Fasten it with four 10-32 x 1/2-inch screws with plastic washers.



EIA* RACK HOLE SPACING DIMENSIONS

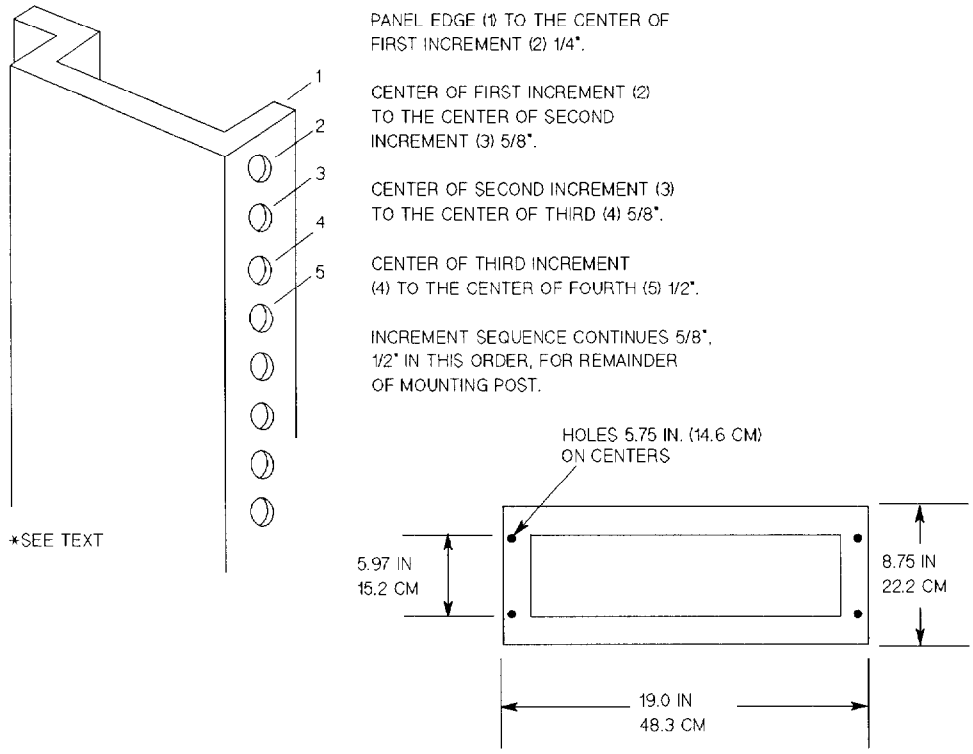


Figure 1-18.
Installation of HP M1403A Option 78599AI #R90 Rack Mount into EIA Cabinet

1.5.2 Receiver Module Installation

After mounting the Receiver Mainframe(s), the receiver modules are installed.

The module insertion procedure is shown in Figure 1-19. Be sure the Receiver Mainframe is NOT powered.

1. Remove the receiver mainframe front (dress) cover and set it aside.
2. Push the receiver module into the chosen mainframe slot.

Note Performing steps 3 and 4 in the order given allows the receiver module to float and makes it easier to align the semi-rigid RF cable.

3. Connect semi-rigid RF cable SMC connector to front of receiver mainframe. Use two small (1/4 in) wrenches, one to secure the connector and the other to fasten the connector nut. Do not overtighten.
4. Secure the receiver module with two screws into the mainframe inner front panel.
5. Replace the mainframe front cover after all receiver modules have been installed and their performance has been verified (see Section 3).

1.5.3 Antenna System Installation

Procedures to install the antenna system can be found in the Antenna System Installation Note immediately following this chapter.

1.5.4 Analog Output Option (J01) Installation

Procedures to install the Analog Output option can be found in the Analog Output Option Installation Note, immediately following the Antenna System Installation Note.

1.5.5 ST Segment Analysis and Two-Channel Delayed Recording Option (C01) Installation

Procedures to install the ST Segment Analysis and Two-Channel Delayed Recording option can be found in the ST Segment Analysis and Two-Channel Delayed Recording Option Installation Note, immediately preceding chapter 2.

1.5.6 Electrical Installation

Line power is connected to the HP M1401A Receiver Mainframe with the power cord provided during shipment. The wall plug is adapted to the country of installation, and the mainframe plug is a standard IEC (Europa) connector.

The rear panel connectors, fuses and voltage selector settings are shown in Figure 1-20.

A standard 100V, 120V, 220V or 240V power receptacle must be installed at each receiver mainframe location.

1.5.6.1 Rear Panel Settings and Connections

Remove the fuse and selector panel cover to access the line voltage selector switches and fuses. One screw holds the power control access cover onto the rear panel of the mainframe. A tab on the cover slides into a rear panel slot to hold the other side of the cover in place.

Two line voltage selector switches must be set to the line voltage of the primary power supply. These switches are set at the factory to correspond to the region to which the instrument is sent. Replace the cover after setting or checking the switches.

Caution Verify the switch setting before applying power to the instrument.

In Figure 1-20, the switches are shown set to 120 V ac line power, for example.

1.5.6.1.1 Instrument Grounding and Power Cord. The three-wire power cable grounds the instrument when plugged into a matching three-wire receptacle. A chassis ground lug on the rear panel is supplied for additional grounding assurance.

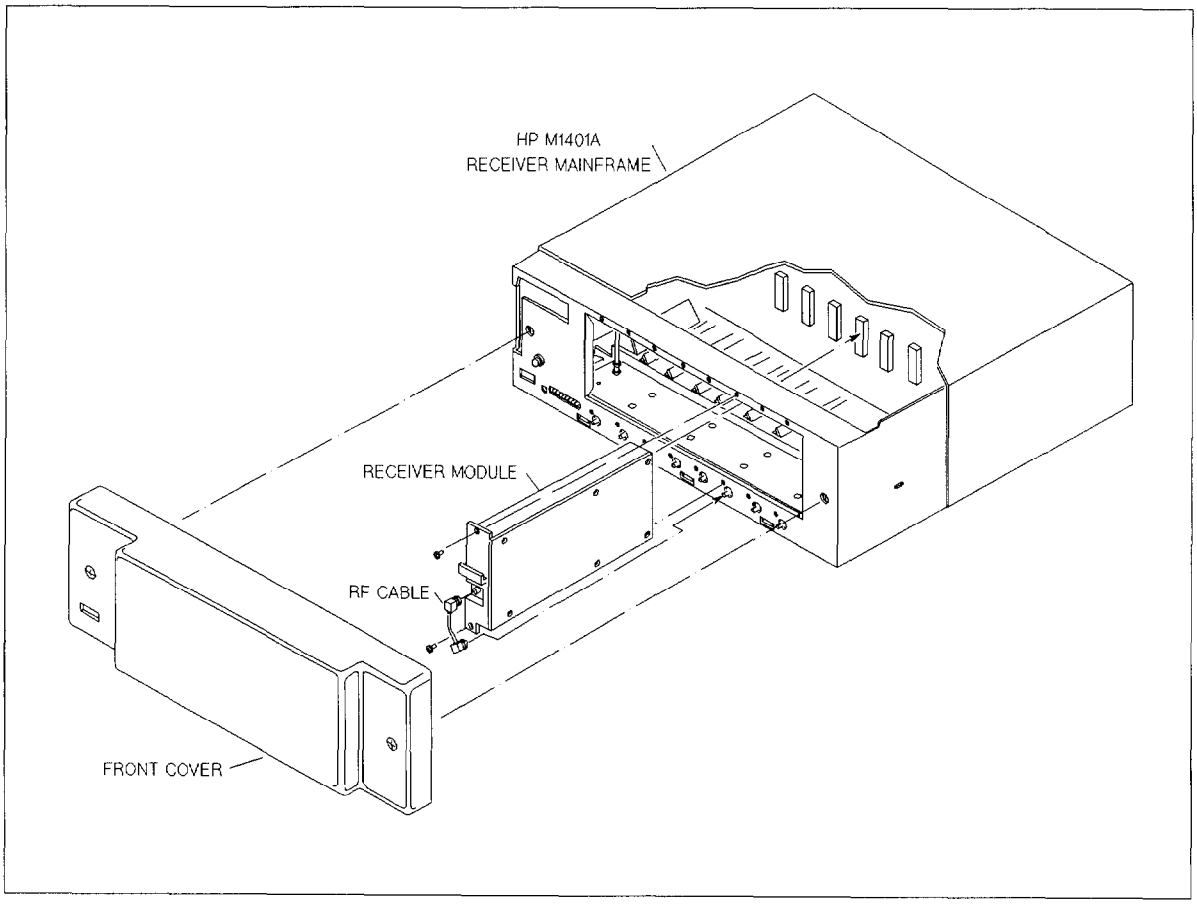


Figure 1-19. Receiver Module Installation

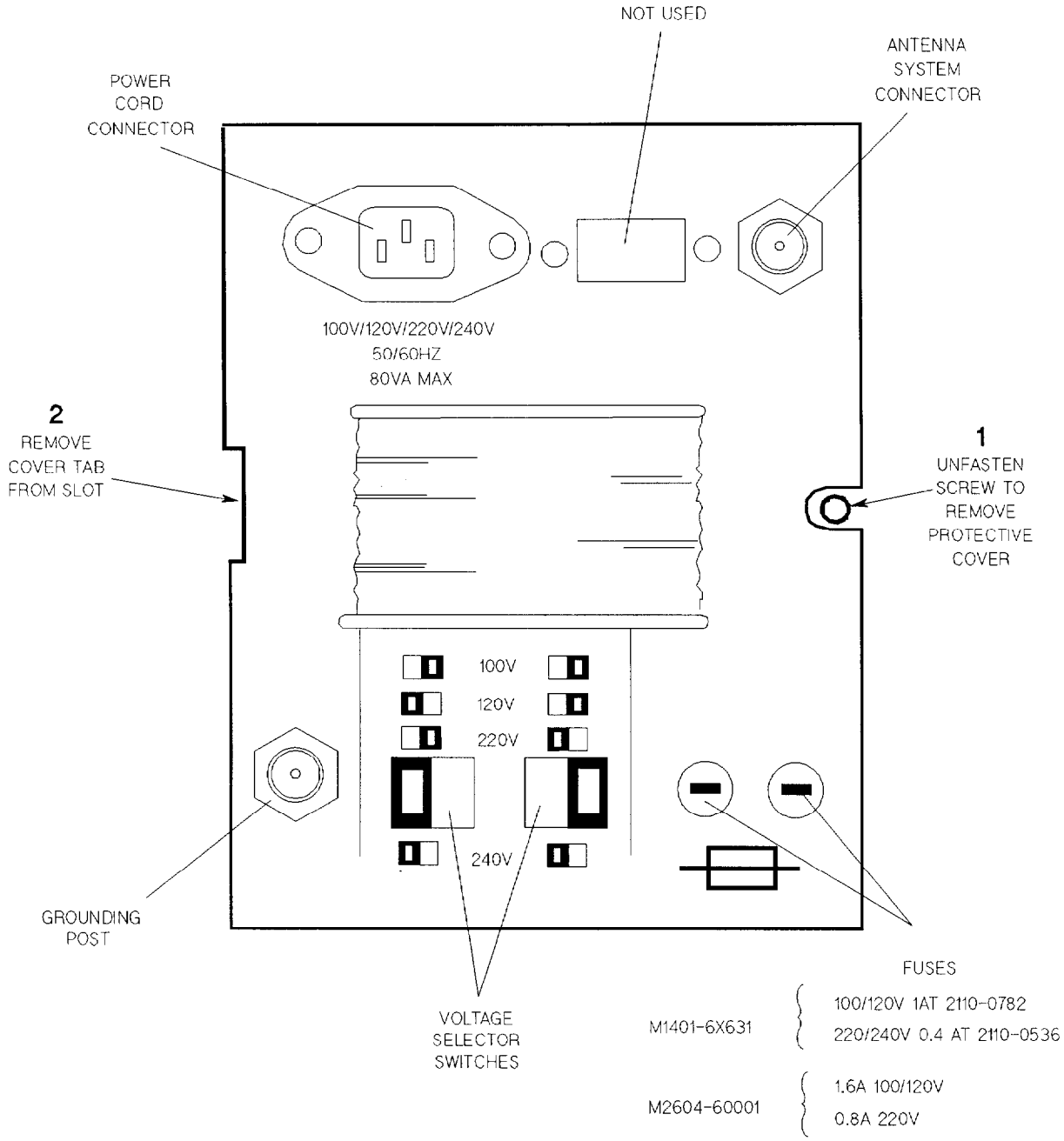


Figure 1-20. Voltage Selector and Fuse Panel

1.5.6.1.2 Instrument Power Fuses. Two fuses are installed at the lower right corner of the fuse and selector panel. Remove the cover to access the fuses (Figure 1-20). The fuse values and part numbers are shown in Figure 1-20. Replace the cover after servicing the fuses.

1.5.6.2 Signal Connections

Radio signals are connected to the Receiver Mainframe rear panel from the antenna system coaxial cabling by a standard BNC coaxial connector, which is shown in the upper right corner of Figure 1-20. It distributes signals from all channels to the receiver modules inside the receiver mainframe.

Digital data outputs go to the Serial Distribution Network via the SDN connectors, as described in "1.3 System Configurations and Cabling". "1.4 Configuration Parameters" contains a configuration checklist.

1.5.7 Transmitter Installation

On initial installation, the button on each transmitter will have been configured to NURSE CALL and/or RECORD mode by an HP customer engineer. (A *button on/off key*, shown in the central station operating guide, permits the button to be disabled at the central station on a per-patient basis.)

The transmitter is supplied with a pouch so the patient can wear it during monitoring, and a battery. The battery is installed only when the patient is being monitored or the transmitter is in test or servicing.

Then each new transmitter is energized by installing a battery, and an identity code is "learned" by its corresponding receiver.

1.5.7.1 Learning the Transmitter Code at a Patient Information Center

The Patient Information Center (PIC) and the receiver mainframe are assumed to be turned on and running and that the telemetry bedside has been assigned to a sector. Refer to Figure 1-21 for the learn code screen.

1. Install a battery into the transmitter.
2. Press the `CONTROL` softkey at the PIC display.
3. Select the bed sector number that has the new transmitter.
4. Open the control door at the right of the display and press the SETUP key.
5. The `Invalid Signal E01` INOP message is shown and the `LEARN CODE` softkey will appear at the lower right corner of the display (Figure 1-21).
6. Press the `LEARN CODE` softkey. Within ten seconds, press the button on the transmitter. The Invalid Signal E01 INOP message and the `LEARN CODE` softkey will disappear if the code was transmitted properly.

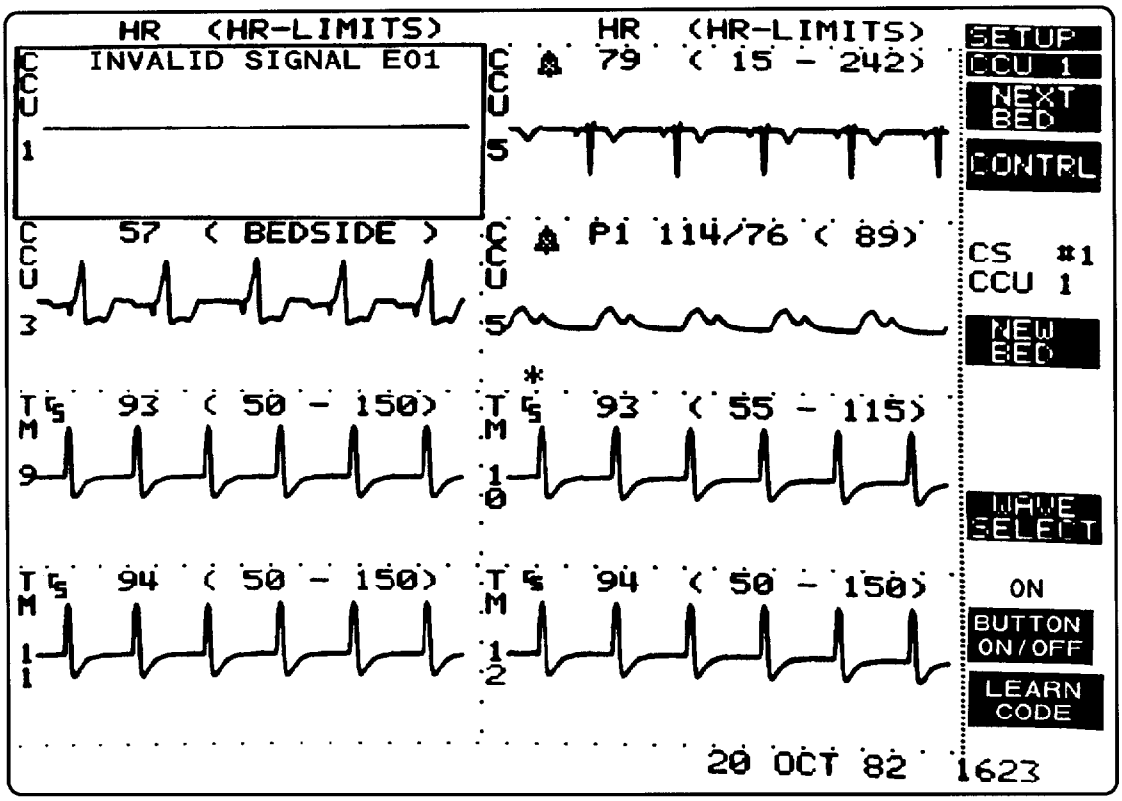


Figure 1-21. HP 78508A PIC Learn Code Screen

1.5.7.2 Learning the Transmitter Code at a Central Monitor

Note

This section shows the Learn Code screen as it appears on the HP 78560A Central Monitor. If you are using an HP M2300A Component Central Monitor, the screen may appear differnetly from that shown, but the function keys are all the same.

If you are using a Component Central Monitor with Option C03, the Learn Code key resides in the Discharge Task Window.

Re-learning the transmitter code at the Component Central Monitor is a two-step process. The first part allows you to enter the Discharge Task Window to get access to the Learn Code key. The second part of the procedure describes how to learn the transmitter code.

Part 1 - To enter the Discharge Task Window

1. To get to the Discharge Task Window, you must first admit a patient. Press the (ADMIT/DISCHARGE) hardkey.
2. Select the desired bed.
3. Select the (STANDARD DISPLAY) hardkey.
4. Select the (ADMIT DISCHARGE) hardkey.
5. Select the desired bed.
6. Select the `Discharg Patient` softkey.

Part 2 - To Learn the Transmitter Code

1. Install a battery into the transmitter.
2. The screen displays the INOP message: "INVALID SIGNAL E01" with the learn code softkey label,
3. Touch the `learn code` softkey label and press the button on the transmitter within 10 seconds. The `learn code` softkey and the "INVALID SIGNAL E01" message disappear, indicating the code has been learning.
4. Touch the (STANDARD DISPLAY) or (MAIN SCREEN) hardkey to resume monitoring.

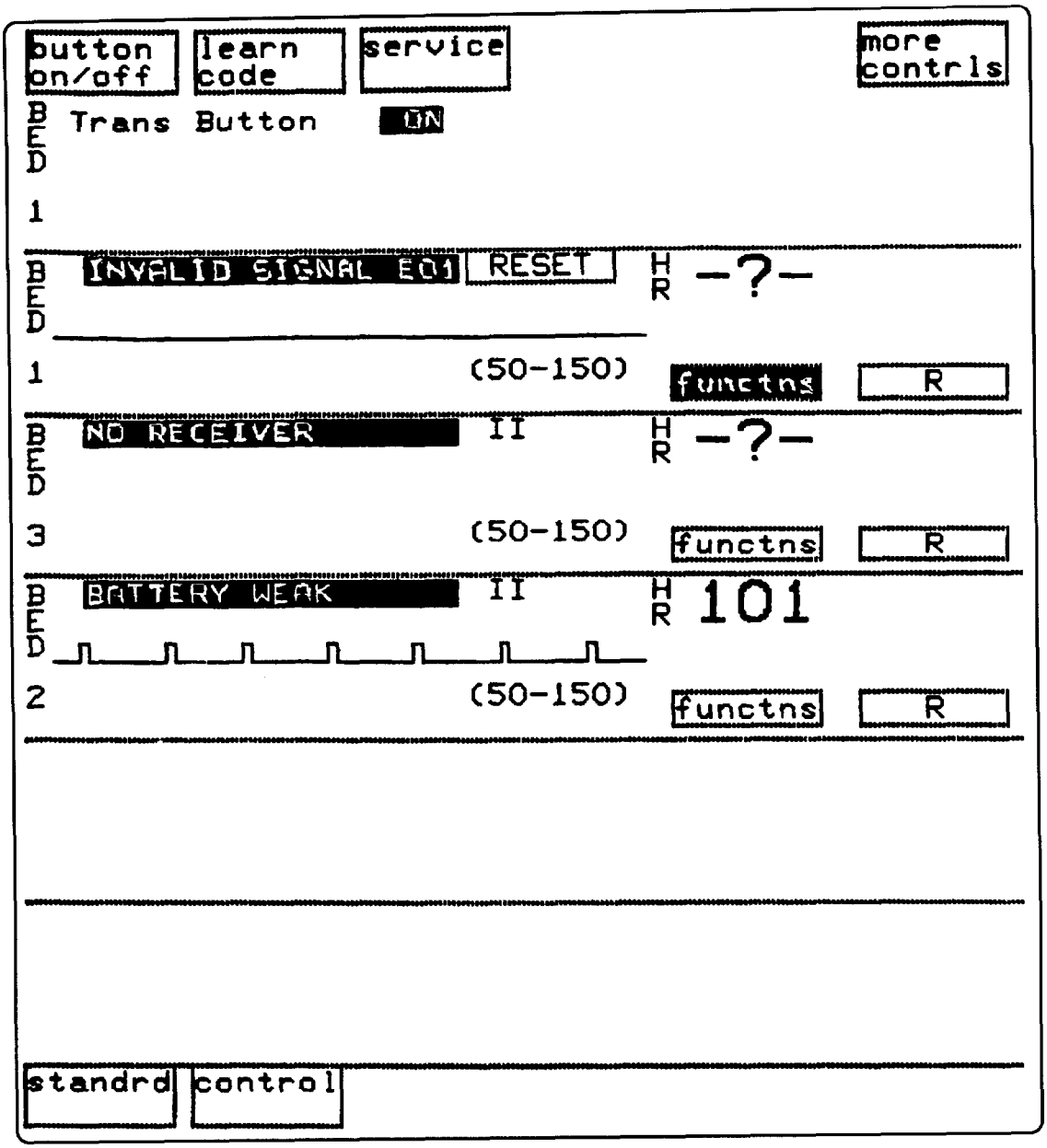


Figure 1-22. HP 78560A Central Monitor Learn Code Screen

2

Theory of Operation

2.1 Introduction

2.1.1 General Information

This section provides the operational theory of the HP M1403A Digital UHF Telemetry System. The section presents an overall functional description of the system, plus the theory of operation of each of its components. Component descriptions contain detailed functional explanations to board level, and an overview of some circuitry to further clarify how each board functions.

2.1.2 Overall Functional Description

Figure 2-1 shows a block diagram of the HP M1403A Digital UHF Telemetry System. The system provides ECG monitoring for an ambulatory patient in a hospital critical care ward. It consists of the following four major components:

- An HP M1400A or HP M1400B Transmitter
- An HP M1413B/M1414B UHF Antenna System, with an HP M1415B Antenna System Combining Network
- An HP M1402A Receiver Module
- An HP M1401A Receiver Mainframe which houses up to eight receiver modules and associated processing and distributing circuitry

Transmitter. The battery-powered HP M1400A/M1400B transmitter is worn by the patient. The transmitter acquires ECG data through an electrode leadset, applied to the patient, which functions as both data receptor and transmitting antenna. Once acquired by the transmitter, the ECG data is amplified, digitized and routed back through the leadset wires to be broadcast, at the transmitter's own unique ultra high frequency (UHF), to the system's receiving antennas.

Antenna System. Each of the system's receiving antennas picks up individual signals from all transmitters in its coverage area. The signals are amplified and routed by coaxial cable through a series of attenuators, line amplifiers, combiners, and splitters. At the output of the final splitter, each signal is forwarded to the transmitter's frequency-paired receiver module.

Receiver Module. The HP M1402A receiver modules process the received UHF ECG signals into a format that can be transferred to and used by the receiver mainframe.

Receiver Mainframe. The HP M1401A receiver mainframe calculates the heart rate from the signal and sends the ECG waveform, alarms, INOPs, and status messages over the Serial Distribution Network (SDN) to the central station for display and recording.

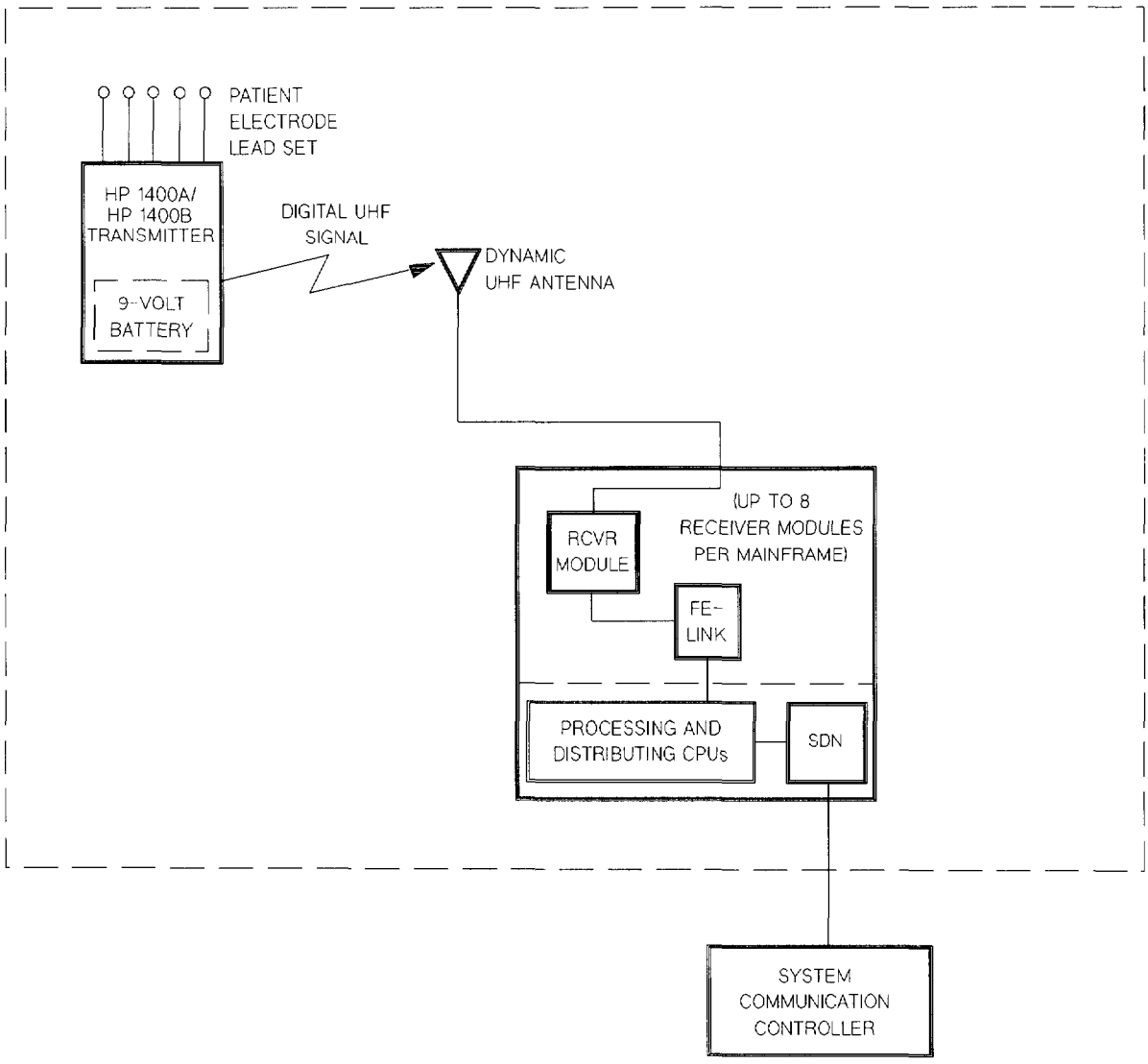


Figure 2-1. Block Diagram of HP M1403A Digital UHF Telemetry System

2.1.3 ECG Monitoring Capabilities

Note

If you have an earlier model of Central Station (before the M2300A Component Central Monitor release C.00), your vcentral station refers to the primary lead as ECG A and the secondary lead as ECG CH2. The Component Central Monitor release C.00 refers to the primary lead as ECG CH1 and the secondary lead as ECG CH2. The following paragraphs use ECG CH1 and ECG CH2 when discussing primary and secondary leads.

The HP M1403A uses three modes of monitoring. The normal mode of operation is defined by the lead set used, and uses the primary lead ECG CH1 as the data source for the cardiotach. (ECG CH2 is the secondary lead.) The HP M1403A operates in the normal mode unless a lead inoperative (INOP) signal is received. An INOP forces the HP M1403A into one or both of the secondary modes: fallback and extended monitoring, if configured—both of which can be disabled at installation as part of the HP M1401A configuration.

2.1.3.1 Fallback Mode

Fallback mode is a limited monitoring mode where a LEADS OFF INOP signal causes the HP M1403A to switch its ECG data source from ECG CH1 to ECG CH2. Fallback mode is invoked automatically 10 seconds after the INOP signal is sent. The HP M1403A reverts back to the normal mode 10 seconds after the inoperative condition is remedied. If an inoperative condition affects both channels, ECG monitoring stops until the inoperative condition for at least one of the channels is remedied.

2.1.3.2 Extended Monitoring

The four electrode leadset uses both transmitted ECG channels to reconstruct four of the six leads which can be monitored. The loss of any electrode and its associated ECG channel disables the four reconstructed leads. If a lead is lost for 10 seconds, the HP M1403A reassigns an operative lead to ECG CH2 to keep the channel operating. This is extended monitoring. Once extended monitoring begins, fallback can occur as described above. Ten seconds after the inoperative condition is remedied, the HP M1403A returns to the original configuration.

The user cannot control the switching between the monitoring modes, other than manipulating the inoperative condition which prevented normal operation.

2.2 Detailed Functional Description

2.2.1 HP M1400A and HP M1400B Transmitter

Note

The difference between the HP M1400A and HP M1400B transmitter is in output power only. The HP M1400A transmits at 2 milliwatts. The HP M1400B is equipped with a more powerful voltage controlled crystal oscillator (VCXO), and transmits at 4 milliwatts. The functional description is the same for both transmitters.

The HP M1400A/M1400B Transmitter is a battery powered (9-volt) transmitter worn by the patient. It acquires the ECG data of the patient via the leadset, amplifies and digitizes the data, and broadcasts the digital data at UHF to the receiver module in a receiver mainframe.

The transmitter transmits two ECG channels. The ECG channels are used to derive leads and are designated channel 1 and channel 2. The displayed waveforms may be viewed by the user as a combination of channel 1 and channel 2. The displayed waveforms are designated as ECG CH1 and ECG CH2, with ECG CH1 the source of the cardiotach. ECG CH1 and ECG CH2 may or may not be the same as channel 1 and channel 2.

The transmitter consists of three subassemblies:

- electrode lead set
- RF module
- transmitter motherboard assembly

Figure 2-2 shows a block diagram of the HP M1400A and HP M1400B transmitters.

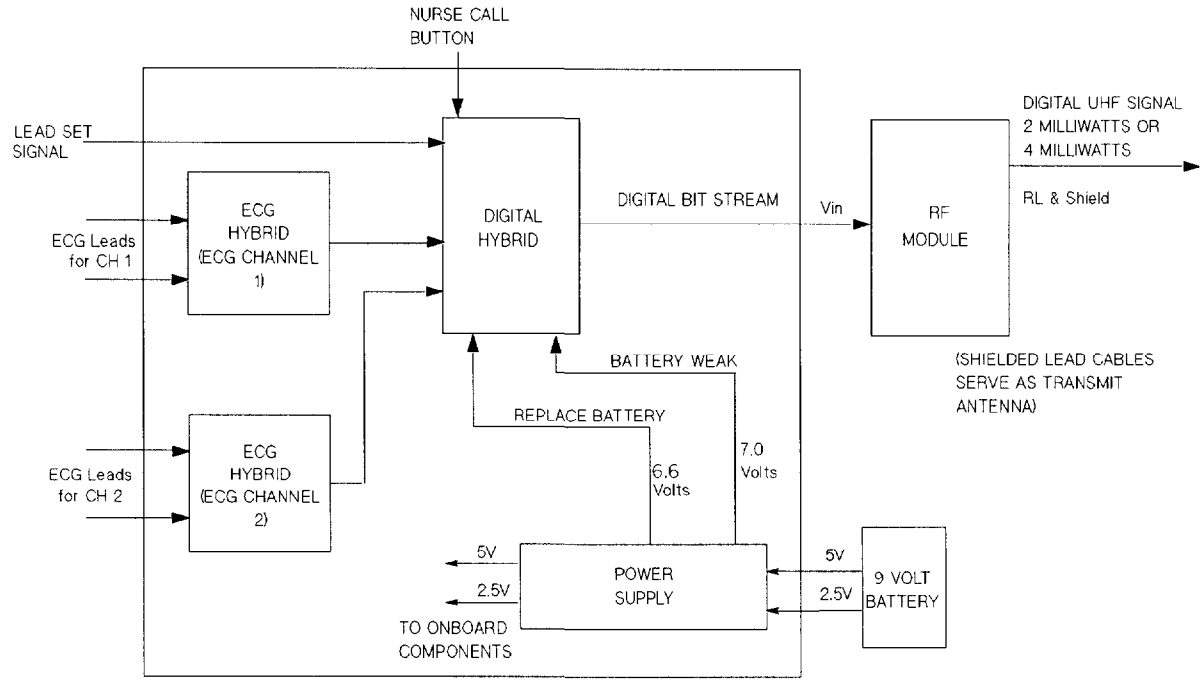


Figure 2-2. Block Diagram of HP M1400A/HP M1400B Transmitter

2.2.1.1 Electrode Lead Set

The electrode lead set provides connection from the inputs of the transmitter to the electrodes on the body of the patient. The system supports three lead set configurations: three-electrode, four-electrode, and five-electrode. All lead sets use the standard electrode placement. Each lead set has a lead set detect pin to allow the transmitter to identify the attached lead set. The detect pin allows the transmitter to distinguish between the four- and five-electrode lead sets; the transmitter treats the three- and five-electrode sets the same.

The transmitter sources two ECG channels when a 4- or 5-electrode leadset is used. Transmitted ECG channels are referred to as ECG channel 1 and ECG channel 2. Two ECG waveforms can also be viewed at the central monitoring station, although these may differ from the transmitted signal. To avoid confusion, the ECG waveforms viewed at the central monitoring station are referred to as ECG CH1 and ECG CH2. The lead assigned to ECG CH1 provides the source for the cardiotach for all leadsets.

The four-electrode lead set requires placement in standard locations and allows the user to choose between the two transmitted leads (I and II), and four reconstructed leads (III aVR, aVL, and aVF). The two ECG channels sent from the transmitter are combined in the receiver mainframe during lead reconstruction to generate the 4 possible reconstructed ECG lead choices. The user selects at the central monitoring station one of the six choices (or OFF) for each ECG CH1 and ECG CH2 (OFF only applies to ECG CH2). The leadset detect pin is shorted to the reference lead identifying the four-electrode leadset to the transmitter.

The five-electrode leadset sources two independent ECG leads. The default settings for the five-electrode lead set, using the standard configuration, are II and MCL. The ECG channels are mapped directly to ECG leads ECG CH1 and ECG CH2. Transmitter channel 1 normally transmits lead II which maps into ECG CH1 and channel 2 normally transmits an MCL lead which maps into ECG CH2. The five-electrode lead set connects to both ECG channels independently. The leadset detect pin is open circuited.

With the five-electrode leadset, ECG CH1 is always Channel 1 and ECG CH2 is either Channel 2 or OFF, unless Lead Swap is selected. The lead swap mode allows the user to swap the cardiotach lead (ECG CH1) between either of two leads selected at configuration. ECG CH2 will automatically receive the lead not swapped to ECG CH1, and will also support the OFF selection. Lead swap is only allowed if ECG CH2 is not OFF. No other lead choices are available in the standard five-electrode configuration. However, the user can use a non-standard electrode placement and receive a different pair of ECG leads. An example of this would be if the user were to move the chest electrode C. The user could receive MCL1, MCL2, MCL3, MCL4, MCL5, or MCL6, but the lead is always known as MCL and it is up to the user to identify which MCL lead is monitored.

The three-electrode lead set, whose label is also configured at installation for each receiver mainframe, sources one ECG lead on ECG CH1. ECG CH2 must be turned off at the central station by the user when the three-electrode lead set is used. Failure to do so results in a lead INOP. The three-electrode lead set connects to the reference pin and only ECG Channel 1 on the transmitter. ECG Channel 2 is open-circuited. The leadset detect pin is open circuited.

2.2.1.2 RF Module

The RF module is a voltage-controlled crystal oscillator (VCXO) operating at ultra-high frequency. It has a crystal frequency of one-quarter of the broadcast frequency. The crystal's fourth harmonic is selected and amplified twice. The digital bit stream from the digital hybrid is used to modulate the carrier frequency. Section 1 lists the actual broadcast specifications of the RF module. The shielded cable of the electrode lead set serves as the broadcast antenna for the transmitter.

2.2.1.3 Transmitter Motherboard Assembly

The transmitter motherboard assembly contains the entire electronics assembly for the transmitter. It is built to withstand pulses up to 4000V between any combination of inputs. This prevents a discharge path for defibrillation pulses. To shield the transmitter circuits as much as possible, all signal foils are run on the inner layers. The transmitter motherboard is comprised of the motherboard itself, two ECG hybrid PCBs (one for each channel), a digital hybrid PCB, and a power supply hybrid PCB.

2.2.1.3.1 ECG Hybrid PCB. The ECG hybrid PCB provides the basic measurement circuitry of the transmitter. It performs the following functions:

- Acquisition and preamplification of ECG signal
- Bandpass filtering
- Analog-to-Digital conversion of the ECG signal
- Leads off detection circuit
- Pace pulse detection circuit

The transmitter houses two identical ECG hybrid PCBs, one for the measurement of each channel. The following paragraphs describe one ECG hybrid PCB:

a. **Signal Acquisition Circuits.** The signal acquisition circuits acquire physiological signals from the patient, provide basic preamplification of the signals, filter the signals, and convert the signals from analog to digital form.

   Input protection circuitry provides protection for front end ICs. An RFI filter filters out unwanted RF on the input leads. The preamplifier circuit provides preamplification of the incoming ECG signal. It consists of a high-impedance differential amplifier feeding a differential-to-single ended converter. The converter converts the output of the differential amplifier to a single voltage referenced to the circuit ground. A high bandpass filter consisting of a 3.7 megohm resistor and an external 1 microfarad film capacitor sets the high pass characteristic at 0.05 Hz.

   Certain changes in dc offset level at the patient skin/electrode interface can result in large dc levels appearing across the 0.05 Hz high bandpass filter. Due to the characteristics of the high bandpass filter, dc signals eventually decay away, but at a time constant which is too slow. To rectify this situation, an INSTO circuit discharges the 1 microfarad capacitor quickly by switching in a lower value resistor across the 3.7 megohm resistor, reducing the time constant of the filter to an acceptable level. The INSTO circuit is asserted for 250 ms when the analog-to-digital conversion values of the ECG signal remain at an extreme positive or negative level for longer than 300 msec.

   A three-pole low pass filter limits the ECG bandwidth to 140 Hz. An analog-to-digital conversion circuit digitizes the ECG signal into 11-bit 2.5 ms samples.

b. **Leads Off Detection Circuit.** The leads off detection performs two functions. It detects leads which have fallen off of the patient, and it detects excessive amounts of dc offset across the signal inputs that may compromise monitoring quality. Excessive offset is defined as more than a 400 mV dc differential between the two signal input leads.

The first case of a lead which has fallen off has three parts:

- a positive input lead
- a negative input lead
- or when both positive and negative leads or the reference lead falls off a patient

When a positive input lead falls off a patient, the differential amplifier sees 0 volts on the positive input, and 2.5 volts on the negative input. This produces the maximum differential output from the amplifier which is sensed by the comparator and reported as an INOP. When a negative input lead falls off a patient, the differential amplifier senses 2.5 volts on the positive input, and 0 volts on the negative input. Again this produces the maximum differential output from the amplifier which is sensed by the comparator and reported as an INOP. When both input leads, or the reference lead fall off a patient, both input sides of the differential amplifier are pulled down to ground. Since the differential output is not large, the comparator does not sense anything. The comparator flags this unusually low voltage on the output of the differential amplifier as an INOP.

The differential amplifier senses dc offset as a valid input and the offset is amplified by the amplifier. The comparator converts this to a dc level reference to circuit ground. The threshold of the comparator is set at 400 mvolts. If a dc offset drives the comparator output above this threshold, an INOP is flagged.

c. **Pace Pulse Detection Circuit.** Pace pulses have a different frequency spectrum than ECG and other physiological signals. The primary circuit of the pace pulse detector is a three-pole high pass filter with the corner frequency at 1 KHz. The filter passes only the pace pulses and inhibits the ECG and other physiological signals.

2.2.1.3.2 Digital Hybrid PCB. The digital hybrid PCB contains the digital control and formatting circuits of the transmitter. It also contains an oscillator for baseband frequency control. The digital hybrid PCB performs the following functions:

- Provides buffering and processing for the patient call button, leadset detect pin, battery weak and replace battery signals, and unique transmitter ID code.
- Compresses and encodes the digital output of the A/D converter into a serial digital bit stream for transmission.
- Provides processing for analog detection circuits on the ECG hybrid PCB.
- Provides timing signals for all digital operations of the transmitter.

The transmitter houses one digital hybrid PCB which handles both ECG channels. The following paragraphs describe the digital hybrid PCB:

a. **Status Input Buffering.** Digital circuits provide buffering and processing for the patient call button, leadset detect pin, battery weak and replace battery signals, and transmitter ID code. These status inputs are multiplexed into the status field in the transmitted packet.

A line is connected to the patient call button on the transmitter case. Pressing the button places a ground on this line, causing a patient call status bit to be added to the transmitted message. Another line goes to the patient electrode leadset block where it is either open-circuited or connected to the 2.5 volt reference supply. The state of this line is level-shifted to a valid CMOS input. When open circuited, this line indicates a 3/5-electrode leadset is connected.

To provide positive identification of the data being received, each transmitter broadcasts a unique ID code. This code is programmed into the ROM of the digital hybrid. The battery weak and replace battery signals are also buffered by the digital hybrid PCB.

b. **Digital Signal Processing.** A compressor circuit compresses and encodes the ECG data from the analog-to-digital converter prior to transmission. The compressed data is packed into 288 bit data packets and output in gaussian shaped pulses to a digital filter. The digital filter chops the pulses and sends them through an analog filter to produce a smooth gaussian shaped digital bit stream.

c. **Detection Circuit Processing.** A pace pulse detection processing circuit flags the location of pace pulses detected by the analog circuits on the ECG hybrid PCB. This circuit also provides inhibit timing to prevent multiple detections of a single pace event. The INSTO processing circuit provides a dc restoration function for the high bandpass filters of the ECG hybrid PCB. If a dc offset forces the analog-to-digital converter to either the positive or negative extremes for a period of time, this circuit asserts the analog filter to bring the signal back into range.

d. **Oscillator.** The circuit timing for all digital operations is provided by a 2.457 MHz crystal oscillator.

2.2.1.3.3 Power Supply Hybrid PCB. The power supply provides regulated 5V and 2.5V from the 9V battery, and monitors battery condition. The power supply provides battery weak notification when the 9-volt battery reaches a voltage level of 7.0 volts. This signals the transmitter has less than an hour of monitoring time available. The power supply also provides replace battery notification when the battery voltage reaches 6.6 volts. The transmitter is inoperative until the battery is replaced.

2.2.1.4 Transmitter Signal

The digital message sent by the transmitter consists of a 288 bit frame sent every 30 milliseconds (ms), a data rate of 9600 baud. The frame consists of a 10-bit coded header, ECG data, status information, and checksums to monitor channel integrity.

Two ECG waveforms are derived from the ECG data and pace pulse information provided by the two channels. The status information is sent over an eight-bit slot in each frame. Status information includes INOP signals, button press information, leadset type information, and transmitter ID code.

2.3 HP M1402A Receiver Module

The receiver module is housed in the receiver mainframe. Each receiver module is dedicated to a specific transmitter. It receives the UHF data transmission from the transmitter and converts the serial data stream into a format that can be transferred through the receiver backplane to the receiver mainframe. The receiver module consists of two sections:

- an RF section
- a digital baseband section

Figure 2-3 and Figure 2-4 are block diagrams of the HP M1402A Receiver Module, and the receiver module RF section respectively.

2.3.1 RF Section

The RF section of the receiver module receives the UHF digital data transmission, down converts and demodulates it, then routes it to the digital baseband section as a serial data stream.

The HP M1402A is a dual-conversion, narrow-band FM receiver. It takes the incoming RF signal (for example, 460 MHz), mixes it with a local oscillator frequency (481.40 MHz) to generate an intermediate frequency (IF) of 21.40 MHz.

The IF is filtered and amplified several times, and then mixed with a second local oscillator frequency (20.945 MHz) to generate the second IF at 455 KHz.

The second IF is filtered and amplified several more times, and finally demodulated.

The receiver frequency is determined by the RF module used to generate the first local oscillator frequency. The RF module circuitry is the same as that of the transmitter RF module.

2.3.2 Digital Baseband Section

The digital baseband section converts the serial data stream detected by RF section into data suitable for transfer through the receiver backplane to the receiver mainframe. The conversion includes bit clock recovery, frame synchronization, unscrambling, error detection, unpacking and expansion of compressed data. The baseband digital section also supplies an automatic frequency control (AFC) voltage to control the local oscillator of the RF section. The digital baseband section can be split into three functional parts:

- detector
- microcontroller
- peripheral devices

2.3.2.1 Detector

The detector performs the basic conversion of the input serial data stream into digital data readable by the microprocessor. The input signal from the RF section is a noisy digital bit pattern. The bit pattern first passes through an RF filter which ensures that digital noise generated in the digital baseband section is not coupled into the shielded RF section. The detector then synchronizes where the bit cells (ones and zeros) are in the digital bit pattern and determines whether a one or zero was sent in each cell.

2.3.2.2 Microcontroller

The serial data stream output from the detector goes to the microcontroller where it is manipulated and processed into separate data items contained in the serial data stream. The serial data is transferred to the receiver backplane of the receiver mainframe. The microcontroller also provides control signals to the peripheral device, and a signal to the board failure line.

2.3.2.3 Peripheral Devices

An analog-to-digital converter and digital-to-analog converter are interfaced to the microcontroller to provide AFC to the RF section and received signal strength measurement.

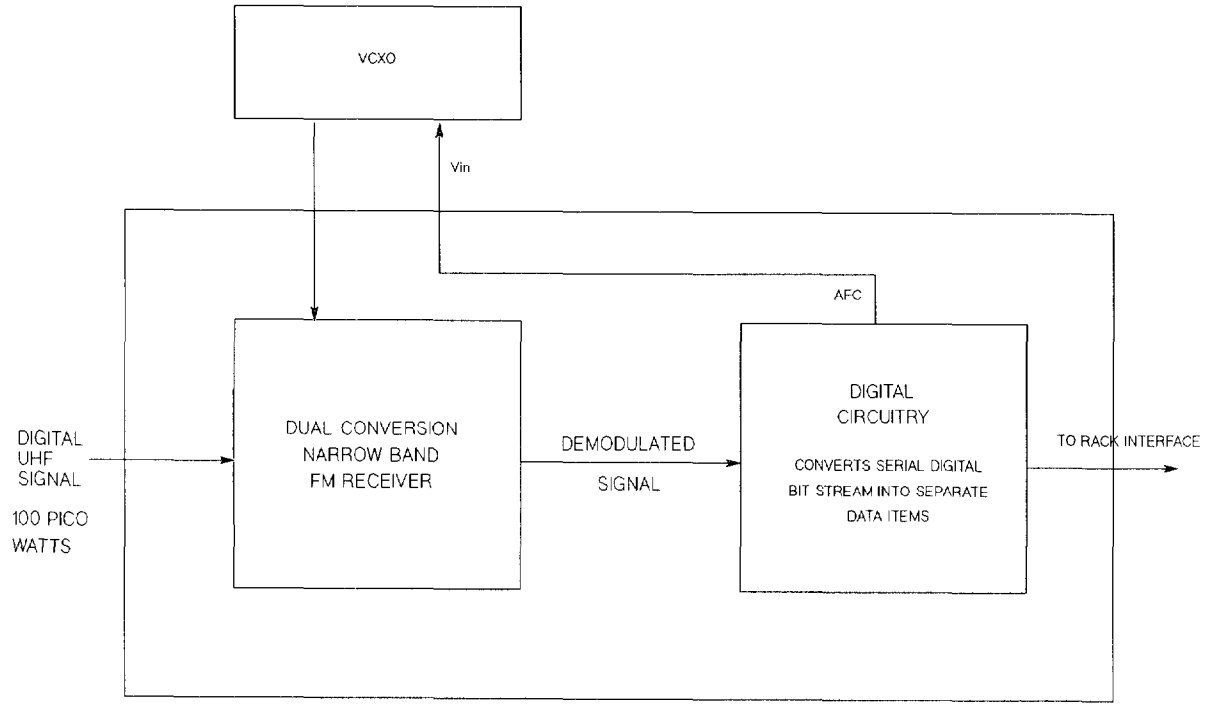


Figure 2-3. Block Diagram of HP M1402A Receiver Module

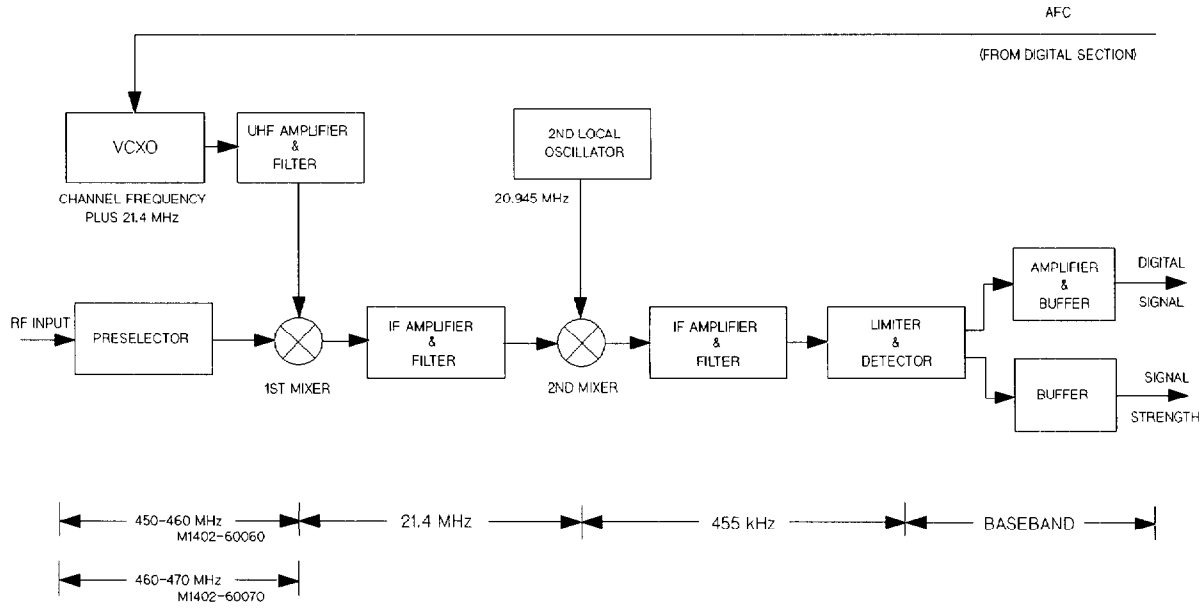


Figure 2-4. Block Diagram of HP M1402A Receiver Module RF Section

2.4 HP M1401A Receiver Mainframe

The HP M1401A receiver mainframe provides the physical interface between the receiver module and the central monitoring station via the signal distribution network (SDN). The receiver mainframe houses up to eight receiver modules, each one frequency matched to a specific transmitter.

For each receiver, the receiver mainframe calculates the heart rate from one of the two ECG leads, and sends the result with the ECG wave information and any alarms, INOPs, and status information over the SDN. The mainframe also provides lead reconstruction, gain adjustment, and filtering. The receiver modules receive incoming RF signals via a semi-rigid RF cable connected to the antenna distribution assembly. The receiver modules plug into the receiver backplane which provides interface to the internal power supply and the digital backplane. The digital backplane provides interface to the digital cardcage which houses the signal processing and distribution circuits. The processing and distribution circuits of the receiver mainframe consist of the following components:

- a rack interface
- utility CPU
- SDN Interface
- Turbo processor card
- EPROM Board

Figure 2-5 shows a block diagram of the HP M1401A Receiver Mainframe.

External LEDs indicate malfunctions that may occur in the receiver mainframe. Each receiver module slot (1 – 8) has a malfunction LED associated with it. The LEDs are located on the antenna distribution board and visible when the front dress cover is removed. When an LED is not illuminated, the receiver module is not recognized by the mainframe. When an LED is flashing at a rate of once per second, the receiver module for that LED is receiving and working properly. When an LED is flickering at a rapid rate, the receiver module cannot find a good signal. When an LED remains illuminated steadily, this indicates a malfunction has been detected in the receiver module corresponding to that LED.

In addition to the eight receiver module malfunction LEDs, the receiver mainframe has a separate mainframe malfunction LED. The mainframe malfunction LED is visible through a hole in the front dress cover and illuminates to indicate a malfunction has occurred within the mainframe.

Cooling for the internal assemblies of the receiver mainframe is provided by a dc fan. You may have one of two fans:

- a 24 Vdc fan that plugs into the receiver backplane, or
- a 12 Vdc fan which plugs directly into the power supply (M2604-60000 and M2604-60001 power supplies only)

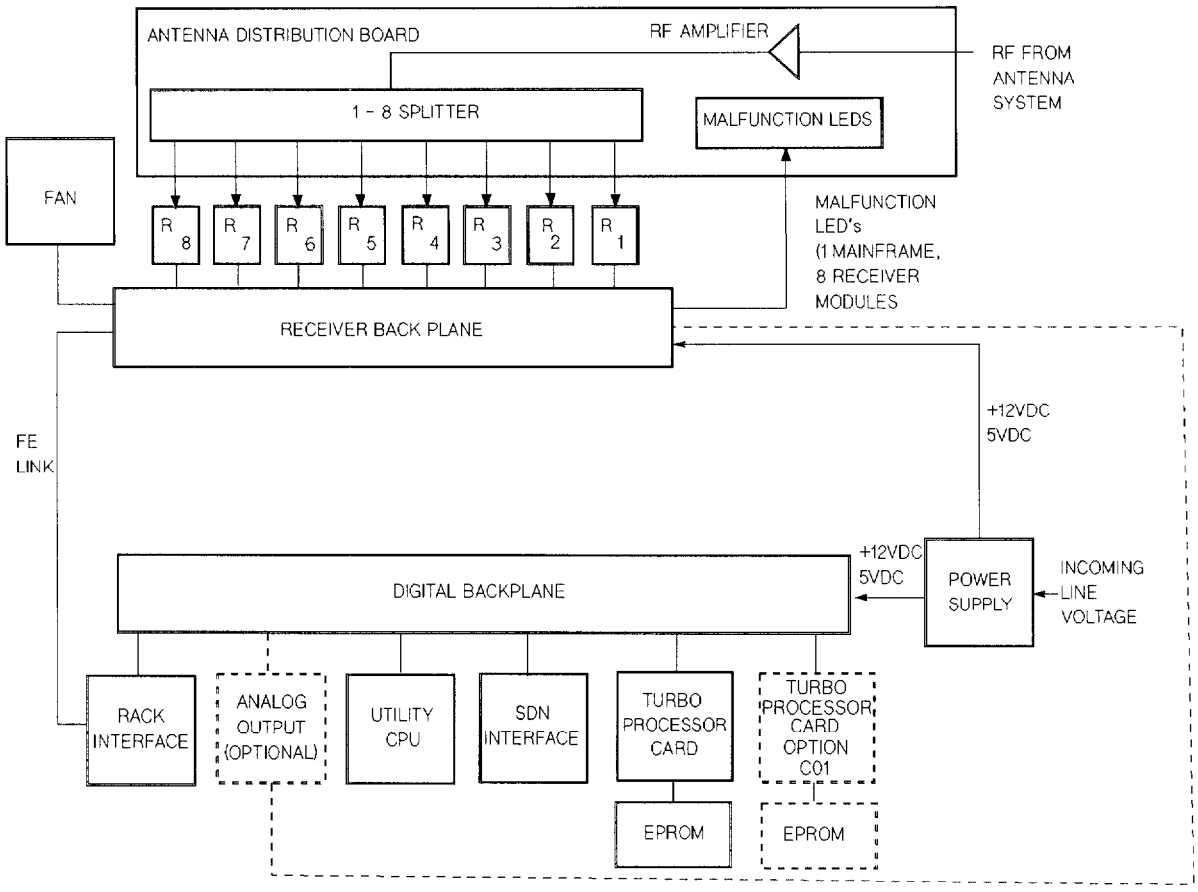


Figure 2-5. Block Diagram of HP M1401A Receiver Mainframe

2.4.1 Power Supply

Note

The original power supply for the M1401A Receiver Mainframe (part number M1401-60630) cannot be used with the ST option, nor can it be used with option C03. If you have installed the ST option or Option C03, you must change the power supply. When you order a new power supply, you will receive either part number M1401-60631 or M2604-60001. Both of these power supplies can support the ST option and Option C03. There is a difference in the ways the internal cooling fan is connected depending upon which power supply you have. This difference is noted where required within the manual.

The power supply is a conventional linear power supply where the incoming line voltage is stepped down in a power transformer. Power supply circuits rectify, filter, and regulate the secondary voltages. The incoming line voltages can be one of four ranges:

- 100 Vac ± 10%
- 120 Vac ± 10%
- 220 Vac ± 10%
- 230-240 Vac ± 10%

Line selector switches S1 and S2 select the incoming line voltages. The power supply uses four primary line fuses. The line and neutral sides of the incoming voltage line have two accessible fuses (F1 and F2) ahead of the power switch. The power transformer has two other fuses (F3 and F4) placed in series with each of its primary windings. Fuses F3 and F4 are not externally accessible. The power supply generates two logic signals:

- the SR (system reset) at start up
- PF (power fail) during power shut down

2.4.2 Antenna Distribution Assembly

The antenna distribution assembly distributes the RF signal received from the external antenna system to each receiver. The external antenna connection to the receiver mainframe is made through a single BNC connector on the rear panel, through the internal antenna cable, and connected to the antenna distribution assembly. An RF amplifier amplifies the incoming RF signal. A low loss 1-to-8 splitter follows the amplifier. It distributes the received RF signal to each receiver module.

The antenna distribution assembly also contains a digital section consisting of eight receiver malfunction LEDs, one power-on LED, and a watchdog circuit which drives the mainframe malfunction LED. A logic pulse train from the rack interface resets the watchdog timer. If greater than 600 msecs elapses between receipt of pulse trains, the watchdog timer output illuminates the mainframe malfunction LED.

2.4.3 Receiver Backplane

The receiver backplane provides the interfaces that were previously described. It provides connections from the eight receiver modules to the rack interface using the front-end high-speed serial link (FE-LINK). The FE-LINK serves as an 8-to-1 multiplexer which allows sequential communication between the rack interface and each receiver.

2.4.4 Digital Backplane

The digital backplane consists of one nine pin connector and nine 96-pin connectors. The nine pin connector interfaces the power supply with the digital backplane. The receiver mainframe PCBs plug into the 96-pin connectors creating a multiprocessor system consisting of the utility CPU and one or more turbo processor cards. The turbo processor card(s) and the utility CPU communicate with each other by exchanging messages, but do not have access to each other's memory. The message passing architecture can be split into three logical parts or busses:

- message passing bus
- local bus
- utility bus

The message passing bus is the global communications bus for the receiver mainframe, and is used for communications between the CPUs and intelligent interface PCBs. The local bus is used for data transfer among the utility CPU, SDN interface, and rack interface. The utility bus routes power and clock functions to the PCBs connected to the backplane.

2.4.5 Rack Interface

The rack interface provides communication between the turbo processor card(s), via the utility CPU, with the eight receiver modules. It acquires serial data at 500 Kbaud and status from the receiver modules, and sends control signals to them using the FE-LINK. The rack interface polls the receivers in the receiver mainframe as to their status. It uses this information to control the logic pulse train to satisfy the watchdog timer on the antenna distribution assembly. If a malfunction occurs in a device in the receiver mainframe, the pulse train is inhibited, causing the watchdog timer to trigger the mainframe malfunction LED.

The rack interface transfers data internally using a switched RAM method. Two banks of switched RAM are used alternately by the on-board 8051 microprocessor and the 68000 microprocessor on the utility CPU. Every 32 ms the RAMs are switched, so the RAMs can be accessed by the other microprocessor. This allows the faster 68000 microprocessor to exchange data with the RAM and then run on before the RAMs are switched. The 8051 microprocessor then converts the data into serial data for passing to the receiver modules over the FE-LINK. Received serial data from the receiver modules is converted to parallel data and placed into RAM by the 8051 microprocessor. The RAMs are then switched, allowing the utility CPU to exchange data again.

2.4.6 Utility CPU

The utility CPU is responsible for the rack and SDN interfaces, synchronization, and all of the clock signals for the receiver mainframe. The utility CPU is based around a 68000 microprocessor and stores the configuration of the receiver mainframe on an 8-Kbyte EEPROM. A description of the interfaces between the utility CPU and the rack interface and SDN interface is found in paragraphs 2.4.5 and 2.4.7, respectively.

2.4.7 SDN Interface

The SDN interface provides the interface between the turbo processor card(s), via the utility CPU, and the serial distribution network (SDN). The SDN interface transmits and receives data to and from the SDN over a two-wire bus.

The SDN polls the SDN interface every 32 ms. The poll cycle is divided into 4 ms dead time and 28 ms for passing data to and from the receiver mainframe. The onboard RAM consists of two 2Kb buffers; one transmit, one receive. During the dead time, the utility CPU places all data into the transmit half of the SDN interface onboard RAM. A SIC chip on the SDN interface sends the data over the SDN during the 28ms communication period. Received data is placed in the receive half of the onboard RAM where it is read by the utility CPU during the dead time.

2.4.8 Turbo Processor Card and EPROM Board

The Turbo Processor Card is a general-purpose processor consisting of:

- a 32-bit microprocessor
- static RAM
- a local-bus interface
- a message passing bus interface

It also has an 84-pin connector and mechanical provisions for mounting the EPROM Board.

The turbo processor card runs the software that controls the overall operation of the receiver mainframe. The software resides in the EPROM board. The message-passing bus interface provides all the necessary communication with other cards plugged into the digital backplane. The local bus interface is not used by the turbo processor card.

With option C01, the receiver mainframe is equipped with a second turbo processor card and EPROM board. The second turbo processor card slaves from the turbo processor card in slot D5, and is configured with firmware which runs the ST segment analysis and handles two-channel delayed recording for the PIC.

2.4.9 Configurable Processor Card (Option CO3 or upgraded mainframe only)

The 40 MHz configurable processor card replaces the turbo processor card(s) in the mainframe with option C03. The CPC is a CPU card. It processes the application data for the receiver mainframe. The CPC receives data from the MPB, processes the data, and places the results of the data processing on the MPB.

The CPC contains the following functional areas:

- Data Processing
- MPB interface
- Memory Array

Figure 2-6 shows a block diagram of the HP M1401A Receiver Mainframe with option C03..

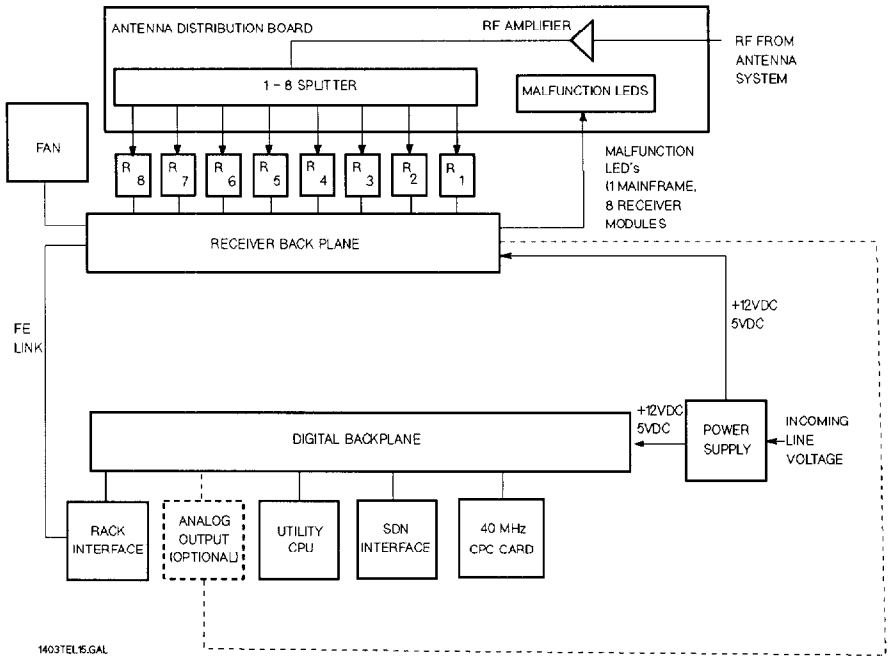


Figure 2-6.
Block Diagram of HP M1401A Receiver Mainframe (option C03) with 40 MHz CPC Card

Data Processing

The data processing functions for the CPC card are controlled by a 68EC030 CPU operating at 40 MHz. The data processing functions performed include:

- Interrupt generation
- Address decoding
- Bus error logic control
- Power fail (PFAIL) and system reset (SYS-RESET) functions
- Error LEDs
  a. One MPB Error LED (red) is used to indicate a problem with a device on the card.
  b. Two Error/Status LEDs (green) are under software control and may be implemented to indicate a hardware failure on the card during the boot phase, when no MPB messages can be sent. When the system is running they may also be used to reflect the status of the card.

Memory Array

The CPC card contains four types of memory. These are:

- Flash EPROM
- DRAM
- Buffered SRAM
- Fast SRAM

The Flash EPROM contains the operating software. The Flash EPROM is programmed using the CPC programming tool. The EPROM normally has VPP set low (between 4.0V and 4.5V) and functions as read-only memory. The tool operates by setting VPP high (12V) and writing an appropriate instruction to the EPROM.

The 1 Mbyte DRAM is used for two purposes: to download programs from the Flash EPROM for faster execution, and to provide unbuffered storage for applications.

The fast SRAM is used primarily for program execution speed enhancement. The fast SRAM is configured as one 32 bit wide bank of 128 kbytes.

The 128 kbytes of buffered SRAM stores application data in the event of a power failure. The SRAM bank is backed up by a super-capacitor to provide a minimum of three hours of storage.

2.4.10 Analog Output

The analog output option creates analog signals that can be used to drive the ECG level inputs of bedside monitors or Holter recorders. Digital data, in the form of a serial data stream, is acquired from the FE-LINK at 500 Kbaud. The stream contains status information for all eight receivers as well as digitized ECG signals. At the analog output board, the data stream is decoded and converted to analog voltages at a gain 500 times the original signal level. A breakout box then splits the signal into eight output pairs which are placed on individual patient jacks to provide one bedside monitor and one Holter recorder output for each receiver module. The bedside and Holter output circuitry attenuates the signals back to ECG levels.

INOP flags from leads off, battery dead, and data invalid conditions are encoded as voltage levels onto each analog output signal, causing the signal to assume a very high impedance that is interpreted by the monitoring device as a LEADS OFF. Additionally, a separate failsafe circuit forces all outputs to a LEADS OFF condition if mainframe power is lost or if there is a malfunction in the analog output system.

Pace pulse flags sent with the data stream cause the analog output system to create a synthesized pace pulse of fixed amplitude and duration. The system analyzes the ECG data surrounding the flags to determine and to match the original polarity of the pace pulse. The duration of the synthesized pace pulse is intentionally made very short so that it will be detected by the bedside monitor, but will not disturb the arrythmia monitoring system.

A block diagram of the Analog Output system is shown in Figure 2-7.

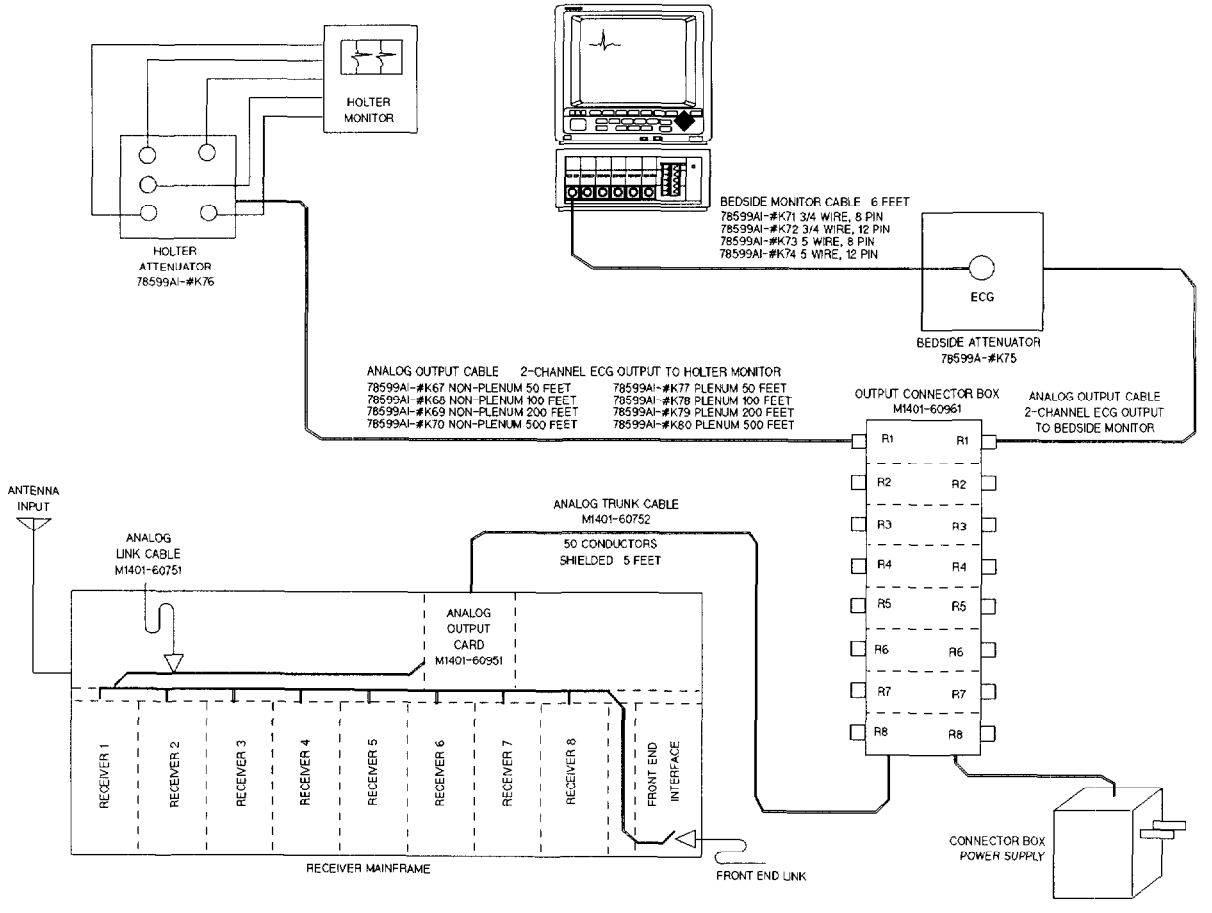


Figure 2-7. Block Diagram of Analog Output System

2.5 Dynamic UHF Antenna System

The antenna system receives the RF signal from each transmitter in the coverage area, and provides the signal to each receiver module in the receiver mainframes. The antenna system consists of active antenna/combiners with quarter-wave monopole antennas, cables, line amplifiers, attenuators, splitter/combiners, and a dc power system which interfaces to the receiver mainframes. Figure 2-8 shows a block diagram of a typical antenna system.

Installation instructions for the antenna system are provided in **Installation Note M1403-91908**, which immediately follows the General Information section in this manual.

2.5.1 HP M1408A Active Antenna/Combiner

The HP M1408A Active Antenna/Combiner incorporates a UHF quarter-wave monopole antenna, a signal combiner, and an RF amplifier in one unit. The amplifier has a bandpass range of approximately 406 - 512 MHz.

The antenna/combiner accepts two RF signals—one from its antenna, and one from the line. The signals are coupled together in an unequal power combiner, amplified, and then cascaded to the next antenna/combiner in the string. At the end of the string, the signal is routed to the antenna system combining network for processing.

A block diagram of the antenna/combiner is illustrated in Figure 2-9. As shown, the incoming RF signal from the antenna is sent through a bandpass filter and coupled with the line signal in a power combiner. The power combiner is unequal for easy manipulation of the system noise figure and 1dB compression point. The two signals are impedance-matched in the combiner and routed to the amplifier, which increases their gain by approximately 9.7 dB. The amplifier's operating voltage is 19 - 32Vdc at 50 mA. It receives dc power from the coaxial cable at its RF output connection.

The antenna/combiner also has a circuit which regulates amplifier voltage to a maximum of +12Vdc, and a sensing circuit that indicates, by LED, whether its power/signal cables are properly connected.

2.5.2 HP M1406A Line Amplifier

The HP M1406A line amplifier increases the RF signal with a typical gain of 12.5 dB to compensate for losses in the antenna network. It is powered through the coaxial cable on its output. The line amplifier draws required dc operating power through its RF signal output connection, and passes unused power through its input to any other active elements further up the antenna string. The line amplifier is used in the HP M1415B Antenna System Combining Network.

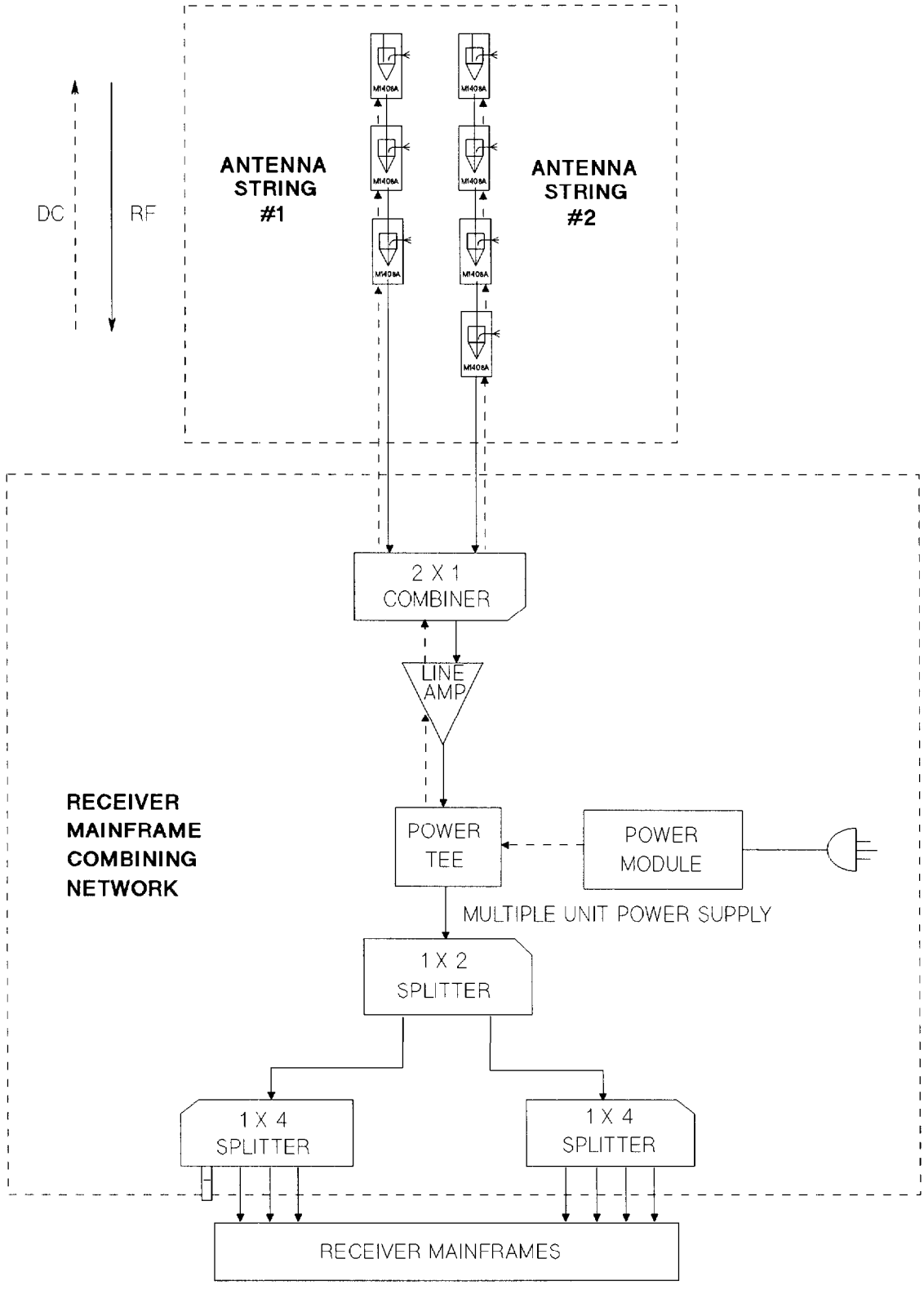


Figure 2-8. Block Diagram of Typical Antenna Subsystem

2.5.3 HP 78103A Two-Way and HP 78104A Four-Way Splitters and Combiners

Two- and four-way splitter/combiners are used to route RF signals from multiple antennas to the receiver mainframe. Used in one direction, the splitter/combiners divide one RF signal into two or four separate signals. Used in the opposite direction, they combine two or four separate RF signals into one signal. Two- and four-way splitter/combiners are used in the HP M1415B Antenna System Combining Networks.

2.5.4 DC Power System

The HP M1407A Multiple Unit Power Supply is comprised of a power tee and a power module, which can supply up to 14 line amplifiers or active antenna/combiners in a pre-configured system. The two components are connected by a 7-foot, multi-conductor cable and a 6-pin Deutsch Industrie Normen (DIN) connector.

The power tee contains an RF biasing circuit, RF filtering circuits, a circuit breaker, and a green power indicator that lights when the tee is receiving power. The power tee passes dc power out of its RF signal input and blocks dc voltage on its RF signal output. By doing so, it prevents unwanted dc voltage at the input of the receiver mainframe, and avoids placing two or more power tees in series and providing excessive power on the cable.

The power module provides 24 Vdc, 0 to 1.4 ampere, unregulated power. Its output varies between 19 and 35 volts depending upon load, temperature, and input conditions. This satisfies the input power requirements of the antenna system.

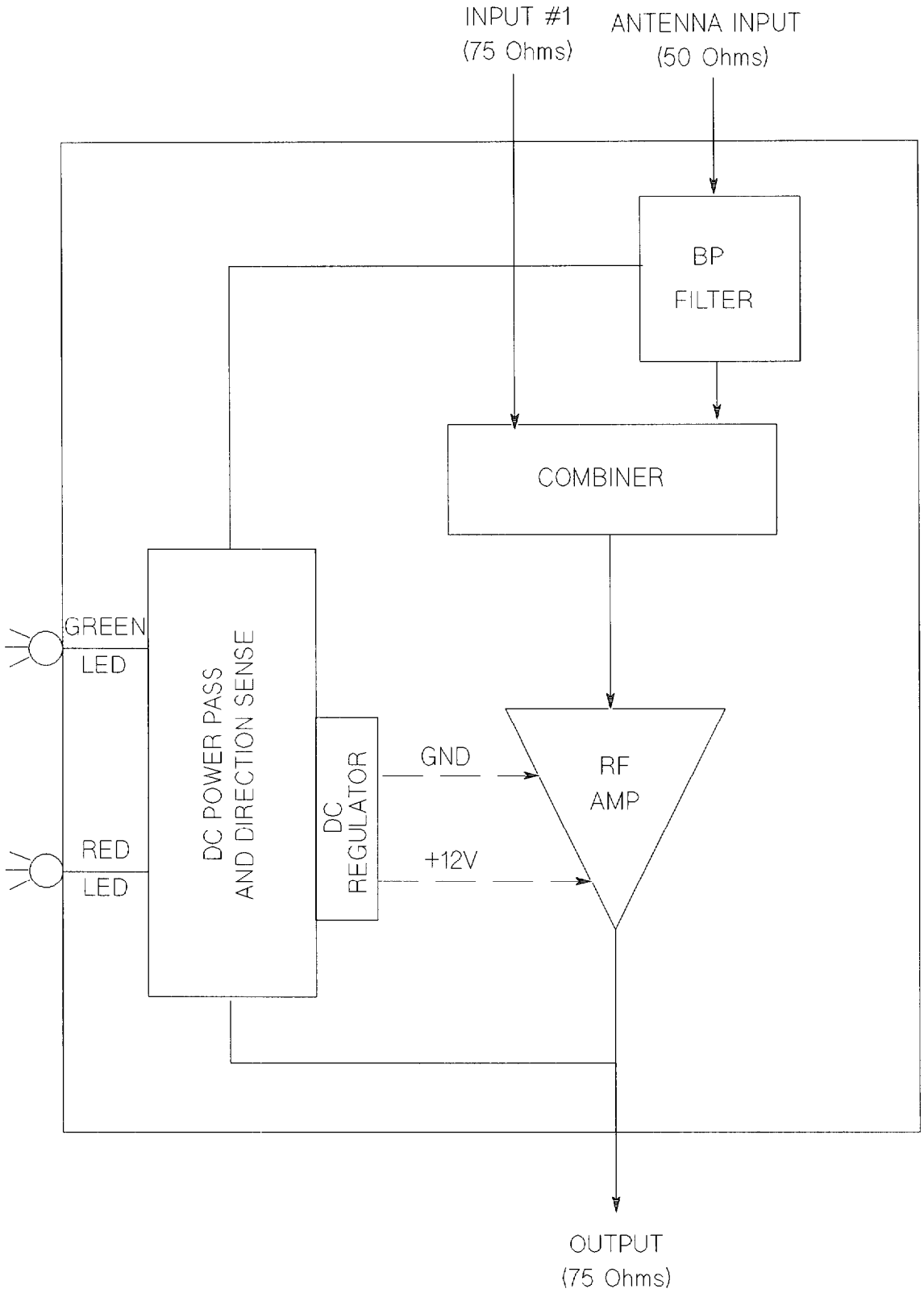


Figure 2-9. Block Diagram of the Active Antenna/Combiner

3

Maintenance

Maintenance consists of performance assurance checks, specification checks, safety checks, and cleaning and sterilization procedures. The HP M1403A Digital UHF Telemetry System has no calibration procedures.

Tools and Equipment Required:

Use any high input impedance multimeter capable of measuring milliohms, true rms millivolts, and milliamperes.

3.1 Performance Assurance Checks

The system performance test checks the telemetry system end to end. Two subsystem diagnostic tests separate the receiver mainframe and Central Monitor from the paired receiver module and transmitter combination in preparation for troubleshooting. An antenna system check and a cooling fan check are provided.

Performance assurance checks should be performed annually or as required.

Note

The performance assurance checks assume that the telemetry system is fully installed, that SDN beds have been assigned, and that the *transmitter identity code* has been learned by the receiver. Also that an antenna (or an antenna system) is attached to the receiver mainframe and that the transmitter is near the antenna.

If a receiver module is transferred into another receiver mainframe slot the *transmitter identity code* has to be re-learned. For more information, refer to paragraph 1.5.7.2.

3.1.1 System Performance Check

To check end-to-end telemetry system performance with a Patient Information Center (PIC) or HP 78560A Central Monitor:

1. Turn on the HP M1401A Receiver Mainframe and the Central Station. Refer to **Note** above for setup conditions.
2. Select the bedside being tested (and `telemetry functions` on the Central Monitor).
3. Put a battery in the transmitter, close the battery door, and attach a leadset (which functions as the broadcast antenna) to the ECG connector.
   a. **If an ECG simulator is available**, attach the ECG leads to the simulator.

      TEST RESULTS: An ECG trace should be visible on the screen.

b. **If a simulator is not available**, remove the ECG leads from the connector or take the battery out of the transmitter.

TEST RESULTS: A Leads OFF INOP should appear on the screen.

4. Check the function of the transmitter button.
5. Remove battery, ECG leads, and simulator (if used) from the transmitter.

If the test indications do not appear, proceed to the following diagnostics to isolate the defective part of the system. Then refer to service manual Troubleshooting, Paragraph 4.3, Telemetry Service Screens to check hardware status, error codes, and INOP indications.

3.1.2 Receiver Mainframe and SDN System Connections Diagnostic Check

This subsystem test applies to telemetry systems that are used only with the HP 78560A Central Monitor. All eight beds are tested at the same time.

The HP M1401A Receiver Mainframe SDN connections are tested by a *demonstration mode* of the Central Monitor. This test is useful in ruling out a transmitter/receiver pair as defective and determining whether the receiver mainframe is communicating with the Central Monitor or SDN system.

Note If demonstration mode is initiated, all monitoring will stop.

The demonstration waveform (Figure 3-1) appears as a simulated square wave with other simulated data on the Central Monitor screen. The demonstration display indicates that the receiver mainframe is working and communicating with the Central Monitor; it does not generate a real waveform or data, nor does it test the receiver module or the RF portion of the system, which is described in Paragraph 3.1.3.

Note If you lose the sequence of softkey labels in this procedure, simply touch the `standard` softkey label and start over again. No transmitters need to be energized for this check.

To check the receiver mainframe and the SDN connections to the Central Monitor:

1. Turn on the HP M1401A Receiver Mainframe. The green power-on LED will illuminate.
2. Turn on the HP 78560A Central Monitor. The green power-on LED will illuminate.
3. Touch the `functns` softkey (video) label shown on the Central Monitor screen. The border of the label will brighten to acknowledge the touch.
4. Touch the `telem functns` softkey label.
5. Touch the `more cntrls` softkey label until the `service` softkey label appears.
6. Touch the `service` softkey label.
7. Enter the code 1-4-0-0 by using the keys in the upper left corner of the screen.
8. Touch the `demo` softkey label.

9. The following message will appear:

   OPERATING MODE CHANGE WILL STOP ALL PATIENT MONITORING ACTIVITY. Continue?

10. See the following NOTE, then touch the yes softkey label.

Note

Selecting yes will cause the telemetry system to change the user-selected patient setting to the user default settings. Sector 1 on the Central Monitor screen will disappear temporarily until the test waveform appears.

TEST RESULTS: The following messages and the demonstration waveform will verify that the receiver mainframe and Central Monitor are in communication.

First, note the message:

NO DATA FROM BED

Then a series of simulated square-wave pulses and the message:

TEST DATA

will appear. After the cardiotach stabilizes, a low heart rate number (60, for example) will be shown to the right of the display.

If the receiver mainframe or SDN cabling is defective, refer to the service manual troubleshooting section.

Note

All bedsides in a receiver mainframe are tested at the same time by this procedure, given that at least one bedside is assigned. To check bed number assignments on the SDN, press the control softkey label and then the setup softkey label. The bed label and sector assignments will be shown.

To resume patient monitoring (or other) activity:

1. Touch the standard softkey label.
2. Touch the functns softkey label.
3. Touch the telem functns softkey label.
4. Touch the more cntrls softkey label until the service softkey label appears.
5. Touch the service softkey label.
6. Enter the code 1-4-0-0 by using the keys in the upper left corner of the screen.
7. Touch the demo softkey label.
8. The following message will appear:

   OPERATING MODE CHANGE WILL RESUME PATIENT MONITORING ACTIVITY. Continue?

9. Touch the yes softkey label. Patient monitoring will resume.

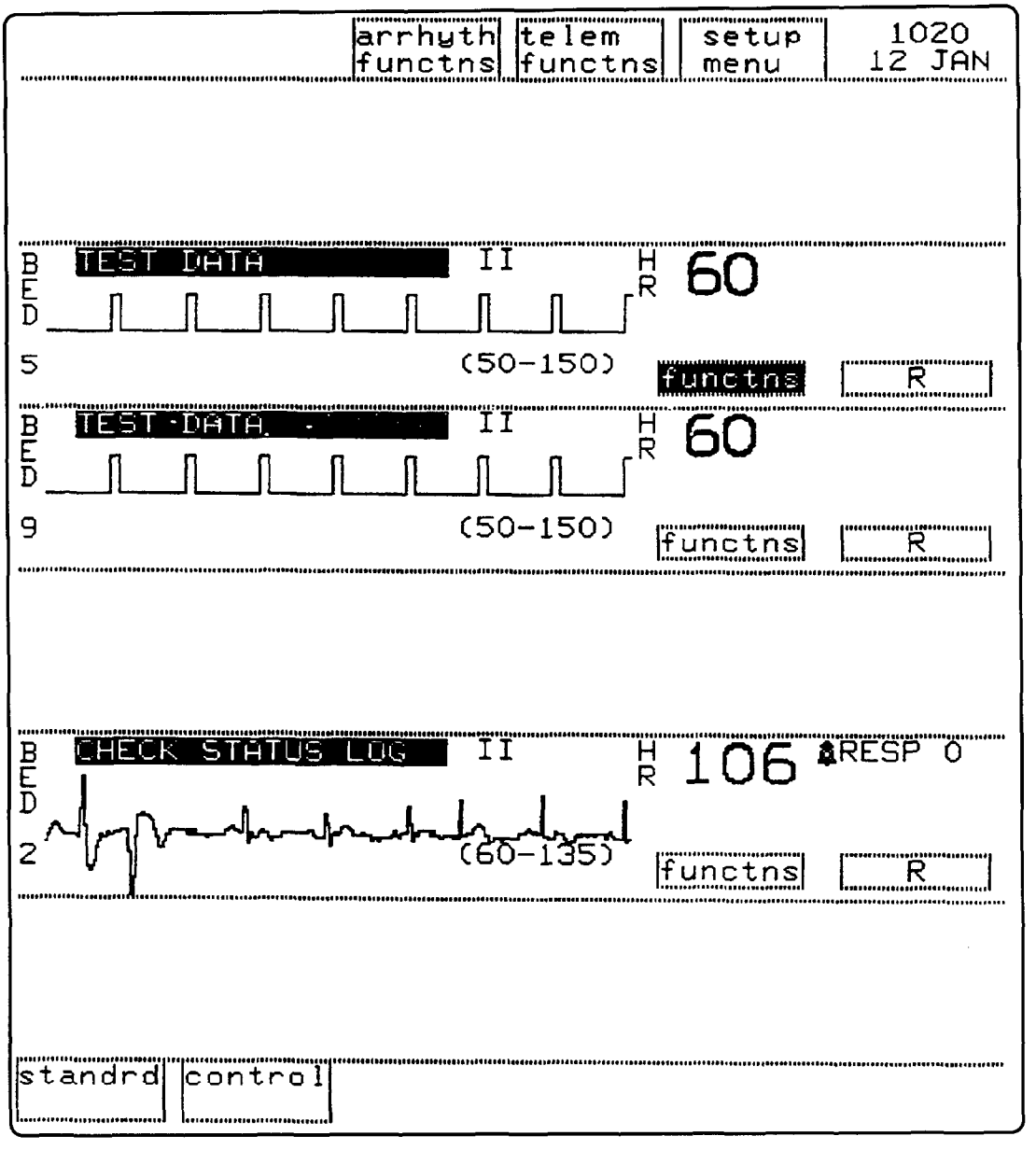


Figure 3-1. Demonstration Mode Screen

3.1.3 Radio Frequency Link and Receiver Module Diagnostic Check

This test is used with Central Monitor and PIC RF subsystems. The transmitter/receiver combination for each bedside (and the antenna system) is checked by a self-test program. Note that the transmitter can be used only with the associated receiver module. See previous note about performance test equipment setup requirements.

To test the receiver module and transmitter:

1. Insert a 9-volt battery in the HP M1400A/HP M1400B Transmitter for the channel under test.
2. Attach an ECG leadset (broadcast antenna) to the transmitter ECG cable connector.
3. Apply power to the HP M1401A Receiver Mainframe. The green power-on LED will illuminate.
4. Remove the receiver mainframe front cover (two quarter-turn fasteners).
5. Inside the mainframe, a group of repeater LEDs indicates receiver module 1–8 status (Figure 3-2). Each module LED has the following meanings:

   Blinks steadily at a 1 Hz rate if the receiver module is working.

   Comes on steadily or stays off if the module failed self-test.

   Blinks randomly if no radio-frequency energy is received.

TEST RESULTS: The LED should blink steadily, once per second. If not, refer to Troubleshooting, Section 4 of the service manual.

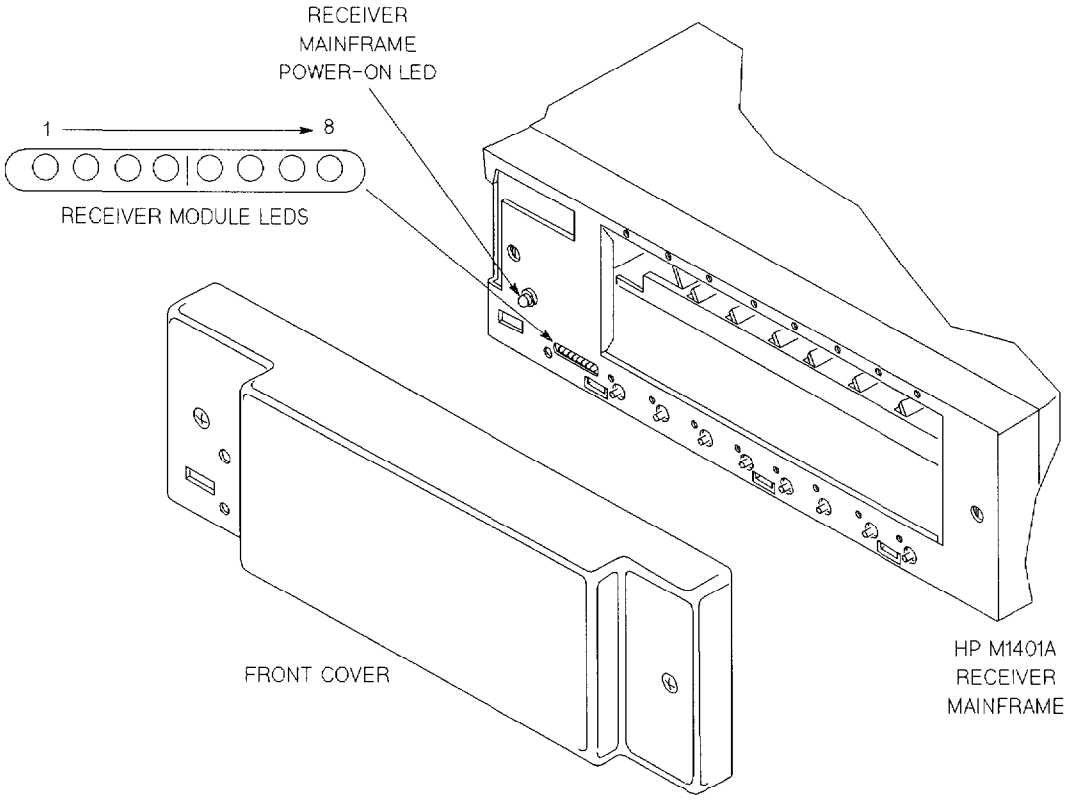


Figure 3-2. Receiver Module LED Indicators

3.1.4 Antenna System Check

Active antenna system power may be checked by observing the green power-on LED on each antenna base. An annual check of all active antenna/combiners is recommended .

Antenna system performance should be checked by following the procedures described in the Dynamic UHF Antenna System Installation Note (HP M1403-91908), which follows chapter 1 in this manual. The performance check should be done when the antenna system is first installed, if it is modified subsequently, or at yearly intervals.

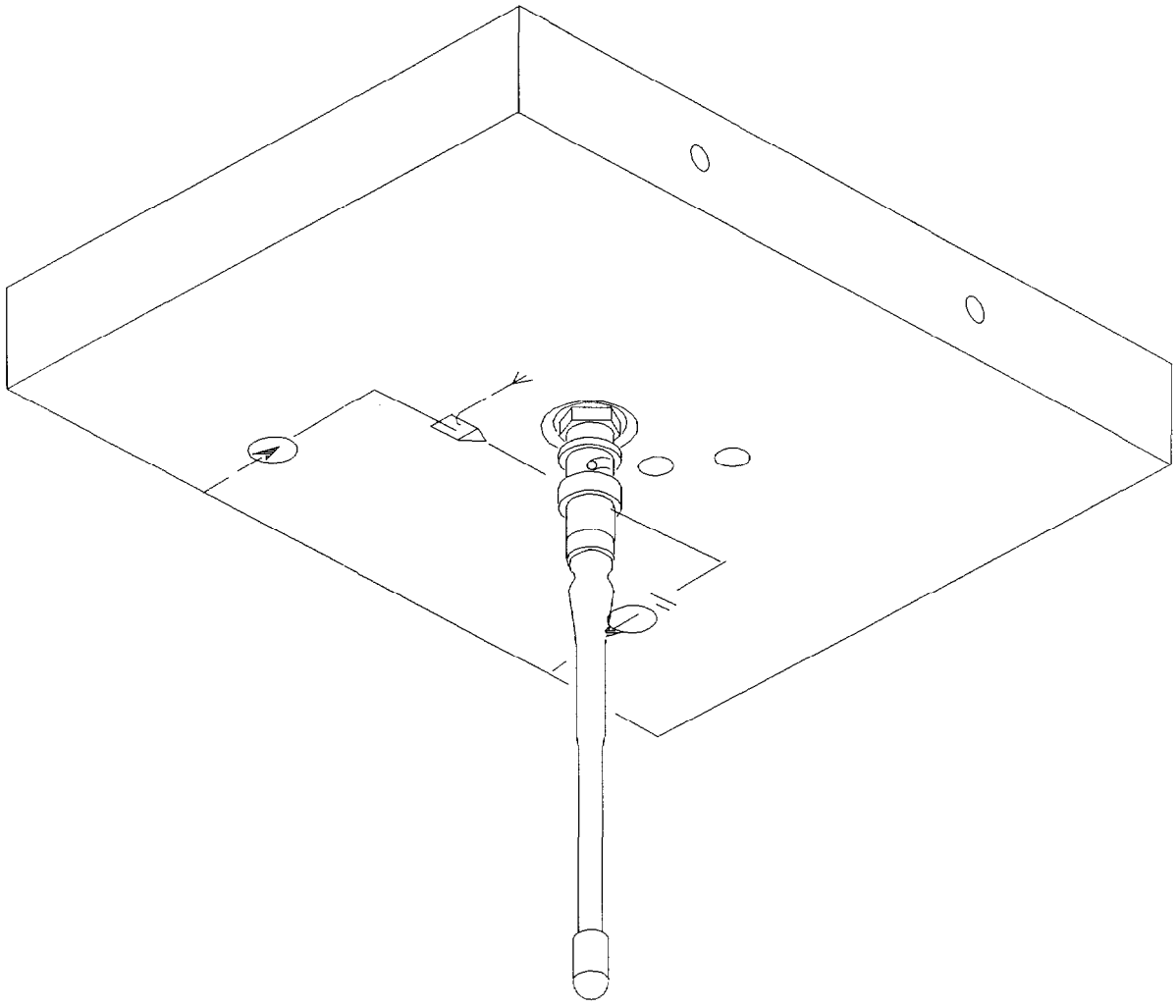


Figure 3-3. HP M1408A Active Antenna/Combiner Power-on LED

3.1.5 Cooling Fan and Filter Maintenance

The fan spindown test checks for worn fan bearings, and will help extend receiver mainframe life by assuring proper component cooling. The fan should be checked at six-month intervals. The filter should be checked and cleaned every month.

To check the cooling fan:

1. Turn on the receiver mainframe power. The cooling fan should run.
2. Remove the front cover (two quarter-turn fasteners) and remove the fan filter from the front of the left side panel (Figure 3-4).
3. To observe the spinning fan, shine a flashlight through the air intake grille on the left side of the mainframe. If a flashlight is unavailable, or if the top cover is already removed, observe the fan directly. If necessary, remove the top cover by unfastening two screws on the rear panel and pulling the cover backwards off the mainframe. Cover removal is the reverse of installation.
4. Turn off the power and note the time in seconds until the fan stops.

TEST RESULTS: Typical spindown time for a new fan is eight seconds. If the fan spins down in less than five seconds, replace it (HP Part Number 78560-60190).

Note

Observe the removed filter. As part of the preventive maintenance procedures, it might be appropriate to wash the filter, if running water is convenient, or replace the filter if it is excessively soiled (HP Part Number M1401-02100). Wash the dust out of the filter from the direction of the inside of the mainframe. Shake the water out of the filter and blot it dry with a paper towel.

Replace the fan filter, the top cover (if removed), and the receiver mainframe front cover.

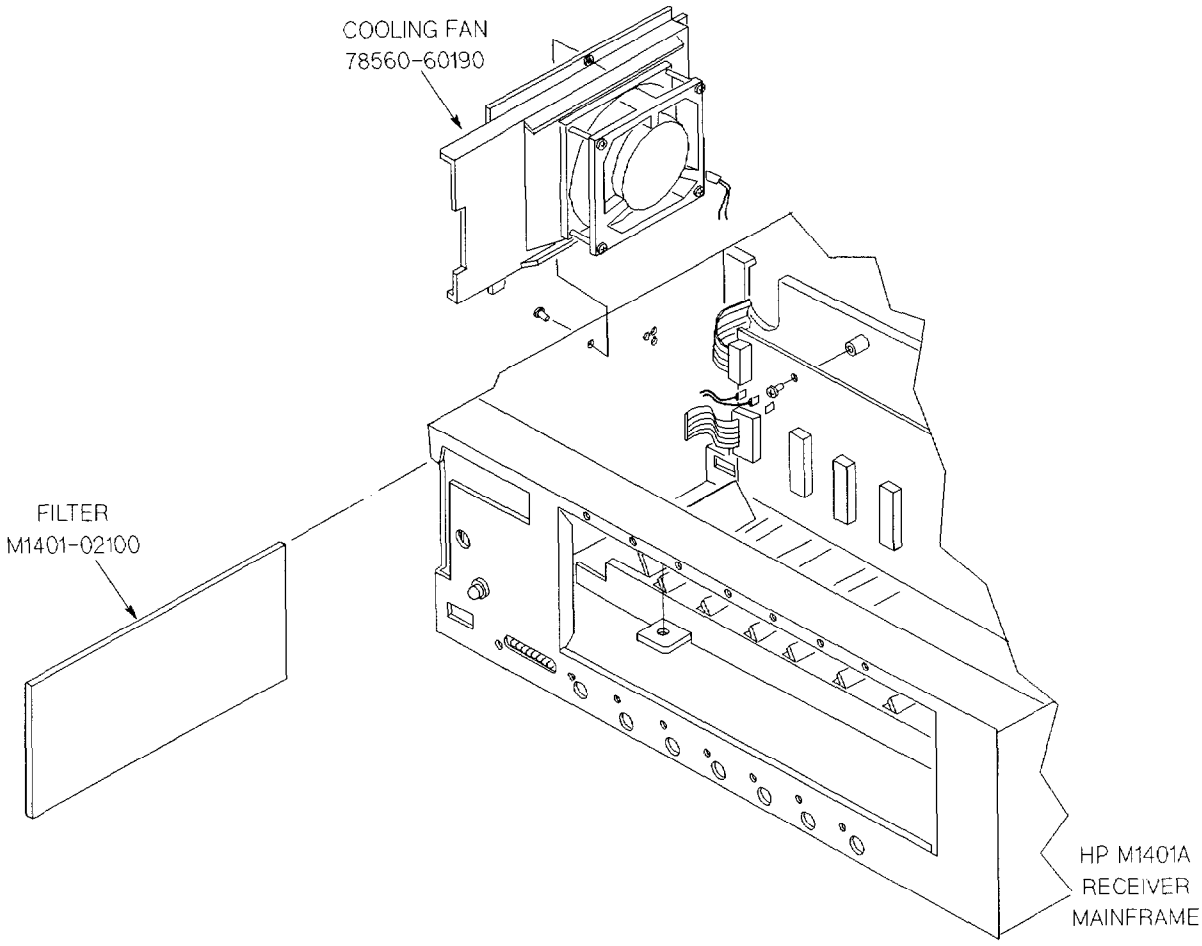


Figure 3-4. Cooling Fan and Filter Locations

3.2 Calibration

No calibration procedures are required.

3.3 Specification Checks

The specification checks test only transmitter battery current, d-c supply voltages in the receiver mainframe, and d-c output voltage to the active antennas.

3.3.1 Carrier Frequency Stability Check

No carrier frequency stability check is required.

3.3.1.1 Frequency Drift

Carrier frequency stability is specified at ±0.0005%. The crystal frequency drift of the HP M1400A/HP M1400B Transmitter is tracked by the corresponding voltage-controlled crystal oscillator (VCXO) in the HP M1402A Receiver Module and followed by automatic frequency control circuitry. Drift is compensated for in the receiver module firmware.

3.3.1.2 Frequency Mismatch

A mismatched transmitter and receiver module can be repaired by replacing the VCXO modules with exchange parts. See service manual Service and Replaceable Parts sections.

3.3.2 Transmitter Battery Current Check

To check the transmitter battery current, follow the test setup in Figure 3-5 and use a milliammeter or a multimeter on the milliamperes scale.

TEST RESULTS: An indication of 4.5 mA, nominal, for the HP M1400A; 6.0 mA, nominal, for the HP M1400B.

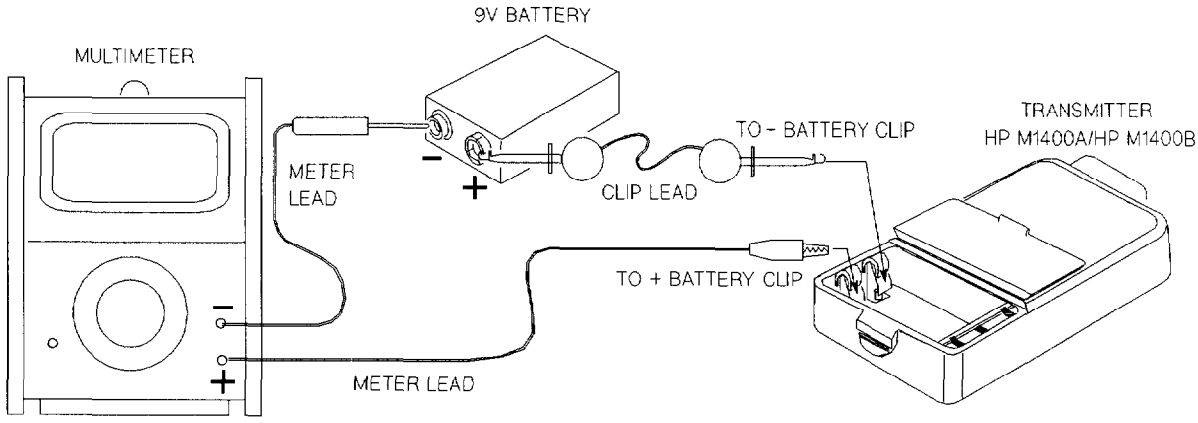


Figure 3-5. Transmitter Battery Current Check

3.3.3 Receiver Mainframe Supply Voltage Checks

The HP M1401A Receiver Mainframe +5V dc, +12V dc, and −12V dc supply voltages are not adjustable.

To check the receiver mainframe supply voltages:

1. Remove the receiver mainframe front cover (two quarter-turn fasteners) and slide off the top cover.
2. Using a Digital Voltmeter (DVM) or multimeter, check the supply voltages on the digital backplane test points shown in Figure 3-6.

TEST RESULTS:	Voltages and tolerances on DVM:
+5 V dc	+5.0 V dc ±0.2 V dc
+12 V dc	+12.0 V dc ±0.48 V dc
−12 V dc	−12.0 V dc ±0.48 V dc

Note

If voltages are out of tolerance, replace the power supply, HP Exchange Part Number M1401-68631.

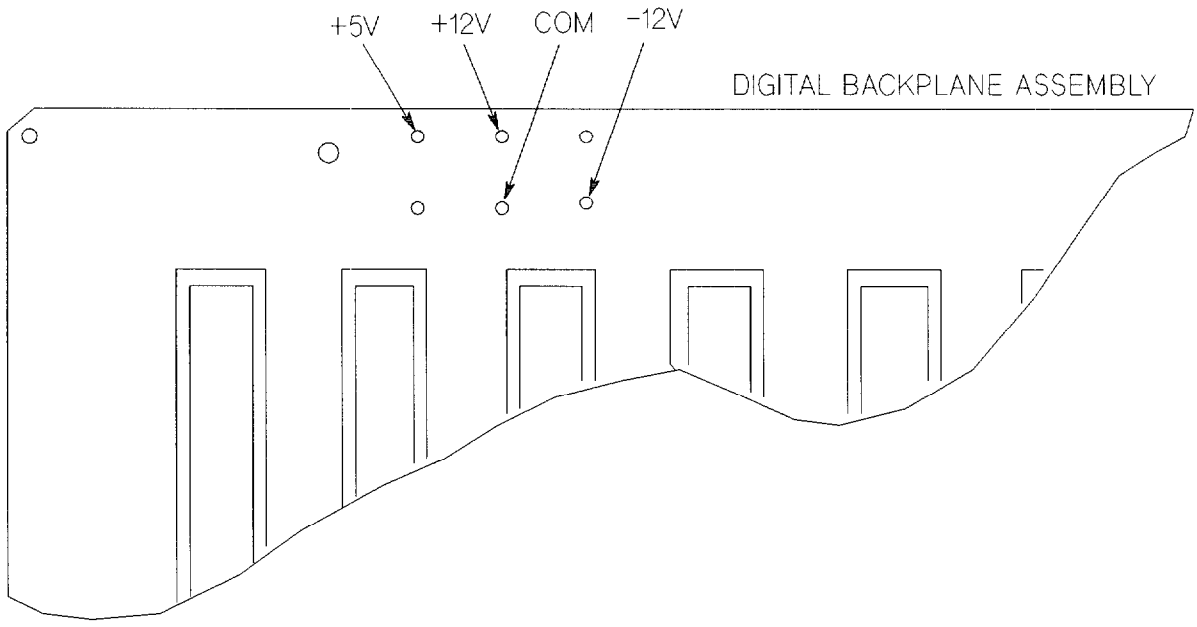


Figure 3-6. Receiver Mainframe Supply Voltage Test Points

3.3.4 Antenna System Supply Voltage Check

With the antenna system disconnected, check the antenna system d-c supply voltage at the antenna system side (RF input side) of the power tee (part of HP M1407A Multiple Unit Power Supply).

The antenna system supply voltage is checked between the center conductor and shield of the power tee, which is usually installed in the equipment room.

TEST RESULTS: Power supply output voltage should be between 25 Vdc and 31 Vdc with no load.

3.4 Patient Safety Checks (U.S.A.)

Patient safety checks include a chassis-to-ground resistance check, and a chassis leakage current test. Because the receiver mainframe must be isolated for these tests, antenna leads and other cabling with grounded shields must be disconnected and the receiver mainframe must be removed from any grounded mounting device.

3.4.1 Test Equipment Required

Checks are made with conventional test equipment or with a Dempsey Safety Analyzer.

3.4.1.1 Checks Using Dempsey Safety Analyzer

For this set of checks, it is optional to use a Dempsey Safety Analyzer, Model 431F (analog meter readout) or a Digital Readout Safety Analyzer, Model 431F-1D (Figure 3-7). Both are available from:

Neurodyne-Dempsey Division of Dynatech Nevada, Inc.
2000 Arrowhead Drive
Carson City
NV 89701, U.S.A.

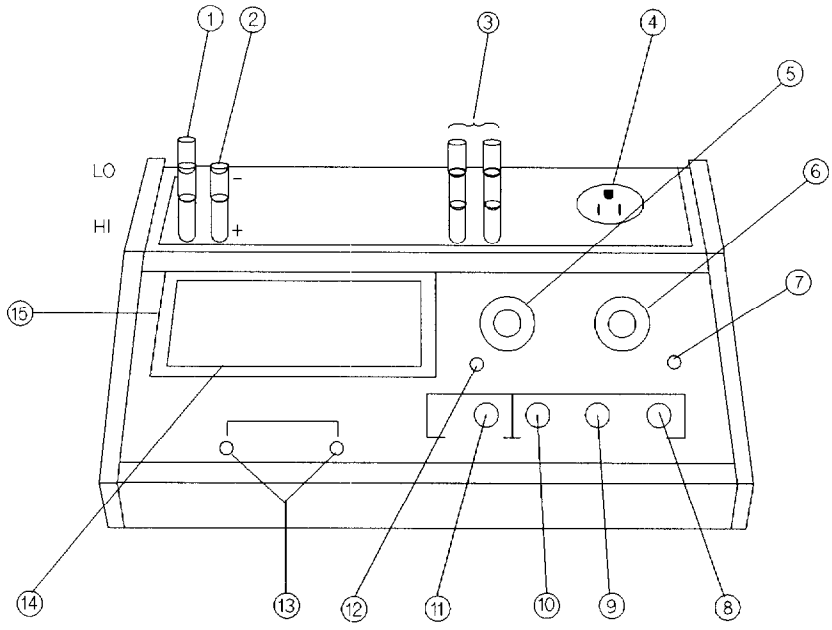


Figure 3-7. Dempsey Safety Analyzer, Model 431F-1D

3.4.1.2 Checks Using Conventional Test Equipment

Alternative setups use any high input impedance multimeter capable of measuring milliohms and true rms millivolts.

3.4.2 Isolation from System Cabling

Before testing, the HP M1401A Mainframe must be isolated from central station or Serial Distribution Network (SDN) and earth ground connections. To ensure isolation from earth ground for safety testing, all system cabling that runs through wall boxes must be disconnected from the receiver mainframe. The safety checks do not test the cabling in the walls from box to box. Cables running directly to an HP 78508A Patient Information Center (HP 78511B Equipment Cabinet) or to a Central Monitor (HP 78560A) also must be disconnected.

3.4.3 Isolation from Wall and Ceiling Mounts

The equipment must be removed from the mount because it must be isolated electrically from earth ground.

3.4.4 Chassis to Ground Resistance Check

In this test, check resistance from the power cord ground pin (mains-cord protective earth conductor) to the instrument chassis (frame) using a Dempsey Safety Analyzer or conventional test equipment specified previously.

Test Preparation:

Set up the instruments as shown in Figure 3-8.

Procedure:

a. Connect dual banana plug of Kelvin cable (part of analyzer, if used) between analyzer LO METER terminal and negative (−) terminal of 1/2 AMP SOURCE on analyzer.

b. Connect power (mains) cord to instrument under test.

c. Connect clip on free end of Kelvin cable to ground pin of male power cable connector (Figure 3-8).

d. Connect dual banana plug of a second Kelvin cable between HI METER terminal and positive (+) terminal of 1/2 AMP SOURCE on analyzer.

e. Clip other end of second Kelvin cable onto rear panel ground lug of instrument under test.

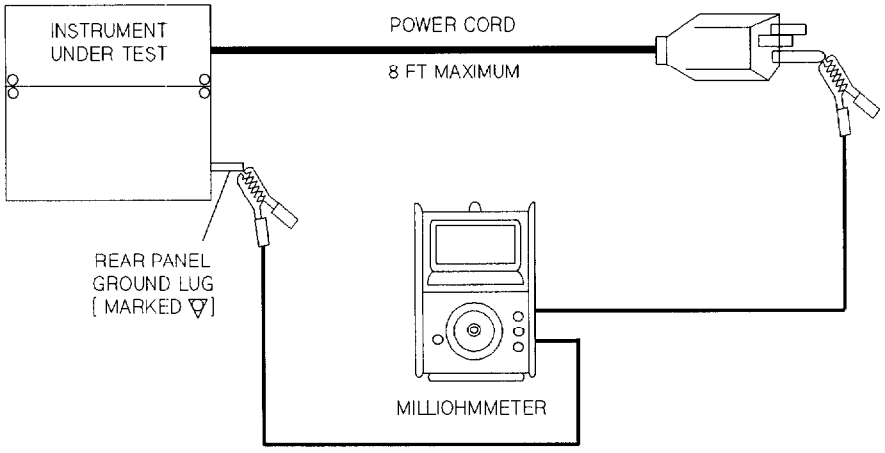
f. Set analyzer FUNCTION switch to EXTERNAL CURRENT position.

g. Press analyzer MILLIOHMS button and read resistance on meter current range. Flex power cord during test to detect intermittent problems.

TEST LIMIT: Less than or equal to 0.1 ohms.

If reading is greater than 0.1 ohms, replace power cord and check instrument power connector ground connections to chassis.

MILLIOHMMETER METHOD



ANALYZER METHOD

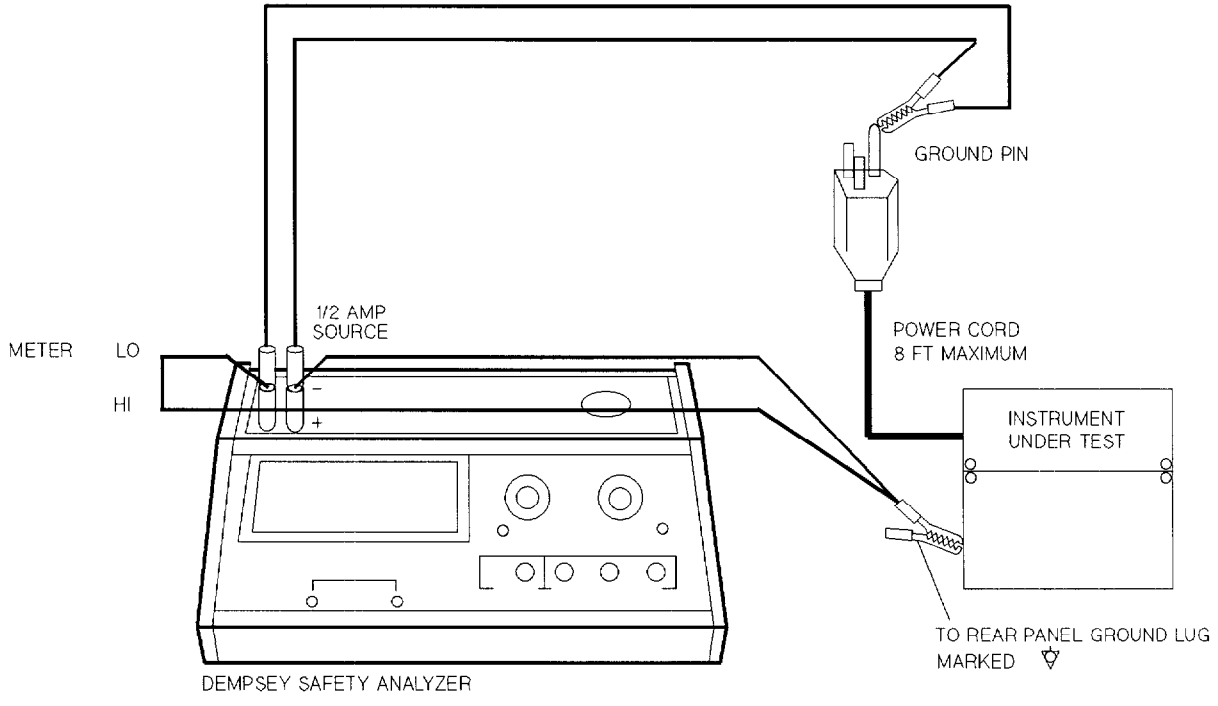


Figure 3-8. Chassis to Ground Resistance Test Setup

3.4.5 Chassis Leakage Current Test

This test checks chassis-to-ground leakage current. A very high leakage current may indicate line filter or transformer failure. Replace any component in the instrument that causes a test failure.

Test Preparation:

Set up the equipment as shown in Figure 3-9, and place instrument(s) under test on a non-conductive surface.

Note

Remove the instrument from the mount for safety checks. Make sure no part of the instrument touches any grounded metal. Unexpectedly low leakage current could indicate shorting of the case (instrument chassis or frame) to an external ground, such as an equipment rack, cart, or mount.

Procedure:

a. Disconnect power cord of instrument to be tested from the wall outlet and plug it into the TEST RECEPTACLE on top of the Dempsey Safety Analyzer.

b. Set the analyzer FUNCTION switch to INTERNAL CURRENT position and SELECTOR switch to TEST I position.

c. Using a clip lead, connect the instrument chassis ground to analyzer terminal labeled CASE.

d. Use the OPEN GROUND and/or REVERSE POLARITY buttons on the analyzer, and the ON/OFF power switch of the instrument under test to obtain following test conditions; read leakage current on analyzer meter and record readings:

Chassis **grounded**, standard polarity, power ON.
Chassis grounded, standard polarity, power OFF.

Chassis grounded, **reverse** polarity, power ON.
Chassis grounded, reverse polarity, power OFF.

TEST LIMIT: Less than or equal to 10 microamperes.

Chassis **ungrounded**, standard polarity, power ON.
Chassis ungrounded, standard polarity, power OFF.

Chassis ungrounded, **reverse** polarity, power ON.
Chassis ungrounded, reverse polarity, power OFF.

TEST LIMIT: Less than or equal to 100 microamperes.

Leakage current limits specified in this test apply to **each power cord** in an installation, whether the power cord is connected to an individual instrument or to several instruments connected with line power in series (daisy-chained).

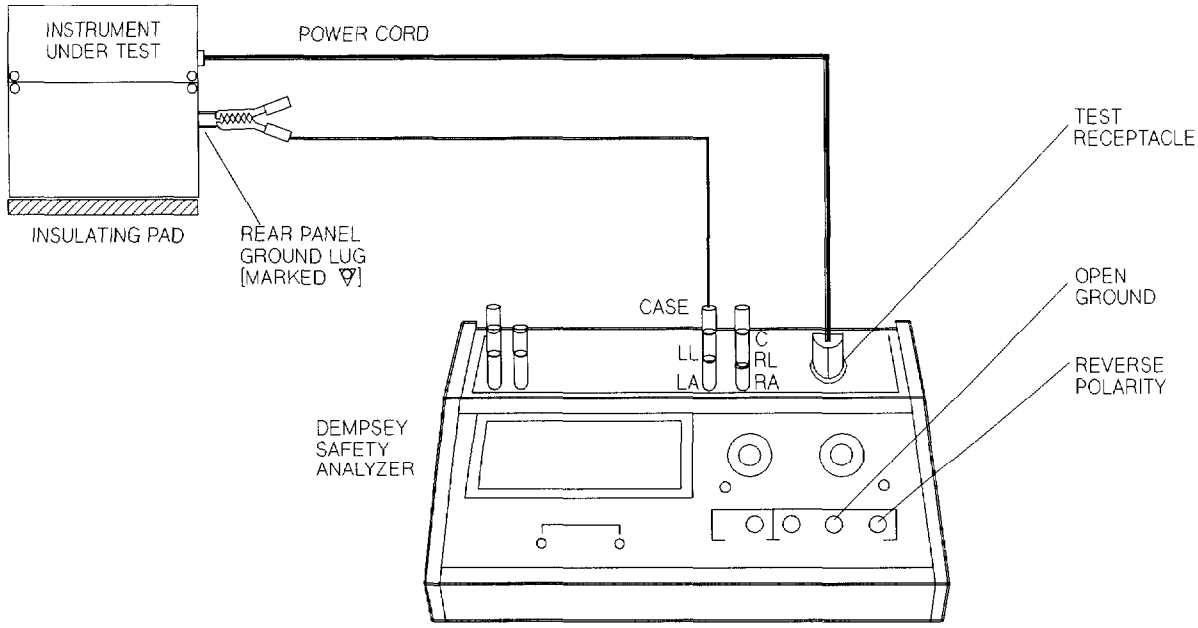


Figure 3-9. Chassis Leakage Current Test Setup

3.5 Cleaning, Disinfection, and Sterilization

Warning

TO PREVENT FIRE, PROVIDE ADEQUATE VENTILATION AND DO NOT PERMIT SMOKING WHEN CLEANING THE TRANSMITTER OR THE RECEIVER MAINFRAME WITH A FLAMMABLE LIQUID, SUCH AS ALCOHOL, OR STERILIZING WITH ETHYLENE OXIDE (EtO).

DISCONNECT LINE POWER FROM THE RECEIVER MAINFRAME TO PREVENT ELECTRICAL SHOCK AND ACCIDENTAL TURN-ON.

3.5.1 Cleaning

The HP M1401A receiver mainframe and M1400A/HP M1400B transmitter should be kept free of dust and dirt. Using one of the cleaning agents or disinfectants listed in Table 3-1, clean only the outside of the instruments following a protocol for cleaning. The HP M1402A receiver module, which is housed in the receiver mainframe, should require no cleaning. If necessary, wipe only the outside of the receiver module with a soft cloth moistened with one of the agents listed in Table 3-1.

3.5.2 Disinfection

To disinfect the receiver mainframe and transmitter, use a low-level (non-critical) disinfection process (Centers for Disease Control, Atlanta, GA; Guidelines: Nosocomial Infections. Bulletin available from U.S. Department of Commerce, National Technical Information Service).

Caution

To avoid damage to the receiver mainframe, transmitter, and antenna system components:

Never use abrasive material such as steel wool or silver polish.

Do not use strong solvents such as acetone for cleaning.

Do not use products that contain ammonia to clean the transmitter case.

Do not autoclave.

Do not use ultrasonic cleaning methods.

Do not pour liquid onto the instrument during cleaning.

Do not allow liquid to enter any part of the instrument case.

Do not allow any cleaner to remain on surface – wipe off immediately.

Do not immerse any instrument during cleaning.

If the battery compartment should become wet, dry it thoroughly.

Use only the cleaning solutions and disinfectants listed in Table 3-1.

Dilute cleaning agents before use, according to manufacturer's instructions.

Table 3-1. Approved Cleaning Solutions and Disinfectants

Soap and water
Ethyl alcohol
Isopropyl alcohol
Hydrogen peroxide (3% solution)
Cidex®
Windex®
Lysol (2.5% solution)
Sodium hypochlorite (Clorox® bleach) (10% solution, freshly made within the past 24 hours)

3.5.3 Sterilization

This generic procedure is used for sterilizing HP M1400A/HP M1400B transmitters and associated patient cables with ethylene oxide (EtO) gas. The sterilization and aeration process for the transmitter and patient cable has been tested for a maximum of 36 cycles[2].

Caution To avoid equipment damage, do not autoclave the patient cable or transmitter. Do not sterilize the patient cable or transmitter with pure EtO.

Follow the mnaufacturer's recommended procedure for your gas sterilizer. To dissipate residual EtO, aerate the sterilized equipment with air that has been bacterially filtered, using a mechanical aerator or combination sterilizer/aerator as follows [2]:

TIME: Eight hours.

TEMPERATURE: 130 ±5°F (54.4 +2.8 −2.7°C).

VENTILATION FREQUENCY: 30 air exchanges per hour.

Warning

ETHYLENE OXIDE IS HIGHLY EXPLOSIVE, TOXIC, AND A POTENTIAL OCCUPATIONAL CARCINOGENIC AND REPRODUCTIVE HAZARD. HANDLE IT WITH EXTREME CARE, FOLLOWING U.S.A OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) STANDARDS FOR ETHYLENE OXIDE (29 CFR 1910.1047)[1]. PERSONNEL EXPOSURE AND/OR ROOM AIR MUST BE MONITORED PER OSHA STANDARDS.

VENT STERILIZER GAS OUTDOORS OR TO A SUITABLE, EVACUATED CONTAINER FOR REPROCESSING, DEPENDING ON STATE, PROVINCIAL, OR COUNTRY ENVIRONMENTAL REGULATIONS. DO NOT VENT STERILANT INDOORS.

VENT AERATOR EXHAUST ONLY TO THE OUTDOORS.

[1] OSHA: Standard for acceptable levels of personnel exposure to Ethylene Oxide Gas: 1.0 ppm on an eight-hour time-weighted average basis.

Reference: U.S.A. Federal Regulations 49 FR 25734/29 CFR Part 1910.1047, June 22, 1984; final approval 50 FR 9800/20 CFR Part 1910.1047, March 12, 1985.

[2] These values will produce EtO residual levels in the transmitter and patient cable plastic below 250 ppm, per FDA regulations for implantable devices.

Reference: U.S.A Food and Drug Administration regulations Part 5, Section 821.100, June 23, 1978.

4

Troubleshooting

4.1 Introduction

This section provides procedures to isolate failures in the Digital UHF Telemetry System to the board level without using any special tools or equipment. Troubleshooting is presented in a table giving fault symptoms along with a list of possible causes and corrective actions. Corrective actions consist of removing and replacing suspected modules. Removal and replacement procedures are contained in Section 5, Service.

The troubleshooting procedures in this section are designed to localize faults system-wide, using the receiver mainframe indicator LEDs, INOP history and patterns, and function card LEDs. LED indicators are inspected visually during receiver mainframe bootstrap sequences to detect failures. To use INOP histories and develop INOP patterns effectively, INOP information should be logged. If the system in use is a HP 78508A Patient Information Center-based system, a log of INOPs must be kept as they occur. If the system in use is a HP 78560A Central Monitor-based system, a log of the fifteen most recent INOPs for each bed can be displayed using the telemetry service screens. The telemetry service screens are described in detail in paragraph 4.4.

4.1.1 Bootstrap Sequence

The LED indicators on the Turbo Processor Card and the Utility CPU board illuminate according to the bootstrap sequence. This sequence is as follows:

Normal Progression:

Turbo Processor Card:

	(a)	(b)	(c)
1 RED	ON	OFF	OFF
2 GREEN	ON	SLOW BLINK	SLOW BLINK
3 GREEN	ON	OFF	SLOW BLINK (normal operation)

40 MHz CPC Card (Option C03 only):

	(a)	(b)
1 RED	ON	OFF|
2 GREEN	ON	SLOW BLINK
3 GREEN	ON	OFF (normal operation)

Utility CPU Board:

Note

The three upper green LEDs on the Utility CPU are for the power supply and should remain GREEN whenever power is applied to the receiver mainframe.

	(a)	(b)	(c)	(d)
1 GREEN	ON	ON	ON	ON
2 GREEN	ON	ON	ON	ON
3 GREEN	ON	ON	ON	ON
4 GREEN	ON	FAST BLINK	FAST BLINK	FAST BLINK
5 GREEN	ON	OFF	ON	OFF
6 RED	ON	OFF	OFF	OFF
				(normal operation)

4.1.2 Troubleshooting Matrix

Table 4-1 is constructed as a troubleshooting matrix. To use the table, look down the column labeled SYMPTOM. When the symptom is found, read across to the center column of the matrix for the possible cause of the fault. Each possible cause has a corrective action in the third column, which gives a defective card to remove and replace.

If the corrective action is inconclusive or the fault still persists after a corrective action, proceed to each subsequent possible cause and perform their corrective actions until the fault is cleared or all corrective actions have been exhausted. After each corrective action has been performed, recheck the fault to see if it has been cleared.

Warning

ALWAYS REMOVE POWER BEFORE REMOVING OR REPLACING ANY PART OF THE SYSTEM. ALWAYS REFER TO THE SAFETY ASPECTS OF SERVICE. ALWAYS REASSEMBLE THE UNITS BEFORE REAPPLYING POWER TO THEM.

Table 4-1. System Troubleshooting

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Power does not come on when power rod is pressed. (GREEN LED not lit.)	Power lead disconnected or incorrect power source.	Connect lead or correct the power source.
	Power supply fuse or fuses blown.	Replace any blown fuses.
	Power supply is bad.	Replace power supply.
Individual receiver malfunction LED remains lit steadily.	Receiver module corresponding to LED is bad.	Replace receiver module.
All or some receiver malfunction LEDs flicker randomly.	Receiver mainframe antenna is bad.	Replace mainframe antenna cable.
		Replace antenna distribution board.
	Interference is preventing signal reception.	Remove source of interference, if possible.
	Problem with antenna system	Repair antenna system. Refer to paragraph 4-2.
RECEIVER MALFUNCTION INOP on a single channel	Receiver module is bad.	Replace receiver module.
	Rack interface to receiver backplane cable disconnected or broken.	Check cable, replace if necessary.
	Receiver backplane is bad.	Replace receiver backplane.

Table 4-1. System Troubleshooting (continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
RECEIVER MALFUNCTION INOP on multiple channels.	Receiver backplane is bad.	Replace receiver backplane.
	Rack interface to receiver backplane cable disconnected or broken.	Check cable, replace if necessary.
	Rack Interface board is bad.	Replace rack interface board.
NO RECEIVER INOP on multiple channels.	Receiver mainframe has been configured for a receiver that does not exist.	Detune bed from central station sector. Have HP Customer Engineer reconfigure the receiver mainframe.
	Rack Interface to Receiver backplane cable disconnected or broken.	Check cable, replace if necessary.
	Rack Interface board is bad.	Replace rack interface board.
	Receiver backplane is bad.	Replace receiver backplane.
NO RECEIVER INOP on a single channel.	Receiver module has not been seated properly.	Re-seat receiver module.
	Receiver module is bad.	Replace receiver module.
	Receiver backplane is bad.	Replace receiver backplane.
	Rack Interface to Receiver backplane cable disconnected or broken.	Check cable, replace if necessary.
INVALID SIGNAL - E01 INOP appears when transmitter is ON and disappears when battery is removed.	New transmitter ID needs to be learned.	Learn code of new transmitter. Refer to Section 1.

Table 4-1. System Troubleshooting (continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
INVALID SIGNAL – E01 INOP appears when transmitter is OFF.	HP M1400A/B transmitter of same frequency is in use in vicinity.	Check other departments or nearby hospitals for same channel. Frequency must be changed by user or bed must be turned off when not in use.
	Heterodyning (RF frequency mixing).	
	a)Used transmitters are being stored together with batteries installed.	a)Remove batteries when storing transmitters.
	b)Other RF source mixing with M1400A transmitter.	b)Check equipment in the vicinity of antennas. If the problem disappears when equipment is turned off, separate antenna and interfering equipment.
	Adjacent channel transmitter has drifted in frequency.	Replace transmitter VCXO. Replace receiver module VCXO of problem channel if necessary.
INTERFERENCE INOP appears on a single channel or on an adjacent channel when transmitter is ON.	On-channel interference.	Broadcast frequency of one user must be changed.
INTERFERENCE INOP appears on multiple channels when transmitters are ON.	High-power outside interference saturating an amplifier, or faulty antenna (RF) distribution assembly.	Change broadcast frequency of interferer. Move interferer away from antenna system. Reduce gain of antenna system (may impact system performance). Additional filtering may be required in antenna system.

Table 4-1. System Troubleshooting (continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Frequent NO SIGNAL or WEAK SIGNAL INOPs on a single channel throughout the coverage area.	Weak RF signal from transmitter.	Clean lead pins on transmitter case. Replace cable set. Replace transmitter VCXO module. Replace transmitter motherboard.
	Problem in receiver mainframe.	Check semi-rigid RF cable, replace if necessary. Replace receiver module VCXO assembly. Replace receiver module. Replace antenna distribution assembly.
Intermittent NO SIGNAL or WEAK SIGNAL INOPs on multiple channels concurrently.	High power outside interference saturating an amplifier.	Change broadcast frequency of interferer. Move interferer away from antenna system. Reduce gain of antenna system (may impact system performance). Additional filtering may be required in antenna system.
	Power supply to antenna system is losing power.	Check power source.
Frequent and random NO SIGNAL or WEAK SIGNAL INOPs on multiple channels.	Patients leaving specified coverage area.	Keep patients in coverage area.
	Antenna system installation error.	Check installation of the antenna system.
	Inadequate antenna system.	More antennas may be needed.
Battery weak or replace battery INOP received.	Battery is weak or needs to be replaced.	Replace battery.
	Battery contacts corroded or bad.	Clean or replace battery contacts.

Table 4-1. System Troubleshooting (continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Pressing nurse call button on transmitter does not produce result consistent with configuration.	Nurse call button is unconfigured.	Reconfigure nurse call button.
	Nurse call button is bad.	Replace transmitter case assembly.
	Digital hybrid board is bad.	Replace transmitter motherboard.
NO DATA FROM BED message – Normal Bootstrap sequence followed.	SDN cable missing or defective.	Inspect SDN cable. Replace if necessary.
	In non-SCC system, SDC cable used in place of LDC cable.	Replace SDC cable with LDC cable.
	Duplicate SDN bed.	Reconfigure receiver mainframe for other beds, or move bed to other branch.
	Two receiver mainframes with identical SDN Unit Numbers.	Reconfigure a receiver mainframe with another SDN Unit Number.
NO DATA FROM BED INOP – Abnormal Bootstrap sequence followed.	Bad connector on SDN PCB.	Replace SDN PCB. Refer to paragraph 4.1.3.
TEL CANNOT ANALYZE INOP on a single channel.	Weak RF signal – patient out of coverage area.	Return patient to coverage area or turn the channel off.
	Weak RF signal – patient in an RF null.	Move transmitter or patient about 6 inches.
	Intermittent RF noise or interference that causes dropout.	a. Ensure that patient is located in signal coverage area. b. If signal is strong (no weak signal INOPs), replace VCXO modules in HP M1401A transmitter and HP M1402A receiver module with pair for a different channel.
Frequent TEL CANNOT ANALYZE INOPs on multiple channels.	RF noise source causing interference.	Disconnect antenna strings then antennas, until position of source is localized. Remove source or relocate antenna.

Table 4-1. System Troubleshooting (continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
LEADS OFF indication, at all analog output bedside monitors, plus red LED on receiver mainframe analog output board illuminated.	Failed analog output board.	Replace board.
LEADS OFF indication, at all bedsides, plus red LED on receiver mainframe analog output board flashing rapidly.	Analog output link cable not properly connected.	Reconnect cable.
LEADS OFF indication, at all analog output bedside monitors, plus following receiver mainframe analog output board LED display: Red LED off, one or both green LEDs on or off steadily.	Failed analog output board.	Replace board.
LEADS OFF indication, at all analog output bedsides, plus STATUS and POWER LEDs on analog output connector box not lit.	No power to connector box.	Plug in or replace power supply.
LEADS OFF indication, at all analog output bedsides, plus the following analog output connector box LED display: POWER LED on; STATUS LED off.	Analog trunk cable not properly connected to receiver mainframe or output connector box. Receiver mainframe power is off. Analog output board is faulty.	Connect analog trunk cable. Energize receiver mainframe. Replace analog output board.
All analog output board and output connector box LEDs indicate normal operation, but one or more analog output channels indicate LEADS OFF, even when valid signal is present.	One or more receiver modules need firmware upgrade.	Check receiver module firmware of affected channels, and upgrade receiver module firmware as necessary.

Table 4-1. System Troubleshooting (continued)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
LEADS OFF indicated on a single analog output bedside monitor.	Bedside not assigned to correct lead selection.	Assign correct lead selection as follows: Transmitter Cableset Valid Lead Selections - 3-lead: II 4-lead: I,II,III,aVR,aVL,aVF 5-lead: II, MCL
	Bedside monitor cable type does not match transmitter cableset type.	Check for valid monitor cable/ transmitter cable combination.
	Analog output cable not properly connected.	Check cable connection at output connector box and at attenuator.
LEADS OFF indicated at the analog output display when certain lead, gain, and bandwidth selections are made at the central monitor.	EPROM board firmware needs upgrade. (Analog output display will indicate LEADS OFF unless gain = 1, bandwidth = diagnostic, and standard leads are selected at the central monitor.)	Check EPROM board firmware, and upgrade if necessary.
When viewing leads III, aVR, aVL, or aVF at the analog output display, the ECG waveform occasionally disappears, and is replaced by a very large noise waveform.	The ability of the analog output system to generate the telemetry INOP message on the bedside monitor (displayed as LEADS OFF) is occasionally impaired in very humid conditions.	Switch to a non-reconstructed lead (I or II), or simply be aware that during these conditions, this display indicates a telemetry INOP.

4.1.3 Abnormal Bootstrap Sequence (for M1401A Receiver Mainframes without Option C03 or mainframes with the Turbo Processor Card)

An abnormal bootstrap sequence is defined as a bootstrap sequence different from that described in paragraph 4.1.1. If an abnormal bootstrap sequence occurs, perform the following procedures:

1. **If Option C01 is installed,**
   a. Remove the Turbo Processor Card in slot D8 and reapply power to the receiver mainframe. Watch the LEDs on the Utility CPU and the slot D5 TPC for the normal LED sequence described in paragraph 4.1.1.
   b. If normal sequence occurs, refer to PROBABLE CAUSE/CORRECTIVE ACTION table below. If normal sequence does not occur, proceed with step 2.a. below.
2. **If Option C01 is NOT installed,**
   a. Remove the Turbo Processor Card in slot D5 and initialize the receiver mainframe. Watch the LEDs on the Utility CPU for the below sequence.

	(a)	(b)	(c)
4 GREEN	ON	FAST BLINK	FAST BLINK
5 GREEN	ON	OFF	SLOW BLINK
6 RED	ON	OFF	OFF

If the above sequence occurs the following conditions may be presenting the problem:

PROBABLE CAUSE	CORRECTIVE ACTION
Turbo Processor(s) in wrong slot.	Check board locations.
Turbo Processor(s) bad.	Replace Turbo Processor.
EPROM(s) bad.	Replace EPROM.

If the Utility CPU LED sequence shown above does not occur, remove the SDN board and reapply power to the receiver mainframe. If the sequence occurs, check the red status LED on the Rack Interface board. If LED is lit, replace the Rack Interface board. If LED is not lit, replace the SDN board and reapply power.

If the Utility CPU LED sequence still does not occur, remove the Rack Interface board and reapply power to the receiver mainframe. If the sequence occurs, replace the Rack Interface board. If the sequence does not occur, replace the Utility CPU.

If the above corrective actions fail to remedy the fault, reinstall the Turbo Processor Card with the EPROM board removed. Watch LED #5 on the Utility CPU. If it blinks slowly, replace the EEPROM on the Utility CPU.

Check voltages on digital backplane (Figure 3-6).

If none of the above actions corrects the problem, replace the digital backplane.

4.1.4 Abnormal Bootstrap Sequence (for M1401A Receiver Mainframes with Option C03 or mainframes with the 40 MHz CPC card installed)

An abnormal bootstrap sequence is defined as a bootstrap sequence different from that described in paragraph 4.1.1. If an abnormal bootstrap sequence occurs, perform the following procedures:

- Remove the 40 MHz CPC card in slot D5 and initialize the receiver mainframe. Watch the LEDs on the Utility CPU for the below sequence.

	(a)	(b)	(c)
4 GREEN	ON	FAST BLINK	FAST BLINK
5 GREEN	ON	OFF	SLOW BLINK
6 RED	ON	OFF	OFF

If the above sequence occurs, the 40 MHz CPC card is faulty and should be replaced.

If the Utility CPU LED sequence shown above does not occur, remove the SDN board and reapply power to the receiver mainframe. If the sequence occurs, check the red status LED on the Rack Interface board. If LED is lit, replace the Rack Interface board. If LED is not lit, replace the SDN board and reapply power.

If the Utility CPU LED sequence still does not occur, remove the Rack Interface board and reapply power to the receiver mainframe. If the sequence occurs, replace the Rack Interface board. If the sequence does not occur, replace the Utility CPU.

If the above corrective actions fail to remedy the fault, reinstall the Turbo Processor Card with the EPROM board removed. Watch LED #5 on the Utility CPU. If it blinks slowly, replace the EEPROM on the Utility CPU.

Check voltages on digital backplane (Figure 3-6).

If none of the above actions corrects the problem, replace the digital backplane.

4.2 Antenna System Troubleshooting

This paragraph provides a general troubleshooting guide for the antenna system. The basic troubleshooting technique used is to divide the larger sections of the antenna system down to smaller sections until the fault is isolated.

Before disconnecting any parts of the antenna system and testing them, a visual inspection should be made. This visual inspection should include checking the green POWER ON LEDs of all the active components to make sure they are illuminated, making sure none of the active components are installed backwards, and that there are no obvious breaks in the antenna cabling. A damaged antenna cable should be replaced on discovery. If an active component has a POWER ON LED which is not illuminated, the following steps should be taken:

1. Check the device to make sure the circuit breaker is not tripped. If it is, reset the circuit breaker by pressing the button. If the circuit breaker continues to trip, a short circuit exists in the system and needs to be repaired.
2. Disconnect d-c voltage input to the device that has the extinguished LED and measure the voltage at the cable. If a d-c voltage is present (at least 23 Vdc), replace the device.
3. If the voltage is not present, go to the power tee immediately preceding the device with the extinguished LED and measure the voltage at the output of the power tee. Proceed back toward the suspected device, measuring the input and output of each device in series. When the voltage is absent, replace the device or cable with the last good input.

4.3 Radio Frequency (RF) Troubleshooting (Option C03 only)

Option C03 provides you with two tools to help you with troubleshooting suspected RF link problems from the transmitter to the receiver. The Receiver Mainframe collects and reports two types of data related to the RF link performance:

- Invalid: a measurement of the validity of each data packet at the receiver.
- Received Signal Strength Indicator (RSSI): an indicator of RF power at the receiver input corresponding to each data packet.

The Receiver Mainframe uses two methods of reporting this information:

- RF History Strip Recording: Long term RF link performance can be observed and trended using the RF History Strip Recording that can be printed from the CCM without leaving the Monitoring mode. The strip shows data reported on a minute-by-minute basis for up to the immediately preceding twenty four hours.
- RF INOP: This is a textual message that appears in the sector for each bed on the CCM display. The RF INOP gives the current RF link performance measurements at the CCM, and is part of the annotation for a requested strip recording.

Note

The RF INOP uses the same reporting mechanisms as that used by the CCM to display INOPs. The RF INOP has been assigned the lowest priority among messages using this reporting mechanism. If any other INOP or alarm condition exists, the RF Measurement Indicator is replaced by the INOP or alarm message.

4.3.1 RF History Strip Recording

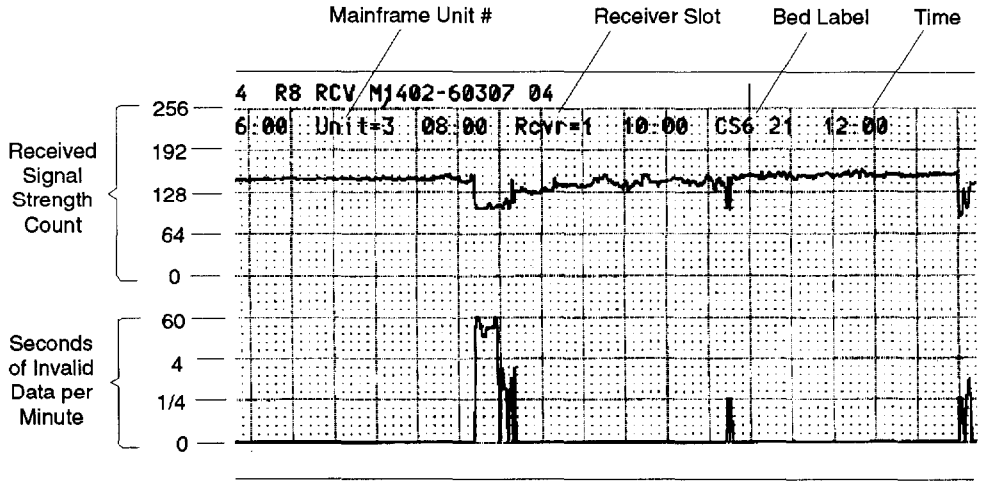


Figure 4-1. Example of an RF History Strip Recording

The RF History Strip Recording gives you signal strength information on each receiver that is assigned in each Receiver Mainframe for the preceding twenty-hour period.

The RF History Strip Recording can be requested from the CCM without leaving monitoring mode. Each request causes an RF History Strip for each receiver in a particular Receiver Mainframe.

You can request the RF History Strip Recording by entering Service Mode for the desired Receiver Mainframe, then printing either the Telemetry Status Log, INOP Log, or the Revision

Log. The RF History Strip Recording data (two waves plus aligned annotation) is added to the respective log data being printed. The procedure for doing this is given at the end of this paragraph.

Each RF History Strip Recording is a two channel stored recording. Each data point on the strip represents on minute of RF history. This means at a recording speed of 25 mm, one inch of recorder paper contains about two hours of RF history. The following paragraphs describe how the information is presented on the strip, and what it means.

To Print an RF History Strip Recording

1. At the CCM, press the `Telem Service` softkey. The password screen appears. Use the five password number softkeys to enter 1400. This gives you access to the Telemetry Service Screens.
2. From Telemetry Service Screen 1, you can select from the `STATUS LOG`, `INOP LOG`, or `EXAMINE REVISIONS`. The log you select determines what information is annotated on the strip.
3. From the log screen, press the `PRINT LOG` softkey. The RF History Strip Recording is printed for each receiver assigned a bed label. The information printed at the top of the strip shows the information contained in the log or revisions screen you printed from.

4.3.1.1 Received Signal Strength and Invalid Data

The RF History Strip Recording shows two graphs of the received signal. The upper graph, channel 1, shows the received signal strength for each receiver. It graphs two sets of data: the signal or noise. These are defined as follows:

The lower graph, channel 2, shows the number of invalid data packets received. By observing trends for particular receivers, you can check to see if a lot of invalid data packets are being received, or what the signal strength is when valid data packets are received. Since situations and received signal tolerances vary, this information is most useful when compared against the performance history of each receiver. The following tables show you the expected received signal strength indicator (RSSI) and its correlation to input power.

Expected Received Signal Strength Indicator

Input Power	RSSI Mini-mum	RSSI Mean	RSSI Max
-100 dBm	100	110	120
-90	120	130	140
-80	147	157	167
-70	163	173	183
-60	180	190	200
-50 or greater	206	231	256

If you have older receivers (prior to 1992), your expected RSSI may be different. Use the following table if this is the case.

Expected Received Signal Strength Indicator

Input Power	RSSI Mini-mum	RSSI Mean	RSSI Max
-100 dBm	107	117	127
-90	129	139	149
-80	157	167	177
-70	174	184	194
-60	193	203	213
-50 or greater	222	239	256

Note

There is some overlap with the RSSI count and different power levels. Check the test sheet that comes with every receiver. If the RSSI count given for the -111 dBm level is on the low end of the range, all the numbers tend to be low. If the RSSI count given for the -111 dBm is on the high end of the range, all the numbers tend to be higher.

Invalid data packets are graphed as a function of time. The graph shows you the amount of invalid data packets (shown by the amplitude or height of the spike), and the duration of time the invalid packets where received (shown by the pulse width of the spike). Since some invalid data packets are expected and allowed during normal operation, all invalid data spikes do not mean your system is operating poorly. If you look at the trace for channel 2, the invalid packets are graphed using the bottom three boxes on the strip recording, and are measured in seconds per minute of invalid data received. Any spikes which remain in the bottom box indicate a low percentage of invalid data packets received, and is indicative of good performance for a receiver. As the amplitude of the spikes increase, the higher percentage of invalid data packets have been received. Spikes which reach the top of the third box, indicate an entire minute's worth of invalid data packets have been received.

4.3.1.2 Aligned Notation

The RF History Strip Recording contains the following aligned notation:

- Date
- Time
- Unit number of the recorded receiver mainframe
- Receiver number (Rcvr) which is the receiver slot being recorded for the respective receiver mainframe
- Bed label for the receiver slot. This is given as the central station (CS) number and the bed number as assigned to the receiver slot.

This information is listed at the top of the strip based for each receiver module in the Receiver Mainframe being printed. The information included is different depending upon which log you print the strip from.

4.3.2 RF Measurement INOP

The RF Measurement INOP, when enabled, is displayed in the upper left corner of the CCM display. The format is "##HHH/LLL/(SSS)NNN", where:

- ## Two characters to indicate this is the RF Measurement INOP
- HHH The value of RSSI+
- LLL The value of RSSI-
- SSS the value of Signal
- NNN If a period of noise occurs, the value of Noise. If no Noise, this is blank.

The following are the definitions of Signal and Noise:

- Signal - This is the median value of the RSSI for valid data packets. Invalid data packets do not affect the value of the signal. The signal value represents the median value of the signal for the preceding minute of valid data.
- Noise - This is the measure of the median value of the RSSI for invalid data packets only. Valid data packets do not affect the value of noise. The value of noise represents noise for the preceding fifteen seconds of invalid data.

The RF Measurement INOP can be turned on and off from the CCM without leaving monitoring mode. When an alarm or INOP condition occurs, the message for the alarm or INOP supersedes and replaces the text for the RF Measurement INOP. The exception to this is if one of the RF Performance INOPs occur. If an RF Performance INOP occurs while the RF Measurement INOP is enabled, then text of the INOP is replaces the text of the RF Measurement Indicator. To turn on the RF Measurement INOP, perform the following procedure:

1. At the CCM press the (Patient Window) hardkey. The screen displays the Patient Window.
2. Press the `Parameter On/Off` softkey. The screen displays the Parameters On/Off screen.
3. Press the `Select Parametr` softkey until you highlight the RF INOP field.
4. Press the `On/Off Parameter` softkey to turn the RF INOP to On.

RF Performance INOPs

The following RF performance INOPs replace the text the RF Measurement INOP if they occur:

- NO SIGNAL
- INTERFERENCE
- TEL CANNOT ANALYZE
- WEAK SIGNAL

4.4 Telemetry Service Screens

Your Central Monitor can display telemetry service screens used in servicing the Digital UHF Telemetry System. The following paragraphs describe the telemetry service screens.

4.4.1 Telemetry Service Screen Access

Accessing the Telemetry Service Screens varies depending upon which central station you are using. If you using an HP 78560A or CCM before release C., the telemetry service screens are accessed by touching the SERVICE softkey in the Telemetry Control III screen. If you are using a CCM with release C or higher, you can enter the Telemetry Service Screens using the (Instrument Config) hardkey. The following procedures tell you how to enter the Telemetry Service screens, and are broken out by which Central Monitor you may have.

4.4.1.1 Accessing the Telemetry Service Screens with an HP 78560 or a CCM lower than Release C.

The telemetry service screens are accessed by touching the SERVICE softkey in the Telemetry Control III Screen.The first screen displayed is the Password screen (Figure 4-2). The Password screen requests the password of the user to gain access to the telemetry service screens. Although receivers for a given receiver mainframe may be tuned to several HP 78650A central monitoring stations, only one central monitoring station may access the telemetry service screens. The Password screen contains five Password Number Keys and the MORE CONTRLS touchkey. The five Password Number Keys are used to enter the correct password for the product. When the correct password (1400) is entered, Telemetry Service I Screen is displayed.

Touching the MORE CONTRLS touchkey terminates the Password screen and returns the user to the Telemetry Control III screen.

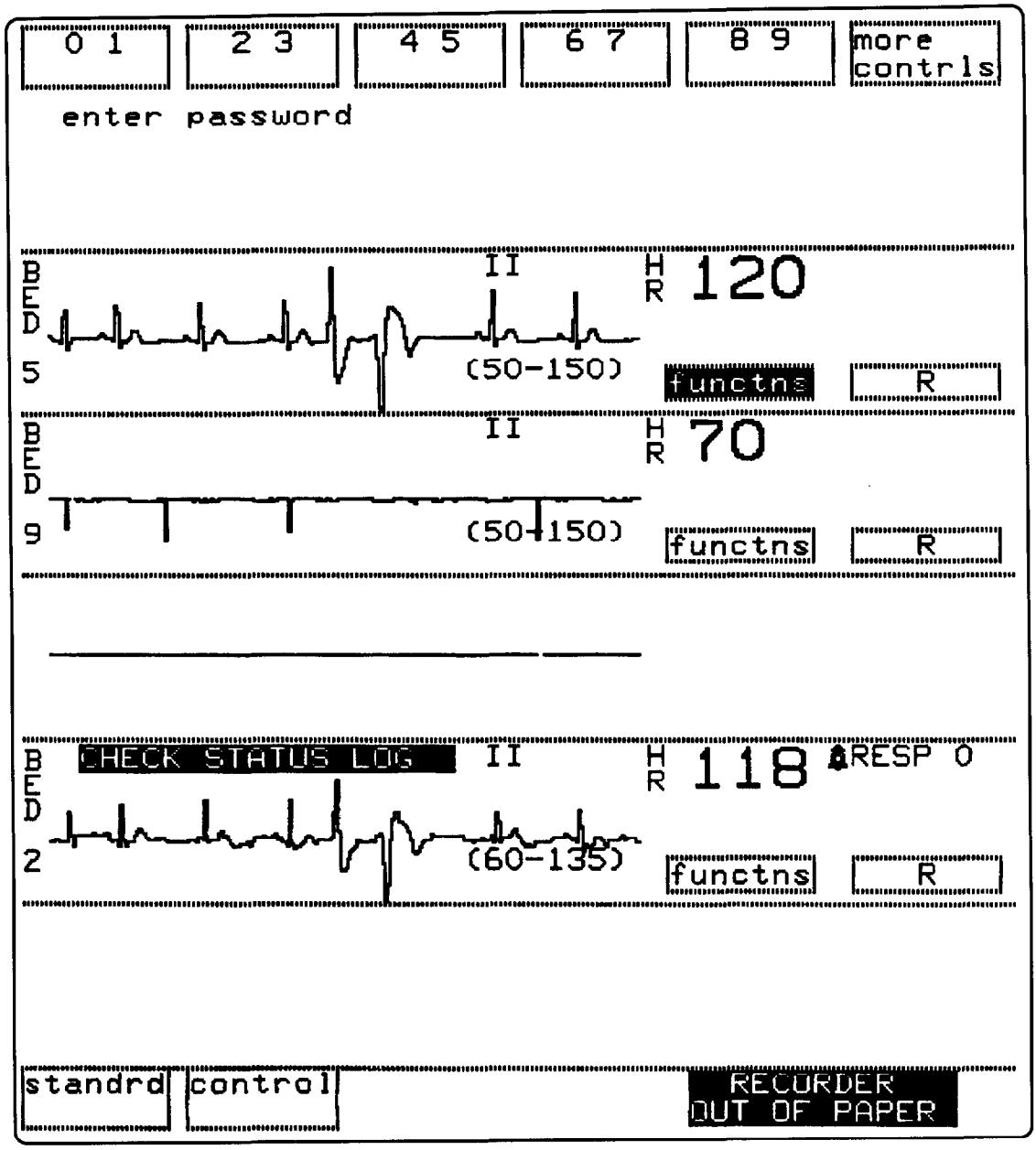


Figure 4-2. Password Screen (Normal Access)

4.4.1.2 Accessing the Telemetry Service Screens with a CCM Release C or Higher

To access the Telemetry Service Screens, perform the following procedure:

1. On the Control Panel press the (Instrument Config) hardkey.
2. Use the UP arrow key to go to the top line.
3. Press the `Telem 3` softkey. The screen displays the Password Screen.
4. Enter 1400 as the password.
5. The screen displays the Telem Service window.

Note

Although the service window for the Telemetry Service Screens is smaller than the screen used with the HP 78560A and the CCM before release C.00, the softkeys and the functionality are the same. The following paragraphs are applicable to the CCM Release C.00 or higher.

4.4.2 Telemetry Service I Screen

The Telemetry Service I screen (Figure 4-3) provides the user with access to various service functions. The screen consists of six touchkeys: `STATUS LOG`, `INOP LOG`, `EXAMINE REVS`, `EXAMINE CONFIG`, `DEMO`, and `EXIT SERVICE`.

a. STATUS LOG. Touching the `STATUS LOG` touchkey displays the Status Log screen.

b. INOP LOG. Touching the `INOP LOG` touchkey displays the INOP Log screen.

c. EXAMINE REVS. Touching the `EXAMINE REVS` touchkey displays the Examine Revisions screen.

d. DEMO. Touching the `DEMO` touchkey causes the receiver mainframe to enter the demonstration mode, sourcing test waveform information on the SDN for all active channels. To exit the demonstration mode, the user touches the `DEMO` touchkey again on the screen.

e. EXIT SERVICE. Touching the `EXIT SERVICE` touchkey returns the user to the Telemetry Controls III screen.

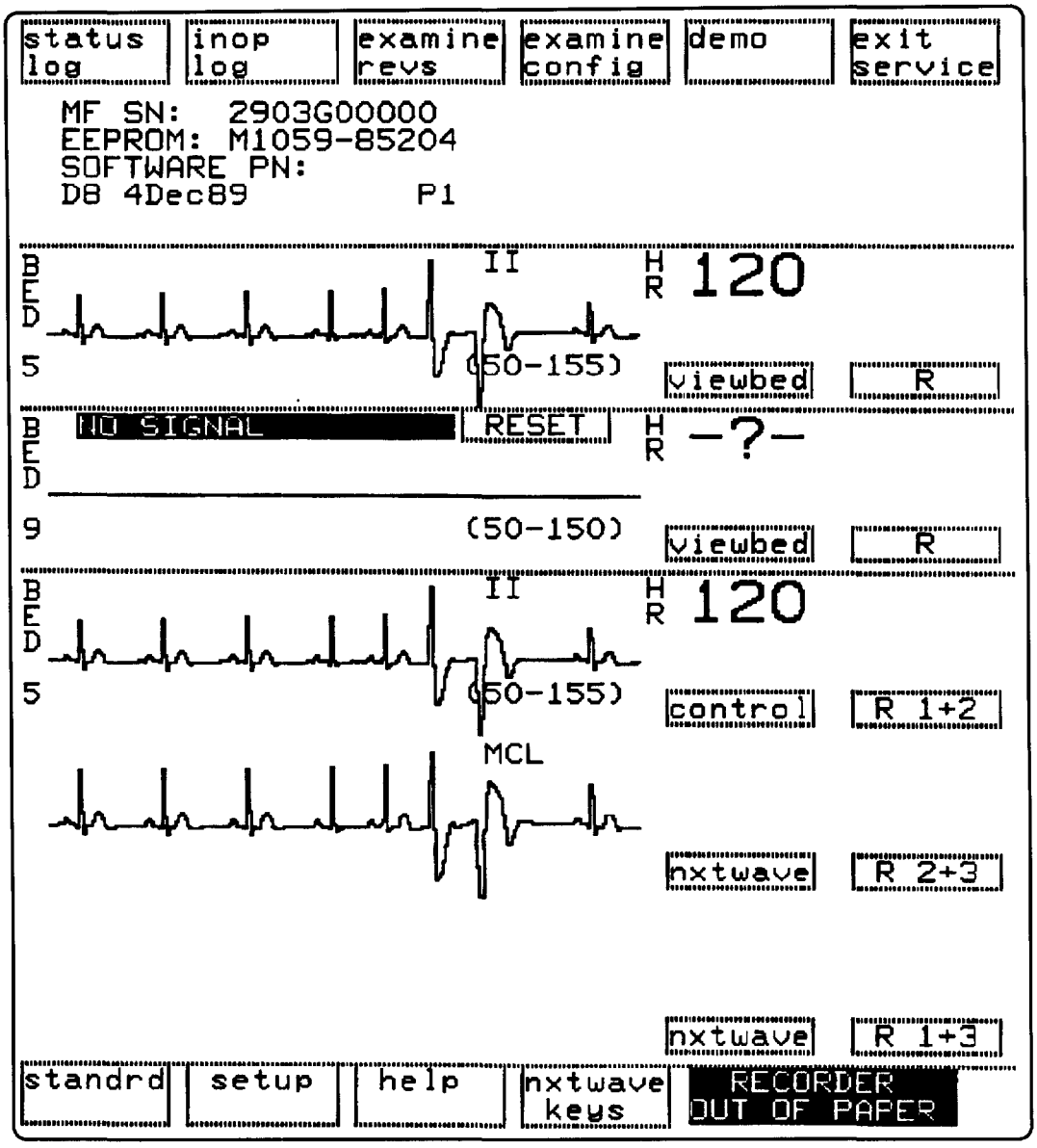


Figure 4-3. Telemetry Service I Screen

4.4.3 Status Log Screen

The Status Log screen (Figure 4-4) provides the user the ability to examine the logged error information. Errors are displayed two at a time. It also provides the ability to erase all logged error information. The screen consists of four touchkeys and four lines of error information. The touchkeys are:

a. MORE ERRORS. Touching the `MORE ERRORS` touchkey lists the next two errors in the log. When the end of the log is reached, a new copy of the status log is retrieved and the first entry is displayed. The same copy of the status log is displayed if a status log recording is in progress.

b. PRINT LOG. Touching the `PRINT LOG` touch key selectively initiates a recorder strip of logged error information. Either the entire fatal or non-fatal status log will be printed. The top status log entry displayed before this keypress occurs determines the type of status log to be printed. If a service log recording is in progress, Cancel Print Verification frame is activated. The touchkey is ignored if the status log is empty.

c. ERASE LOG. Touching the `ERASE LOG` touchkey displays the Erase Verification screen. This touchkey is ignored if the status log is empty.

d. BACK TO SERVICE. Touching the `BACK TO SERVICE` touchkey returns the user to the Telemetry Service I screen.

4.4.3.1 Log Entries

Each log entry has two lines of error information in the following format:

```
nn ccc ddddd ss eeeee
r dd/mm/yy hh:mm
```

Where: "nn" is the status log entry number displayed (1 - 28).
"ccc" is the abbreviated card name in ASCII:

APC = Turbo Processor Card
EPR = EPROM Board
RCK = Front-end Interface
RS2 = Dual RS232 card
SDN = SDN Interface
UTL = Utility CPU

"ddddd" is the device/module ID number in decimal.
"ss" is the slot type (F = function card, R = receiver) and slot number in decimal.
"eeeee" is the error code in decimal.
"r" defines the error class:

C = Cold start
W = Warm start
H = Hot start
F = Fatal
N = Non-fatal

"dd/mm/yy" is the day/month/ year of occurrence.
"hh:mm" is the hour:minute of occurrence.

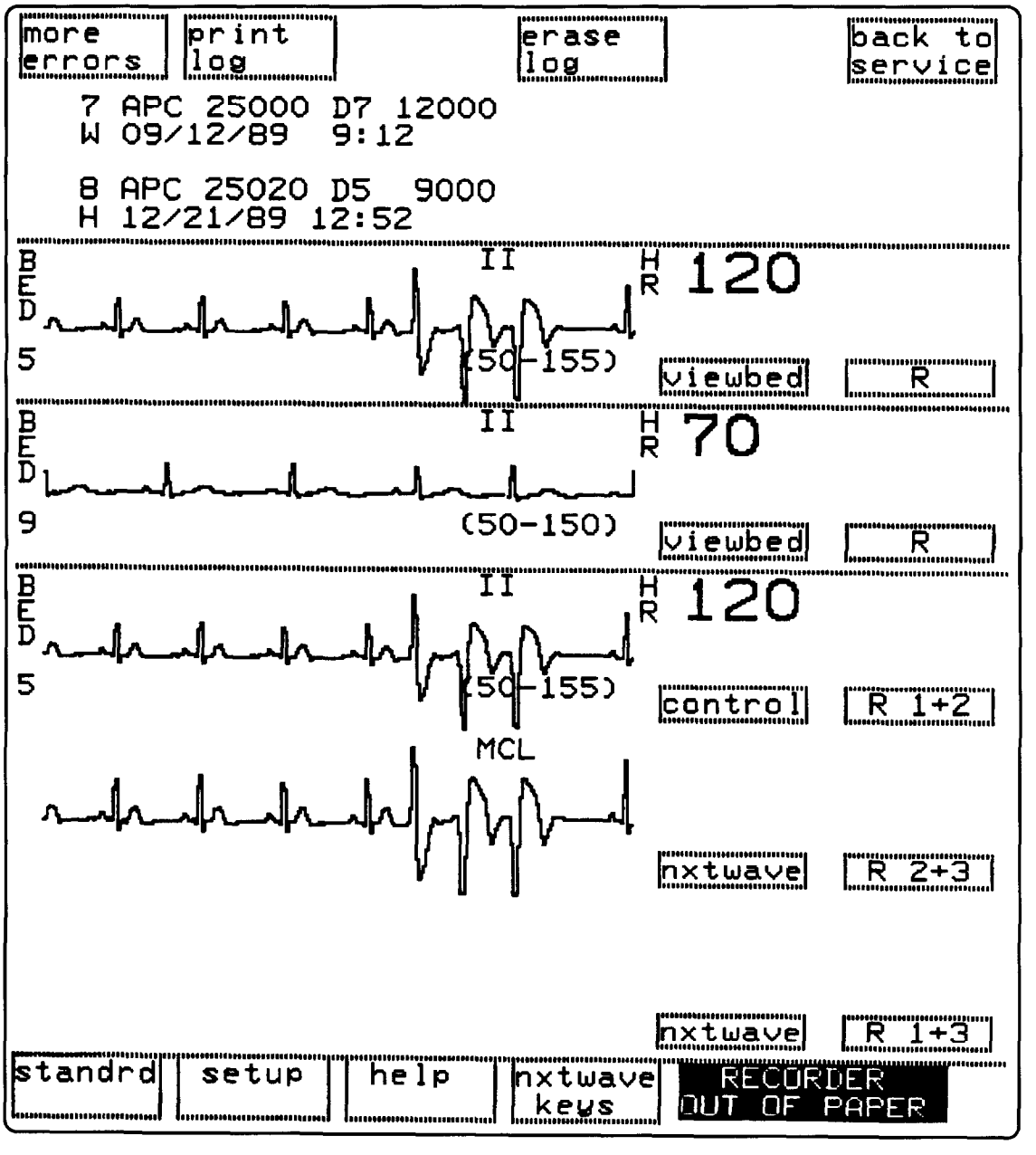


Figure 4-4. Status Log Screen

4.4.4 Erase Verification Screen

The Erase Verification screen (Figure 4-5) provides the user with the ability to erase either the INOP log or the status log. The screen displays a NO and a YES touchkey. Touching the NO touchkey terminates the erase operation and returns the user to either the Status Log screen or the INOP Log screen. If the Status Log screen is returned to, the previous two status log entries are displayed. Touching the YES touchkey erases the appropriate log and returns the user to the Telemetry Service I screen.

4.4.5 Cancel Print Verification Screen

The Cancel Print Verification screen (Figure 4-6) provides the user with the ability to stop the service recording in process. The screen displays a NO and a YES touchkey. Touching the NO touchkey terminates the cancel print operation and returns the user to the Telemetry Service I screen. Touching the YES touchkey cancels the print operation and returns the user to the Telemetry Service I screen.

4.4.6 Demonstration Verification Screen

The Demonstration Verification screen (Figure 4-7) allows the user to initiate demonstration waveforms for all receivers in a mainframe. A system Cold Start occurs to change the operating mode from MONITORING to DEMO and vice-versa. The screen displays a NO and a YES touchkey. Touching the NO touchkey terminates the demonstration operation and returns the user to the Telemetry Service I screen. Touching the YES touchkey forces the proper operating mode change and drops the user out of the telemetry service screens. To exit the demonstration mode, you must cycle back through a cold start as if returning to the demonstration mode. Pressing the YES touchkey at the demonstration mode query will now return the screen to the original patient monitoring waveform.

Note

All patient monitoring stops during demonstration mode, and when normal monitoring resumes, all user-controlled settings return to default values.

4.4.7 INOP Log Control Screen

The INOP Log Control Screen (Figure 4-8) provides the user with selective access to INOP information logged during normal operation. The INOP log is structured to provide fifteen entries of the most recent INOP codes for each transmitter-receiver pair, and to total the INOP codes for each pair. The screen consists of four touchkeys:

a. SORT BED. Touching the SORT BED touchkey displays the INOP Sort Bed screen.

b. SORT TIME. Touching the SORT TIME touchkey displays the INOP Sort Time screen.

c. ERASE INOPS. Touching the ERASE INOPS touchkey displays the Erase Verification screen.

d. BACK TO SERVICE. Touching the BACK TO SERVICE touchkey returns the user to the Telemetry Service I screen.

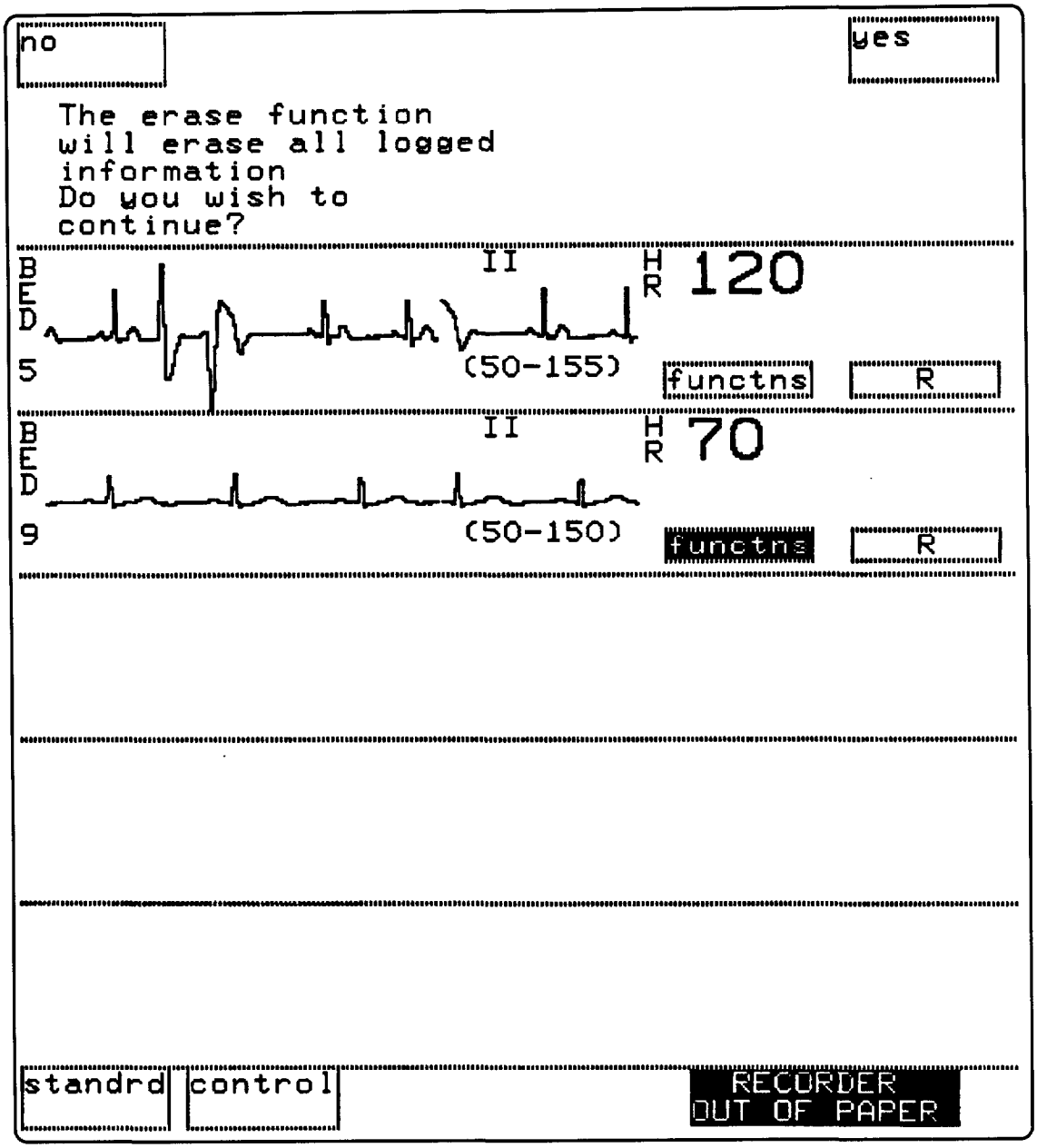


Figure 4-5. Erase Verification Screen

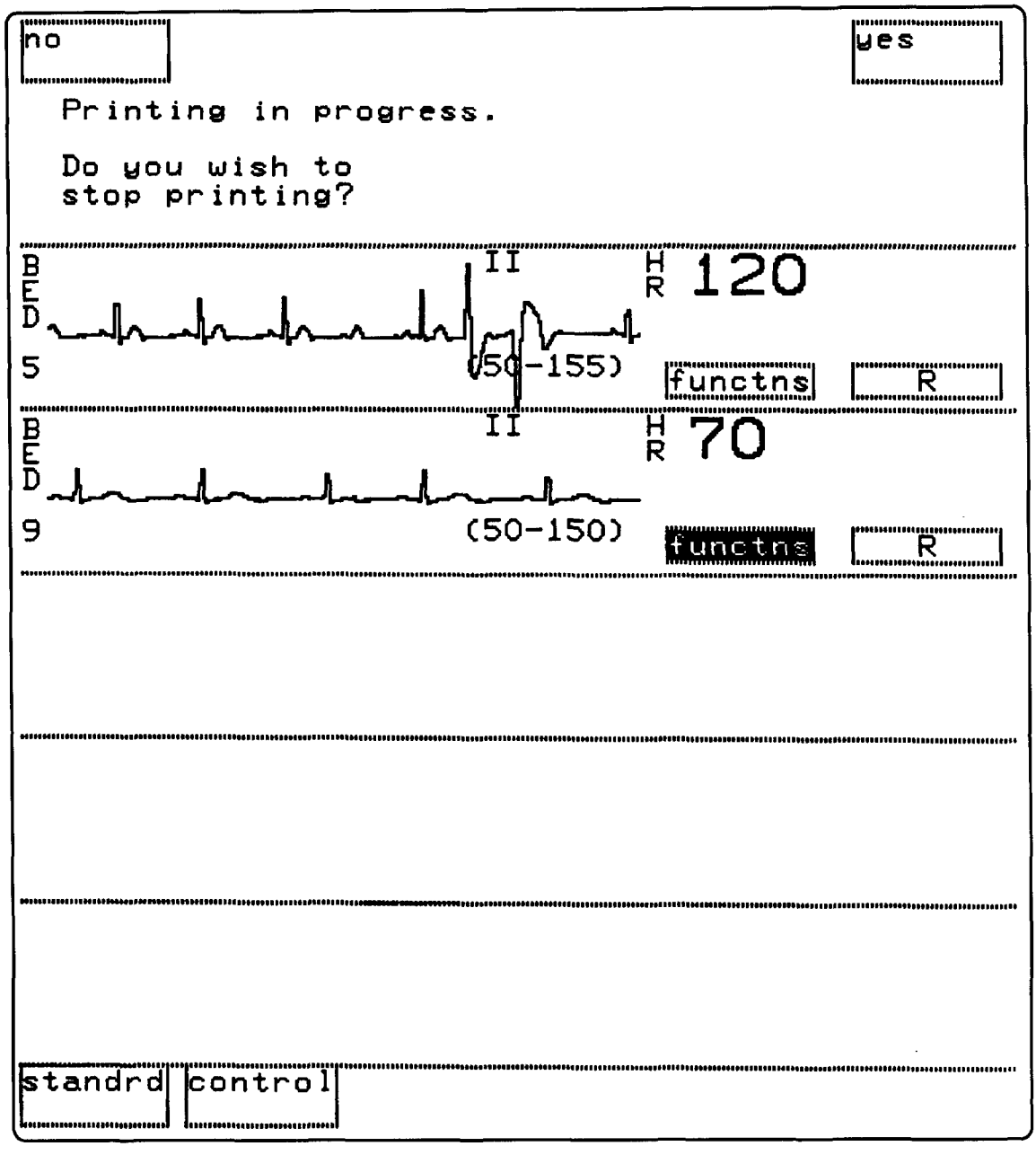


Figure 4-6. Cancel Print Verification Screen

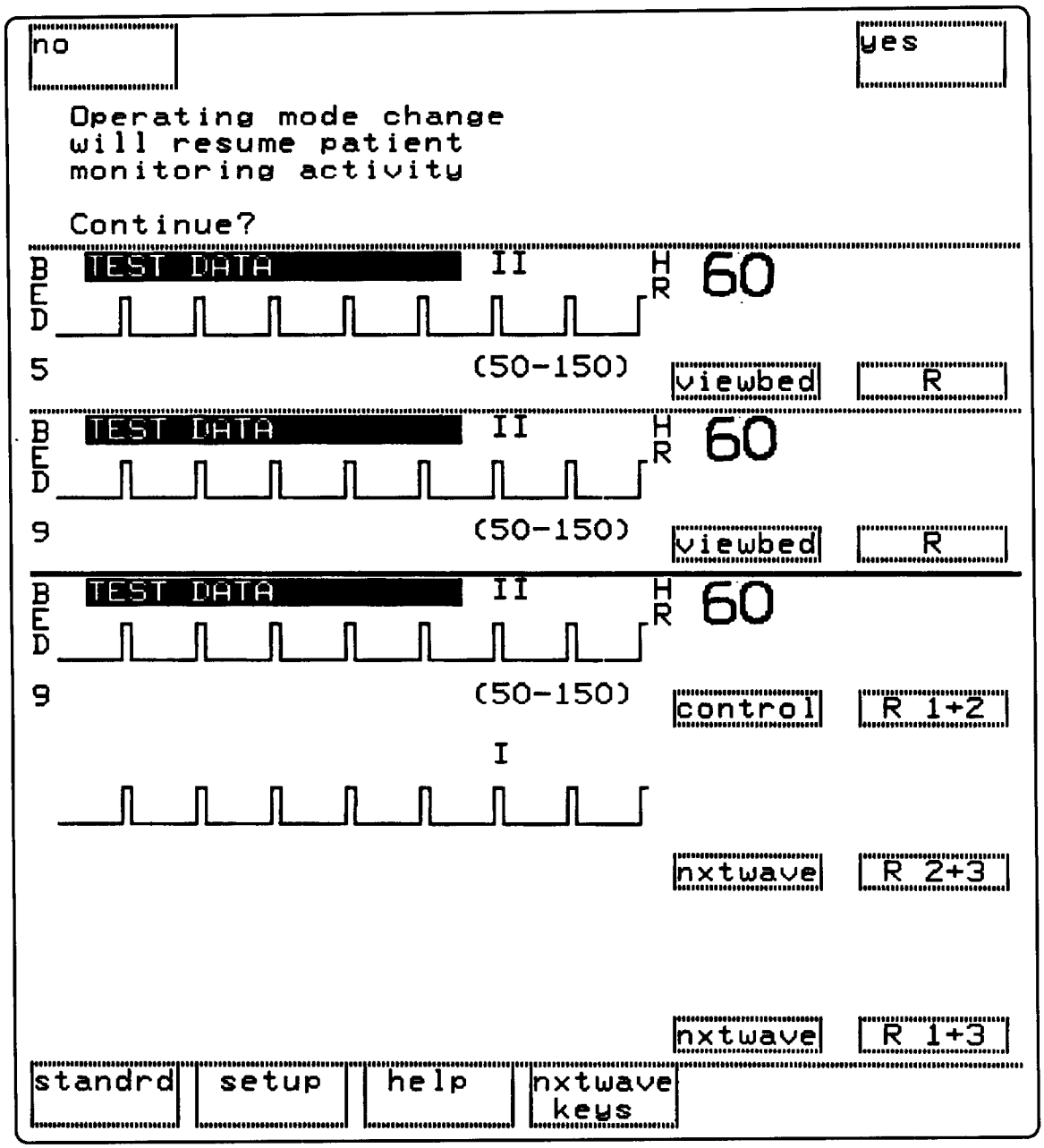


Figure 4-7. Demo Verification Screen

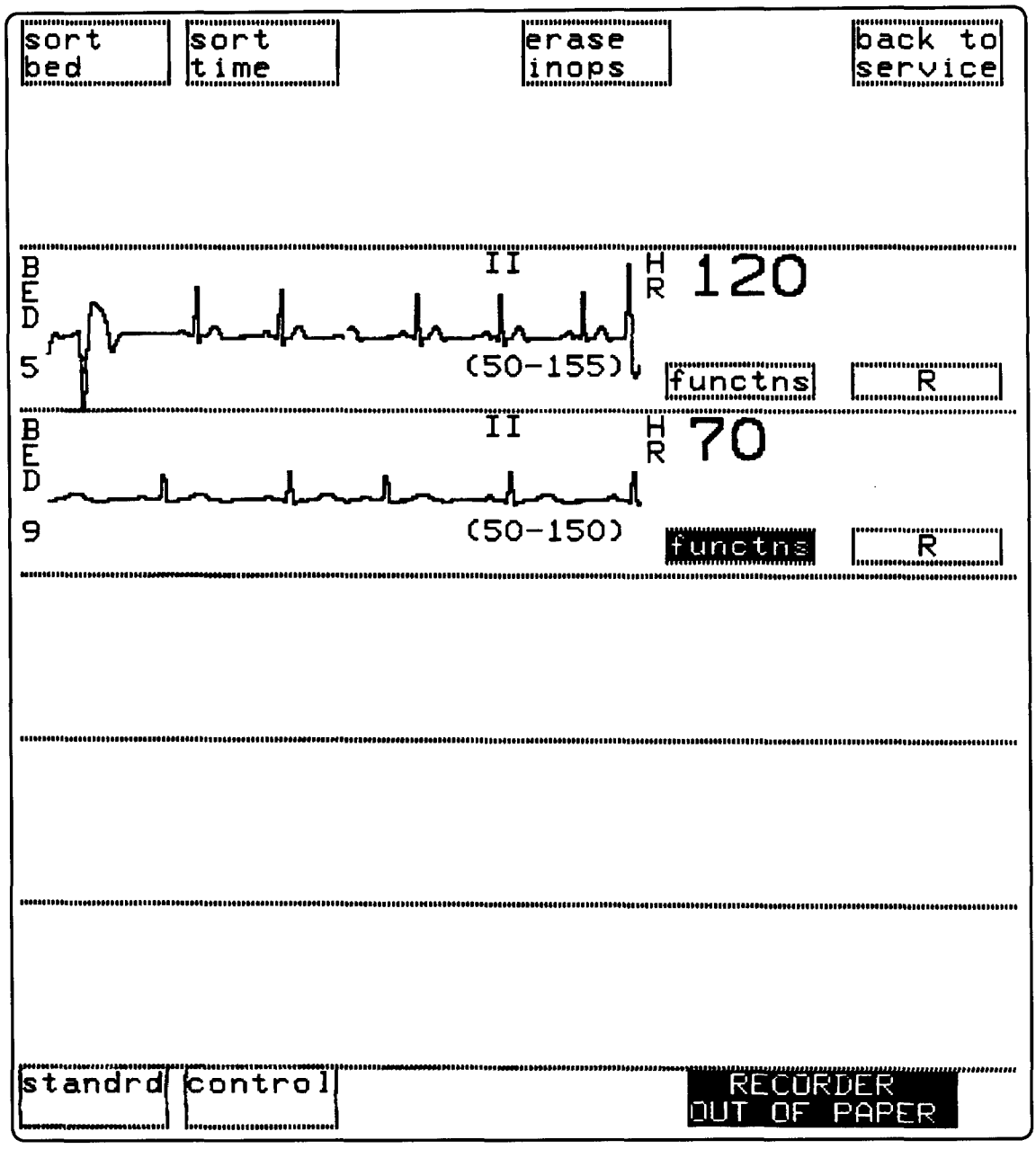


Figure 4-8. INOP Log Control Screen

4.4.8 INOP Sort Bed Screen

The INOP sort bed screen (Figure 4-9) provides the user with access to INOP information for a selected transmitter-receiver pair. The screen display consists of five touchkeys and five lines of information. The touchkeys are:

a. MORE INOPS. Touching the MORE INOPS touchkey shows the next five lines of INOP information.

b. PRINT LOG. Touching the PRINT LOG touchkey initiates a recorder strip of all INOP information for a selected transmitter-receiver pair. If the INOP totals are displayed, then all INOP totals are printed; if the INOP information is displayed, than all INOP data entries are printed. If a service log recording is in progress, Cancel Print Verification screen is displayed.

c. NEXT BED. Touching the NEXT BED touchkey displays INOP information for the next transmitter-receiver pair.

d. PREVIOUS BED. Touching the PREVIOUS BED touchkey displays INOP information for the previous transmitter-receiver pair.

e. BACK TO INOP. Touching the BACK TO INOP touchkey returns the user to the INOP Log Control screen.

4.4.8.1 Log Entries

INOP information is displayed in the following format:

1. Total INOP codes for the selected bed

ii-rr dd/mm hh:mm xxx

Where: "ii" is the two character INOP code:

Code	INOP	Cause
LO	Leads Off	Loss of one or more electrodes
WK	Weak Signal	Transmitter at fringe of antenna range
NO	No Signal	Transmitter out of antenna range
BW	Battery Weak	Transmitter battery weak
RB	Replace Battery	Transmitter battery dead
ID	Invalid Data EO1	Transmitter ID error
IN	Interference	RF Interference
RM	Receiver Malfunction	FE rack loss of communication with one or more receivers
NS	Telemetry Cannot Analyze	Intermittent noise or signal loss

"rr" is the receiver number (e.g. R1).

"dd/mm" is the day/month of first occurrence.
"hh:mm" is the hour:minute of occurrence
"xxx" is the total occurrences of this INOP code.
(Range: 0–999) (*** Code is displayed if total INOP count exceeds 999.)

2. INOP codes sorted by occurrence for the selected bed.

ii-rr dd/mm hh:mm:ss

Where: "ii" is a two character INOP code.
"rr" is the receiver number (e.g. R1).
"dd/mm" is the day/month of occurrence.
"hh:mm:ss is the hour:minute:second of occurrence.

If no INOPs are logged for a transmitter-receiver pair, only the INOP totals are displayed. If the INOP total is zero, the time and date fields indicate when the INOP log was last cleared.

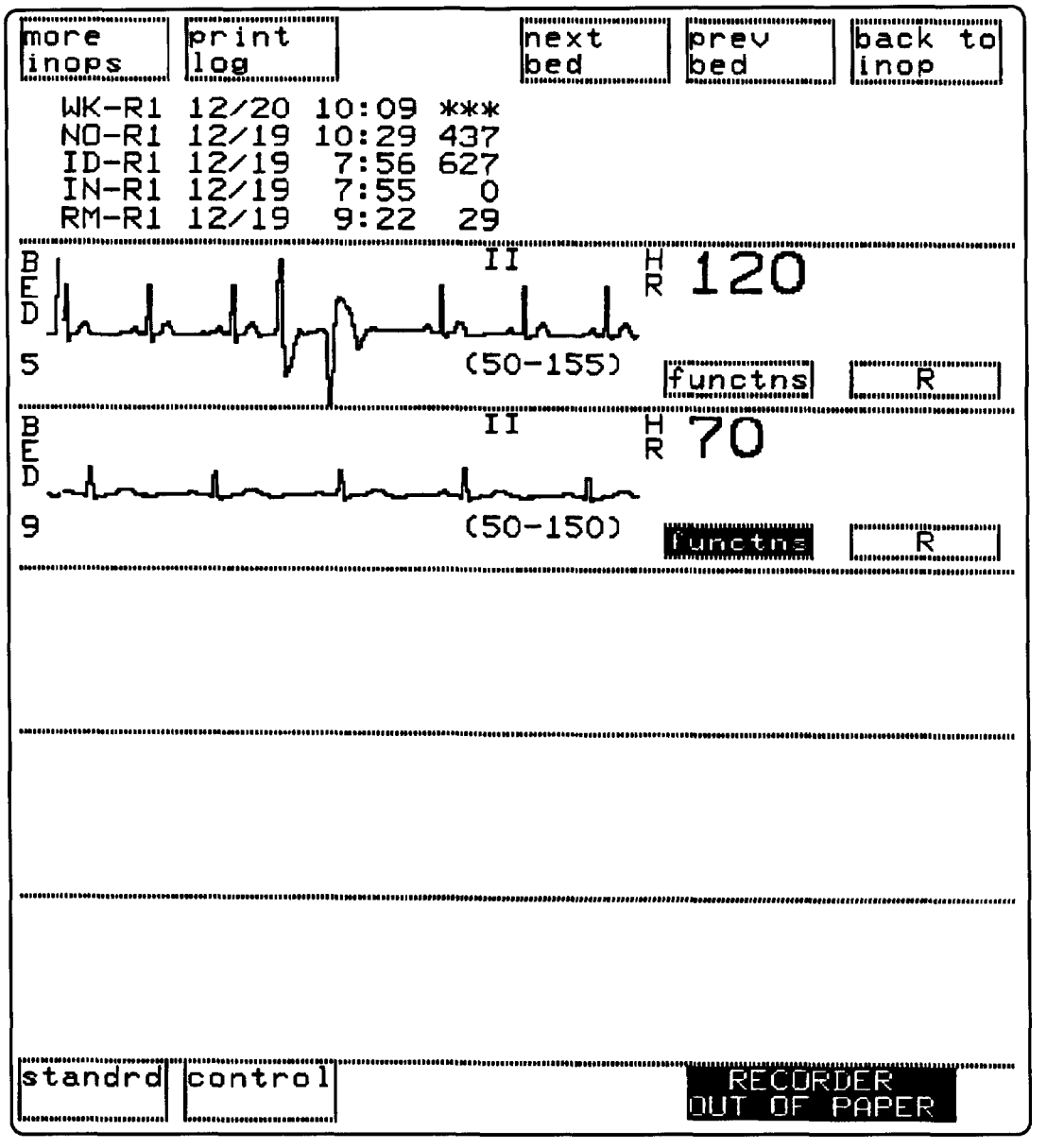


Figure 4-9. INOP Sort Bed Screen (INOPs Totaled)

4.4.9 INOP Sort Time Screen

The INOP Sort Time screen (Figure 4-10) provides the user with the capability to sort all INOP log entries by their time of occurrence. Screen display consists of three touchkeys and five lines of information. The touchkeys are:

a. MORE INOPS. Touching the MORE INOPS touchkey shows the next five INOPs logged.

b. PRINT LOG. Touching the PRINT LOG touchkey initiates a recorder strip of all INOP information for a selected transmitter-receiver pair. If a service log recording is in progress, Cancel Print Verification screen is displayed.

c. BACK TO INOP. Touching the BACK TO INOP touchkey returns the user to the INOP Log Control screen.

4.4.9.1 Log Entries

INOP information is displayed in the following format:

ii-rr dd/mm hh:mm:ss

Where: "ii" is the two character INOP code. See paragraph 4.4.8.1.
"rr" is the receiver number (e.g. R1).
"dd/mm" is the day/month of first occurrence.
"hh:mm:ss" is the hour:minute:second of occurrence

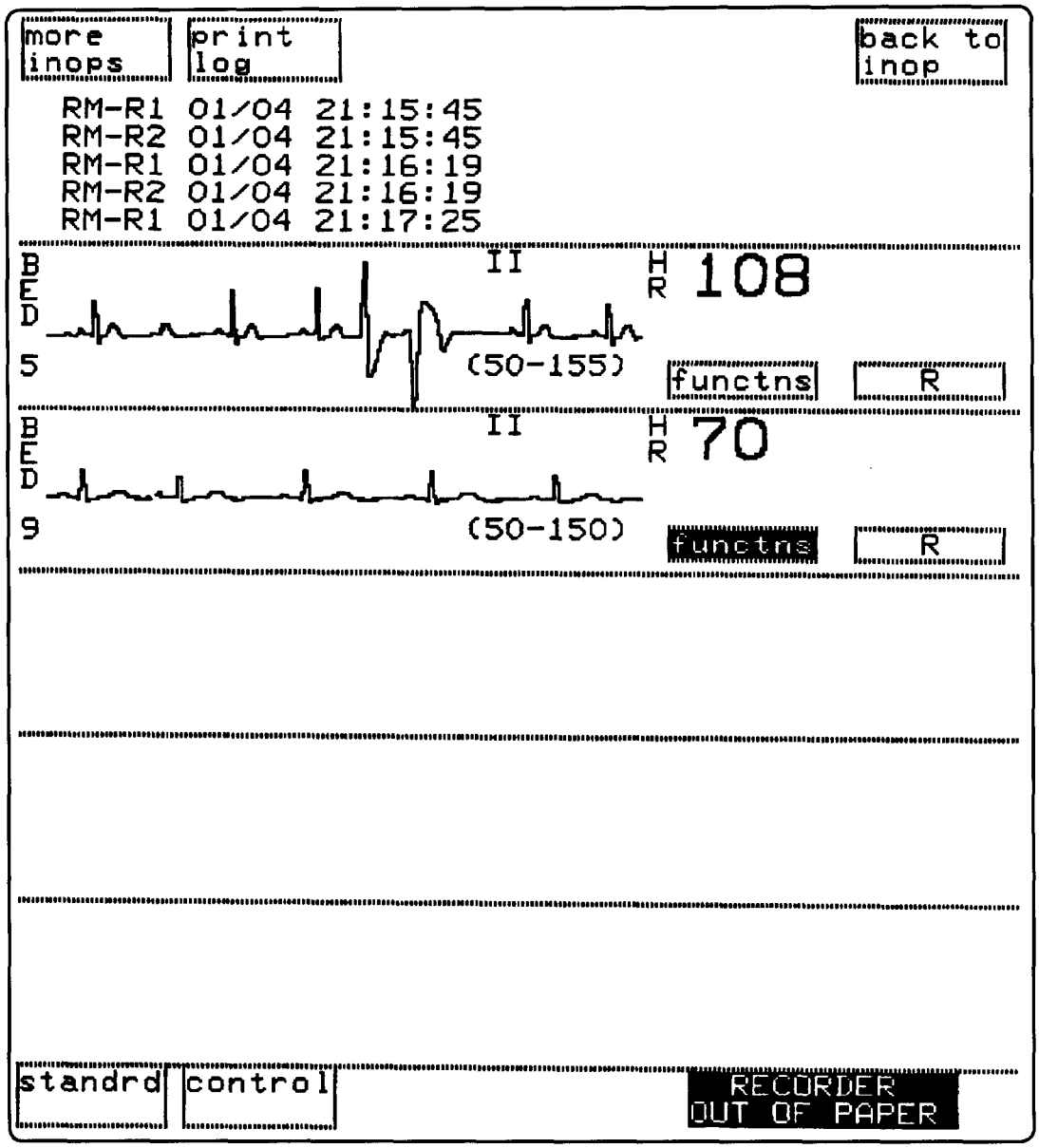


Figure 4-10. INOP Sort Time Screen

4.4.10 Examine Revisions Screen

The Examine Revisions Screen (Figure 4-11) provides the user access to the revision levels for the hardware resident in the telemetry system for use in servicing to avoid revision incompatibility problems. The screen displays three touchkeys and five lines of information. The touchkeys are:

a. MORE REVS. Touching the MORE REVS touchkey lists the next five part numbers.

b. PRINT REVS. Touching the PRINT REVS touchkey initiates a recorder strip at the central monitoring station to identify the hardware resident in the telemetry system. If a service log recording is in progress, the Cancel Print Verification screen is displayed.

c. BACK TO SERVICE. Touching the BACK TO SERVICE touchkey returns the user to the Telemetry Service I screen.

4.4.10.1 Examine Revisions Information

The Examine Revisions information is displayed in the following format:

ss ccc Mpppp-ppphh ff

where: "ss" is the slot type (D = Digital backplane, R = receiver backplane), and slot number in decimal.

"ccc" is the abbreviated card name in ASCII (see paragraph 4.4.3.1).

"Mpppp-ppphh" is the HP part number of the hardware, Where hh is the hardware revision number. The ** code indicates no revision is available.

"ff" is the firmware revision number for the card. The ** code indicates no revision is available.

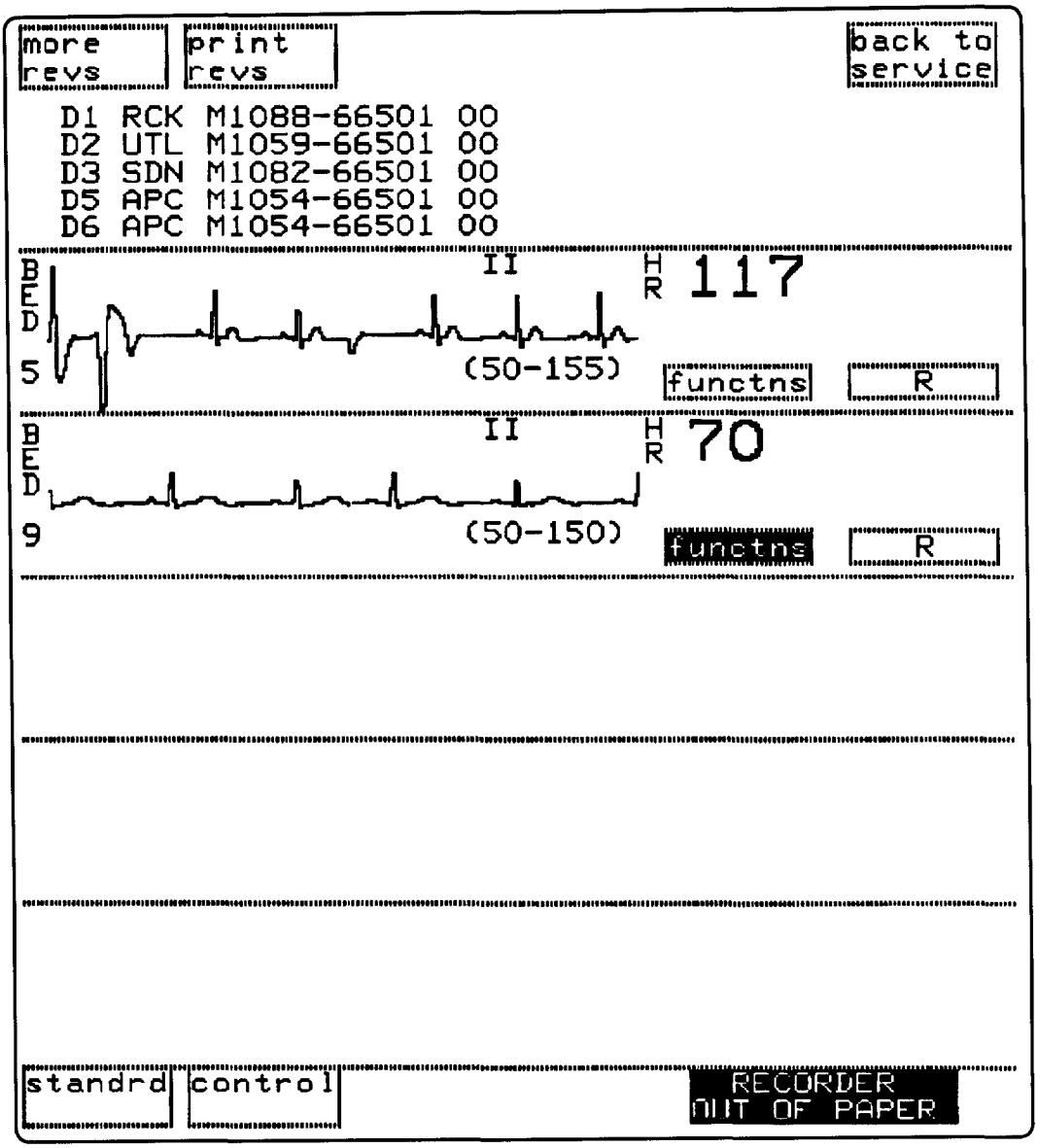


Figure 4-11. Examine Revisions Screen

4.4.11 Examine Configuration Screen

The Examine Configuration Screen (Figure 4-12) provides the user access to the configuration information for the receiver mainframe. The screen displays two touchkeys. The touchkeys are:

a. MORE CONFIG. Touching the MORE CONFIG touchkey lists the next set of configuration information.

b. BACK TO SERVICE. Touching the BACK TO SERVICE touchkey returns the user to the Telemetry Service I screen.

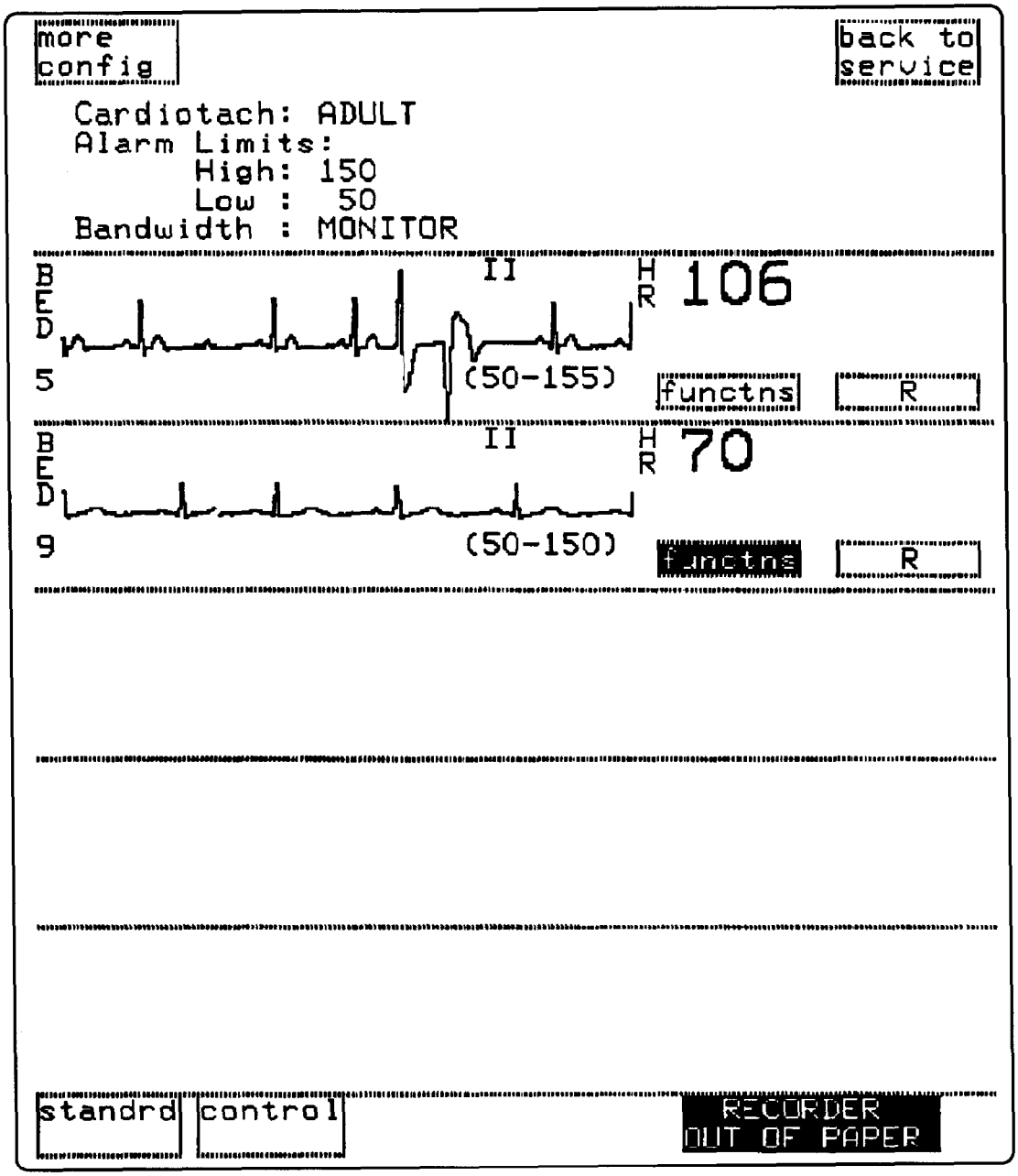


Figure 4-12. Examine Configuration Screen

4.5 Error Codes

The HP M1403A Digital UHF Telemetry System Service Tool Software displays error codes which indicate faulty conditions in the software or hardware of the receiver mainframe. The subsequent tables list the error codes along with a text description. The service tool only displays the error code. Accompanying each error code is the recommended action upon detection of a faulty condition.

4.5.1 Error Code Fields

There are two fields for each error code. The first field is the device identification number of the software module reporting the faulty condition. The device ID can either be the Operating System (OS) module, or one of the Application Software (ASW) modules. The second field is a five-digit number which defines the faulty condition which has occurred. It is important to note that numbers in the second field are not unique to a device ID number in the first field. Since software modules are independent and operate in a multitasking environment, each module may report the same type of fault.

Device Identification Numbers

Software Module	Identification Number
(Numbers in parentheses refer to error codes tables for the modules.)	
Operating System (4-2, 4-3)	16400
Global Information Handler (4-4)	16500
Recorder Manager Module (4-5)	17004
ECG Module (4-6)	25000
Heart Module (4-7, 4-8)	25001
Rack Manager (4-9)	25010
Alarm Manager (4-10, 4-11)	25011
SDN Module (4-12, 4-13)	25020
INOP Module (4-14)	25100
Service Module (4-15)	25101
User Application (4-16)	25102
Three-Channel ST Module (4-17)	32734

Table 4-2. Operating System (16400) Fatal Error Codes

Error Code	Description	Probable Cause/ Action
00001	Boot ROM checksum not correct.	Boot error.
00002	Undelayed bus error test failed.	Boot error.
00003	Delayed bus error test failed.	Boot error.
00004	Internal to external RAM error offset.	Boot error.
00010	RAM access test Hi-byte failed.	Boot error.
00011	RAM access test Lo-byte failed.	Boot error.
00012	Walking zero test Hi-byte failed.	Boot error.
00013	Walking zero test Lo-byte failed.	Boot error.
00014	Walking one's test Hi-byte failed.	Boot error.
00015	Walking one's test Lo-byte failed.	Boot error.
00016	March address "0" test Hi-byte failed.	Boot error.
00017	March address "0" test Lo-byte failed.	Boot error.
00018	March address "1" test Hi-byte failed.	Boot error.
00019	March address "1" test Lo-byte failed.	Boot error.
00020	External RAM smaller than needed for the specified configuration.	Boot error.
00021	Invalid MPB slot read (slot = 0) or 8-bit CPU flagged.	Boot error.
00022	Internal RAM walking zero test failed.	Boot error.
00023	Internal RAM walking one test failed.	Boot error.
00024	Internal RAM marching address test failed.	Boot error.
00025	Internal RAM marching address test failed.	Boot error.
00026	External RAM walking zero test failed.	Boot error.
00027	External RAM walking one test failed.	Boot error.
00028	External RAM marching address test failed.	Boot error.
00029	External RAM marching address test failed.	Boot error.
00040	Preamble not correctly written into buffered memory.	Boot error.
00041	Intermittent read or write error in buffered memory.	Boot error.
00100	Bus error.	Boot error.
00101	Address error.	Boot error.
00102	Illegal instruction.	Boot error.
00103	Zero divide.	Boot error.
00104	Check instruction.	Boot error.

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
00105	TRAPV_INSTR	Boot error.
00106	PRIV_VIOL	Boot error.
00107	TRACE	Boot error.
00108	EMUL_1010	Boot error.
00109	EMUL_1111	Boot error.
00120	UNKNOWN_EXC1	Boot error.
00121	UNKNOWN_EXC2	Boot error.
00122	UNKNOWN_INT	Boot error.
00123	UNKNOWN_TRAP	Boot error.
00124	USER_INT	Boot error.
00200	MPB life tick message absent.	Boot error.
00201	Initialization phase 1 timeout.	Boot error.
00202	Initialization phase 2 timeout.	Boot error.
00210	Asynchronous receive fifo overflow.	Boot error.
00211	Synchronous receive fifo overflow.	Boot error.
00212	Asynchronous transmit fifo overflow.	Boot error.
00213	Synchronous transmit fifo overflow.	Boot error.
00214	Internal MPB logic error.	Boot error.
00215	MPB blocked because of zero length message on bus.	Boot error.
00220	Received asynchronous message with length of zero.	Boot error.
00221	Less words in asynchronous received fifo message than expected (wrong length).	Boot error.
00230	Received synchronous message with length of zero.	Boot error.
00231	Less words left in synchronous received fifo than expected (wrong length).	Boot error.
00232	Synchronous read garbled caused by UTO overrun or transmission error.	Boot error.
00240	Attempted to send asynchronous message with length of zero.	Boot error.
00241	Asynchronous transmit fifo permanent full.	Boot error.
00242	Attempted to send synchronous message with length of zero.	Boot error.
00243	Synchronous transmit fifo permanent full.	Boot error.
00300	Bad PROM pack checksum - corrupt PROM pack.	Boot error.
00301	Bad PROM pack user flag - corrupt PROM pack.	Boot error.

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
00310	More than 4095 dynamic message headers required for this system.	Boot error.
00311	Too many message headers for one message variable.	Boot error.
00315	Internal error.	Boot error.
00316	MPB chip timing problem - MPB chip cannot transmit message asynchronously and receive the same message synchronously.	Boot error.
00320	Unable to delete process.	Boot error.
00321	Unable to spawn process.	Boot error.
00322	Unable to activate process.	Boot error.
00323	Unable to create exchange.	Boot error.
00326	Unable to create buffers.	Boot error.
00327	Card does not reach required card status within the limit defined in the MCT.	Boot error.
00335	Bad card info response message received.	Boot error.
00340	Error in memory map request.	
00350	Unable to allocate master boot data area at start of RAM.	Boot error.
00351	Too many devices: change MAX_DEVICE NO in resource h.	Boot error.
00356	MPB-part. did not send a res. info.	Boot error.
00360	Installation table too large to fit into one message.	Boot error.
00365	Error in MT: link mode neither male nor female.	Boot error.
00370	Timeout in mem map distribution.	Boot error.
00380	Boot ROM firmware revision not corresponding to boot software on PROM pack.	Boot error.
00400	No more buffered memory available.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
00401	No more unbuffered memory available.	Utility CPU error. Refer to paragraph 4.6.2.
00402	Out of buffered and unbuffered memory.	Replace Turbo Processor or 40 MHz CPC Card and/or utility CPU as indicated by LEDs.
00410	Module has no files.	Replace EPROM board.
00411	File not found on PROM pack.	Replace EPROM board.

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
00412	Whole code of module or device not present on any PROM pack.	Replace EPROM board.
00413	Master CPU cannot find slave boot software in master PROM pack.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
00420	Wrong MCT structure revision.	Utility CPU error. Refer to paragraph 4.6.2.
00421	MCT general conference block missing.	Utility CPU error. Refer to paragraph 4.6.2.
00422	MCT HW conference block missing.	Utility CPU error. Refer to paragraph 4.6.2.
00423	MCT SW conference blocks missing.	Utility CPU error. Refer to paragraph 4.6.2.
00424	MCT OS conference blocks missing.	Utility CPU error. Refer to paragraph 4.6.2.
00425	MCT general conference checksum wrong.	Utility CPU error. Refer to paragraph 4.6.2.
00426	MCT HW conference checksum wrong.	Utility CPU error. Refer to paragraph 4.6.2.
00427	MCT SW conference checksum wrong.	Utility CPU error. Refer to paragraph 4.6.2.
00428	MCT MOS conference checksum wrong.	Utility CPU error. Refer to paragraph 4.6.2.
00429	No information about external tool from interface CPU received.	Utility CPU error. Refer to paragraph 4.6.2.
00430	SW configuration in MCT corrupt.	Utility CPU error. Refer to paragraph 4.6.2.
00431	Internal SW conference table corrupt.	Utility CPU error. Refer to paragraph 4.6.2.
00432	Size in received MCT is smaller than MCT prefix.	Utility CPU error. Refer to paragraph 4.6.2.
00433	Specified number of blocks not available in EEPROM.	Utility CPU error. Refer to paragraph 4.6.2.
00434	Size in MCT prefix and received data size do not match.	Utility CPU error. Refer to paragraph 4.6.2.
00435	No contents were found for a CPU in CPU configuration part of MCT.	Remove surplus CPU.
00436	Illegal boot ROM loaded for this type of CPU; e.g. 15 MHz FW in 10 MHz CPU board.	Utility CPU error. Refer to paragraph 4.6.2.

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
Note: Error codes 00500 through 00940 are software/configuration errors. Refer to paragraph 4.6.5.		
00500	ut1 time-driven task overrun.	Operating System run-time error
00501	ut2 time-driven task overrun.	Operating System run-time error
00502	ut3 time-driven task overrun.	Operating System run-time error
00503	ut4 time-driven task overrun.	Operating System run-time error
00510	ut1 message-driven task overrun.	Operating System run-time error
00511	ut2 message-driven task overrun.	Operating System run-time error
00512	ut3 message-driven task overrun.	Operating System run-time error
00513	ut4 message-driven task overrun.	Operating System run-time error
00520	Internal error: header out of range.	Operating System run-time error
00521	Internal error: "send_x" returns error code.	Operating System run-time error
00522	Internal error: message was tuned asynchronous, but there is a synchronous routine interested in this message too.	Operating System run-time error
00530	ut0 stack overflow.	Operating System run-time error
00531	ut1 stack overflow.	Operating System run-time error
00532	ut2 stack overflow.	Operating System run-time error
00533	ut3 stack overflow.	Operating System run-time error
00534	ut4 stack overflow.	Operating System run-time error
00535	ts0 stack overflow.	Operating System run-time error
00536	up0 stack overflow.	Operating System run-time error
00537	up1 stack overflow.	Operating System run-time error
00538	up2 stack overflow.	Operating System run-time error
00539	Background stack overflow.	Operating System run-time error
00540	Distributor stack overflow.	Operating System run-time error
00550	ut0 task overrun.	Operating System run-time error
00551	Wrong process ID for "signal_v".	Operating System run-time error
00552	OS variable destroyed.	Operating System run-time error
00553	OS variable destroyed.	Operating System run-time error
00560	Out of pSOS message buffers because too many received messages are waiting in front of the uts.	Operating System run-time error
00561	Internal error: header of range.	Operating System run-time error
00562	Out of buffers to store a received long message.	Operating System run-time error

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
00563	Not able to pass synchronous received message to asynchronous user task: out of pSOS message buffers because too many received messages are waiting in front of the uts.	Operating System run-time error
00570	ut0 - can't get message out of pSOS exchange.	Operating System run-time error
00571	ut1 - can't get message out of pSOS exchange.	Operating System run-time error
00572	ut2 - can't get message out of pSOS exchange.	Operating System run-time error
00573	ut3 - can't get message out of pSOS exchange.	Operating System run-time error
00574	ut4 - can't get message out of pSOS exchange.	Operating System run-time error
00575	ts0 - can't get message out of pSOS exchange.	Operating System run-time error
00576	up0 - can't get message out of pSOS exchange.	Operating System run-time error
00577	up1 - can't get message out of pSOS exchange.	Operating System run-time error
00578	up2 - can't get message out of pSOS exchange.	Operating System run-time error
00580	Internal errors when starting the ts0 user task.	Operating System run-time error
00581	Internal errors when stopping the ts0 user task.	Operating System run-time error
00590	OS background is not running.	Operating System run-time error
00700	Too many boot software download errors occurred.	Operating System run-time error
00701	Too many file directory download errors occurred.	Operating System run-time error
00702	Too many system table download errors occurred.	Operating System run-time error
00710	Different file directory size received.	Operating System run-time error
00711	Too many file directory request errors occurred.	Operating System run-time error
00712	Too many file request errors.	Operating System run-time error
00720	Too many asw file transfer errors occurred.	Operating System run-time error
00725	Internal error: MPB driver called with message length more than 256 words (too long).	Operating System run-time error
00726	Internal error: MPB driver called with message length less than 2 words (too short).	Operating System run-time error
00800	System call has become obsolete.	Operating System run-time error
00801	System call number is too large; system call doesn't exist.	Operating System run-time error
00802	System call allowed only on master CPU.	Operating System run-time error
00805	Size of buffered data must be even.	Operating System run-time error
00810	Unlock was executed more often than lock.	Operating System run-time error
00815	No more entries in tune fifo.	Operating System run-time error

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
00900	Header table checksum error.	Operating System run-time error
00901	Routine table checksum error.	Operating System run-time error
00902	Checksum error: CPU real info table.	Operating System run-time error
00903	Checksum error: message ID header table.	Operating System run-time error
00904	Tune table checksum error.	Operating System run-time error
00905	Checksum of a local used file.	Operating System run-time error
00906	Checksum of a file directory wrong.	Operating System run-time error
00907	Checksum of system file wrong.	Operating System run-time error
00908	Checksum of MPB tune RAM wrong.	Operating System run-time error
00909	Checksum of MPB data in data.c.	Operating System run-time error
00910	Realization table checksum error.	Operating System run-time error
00911	Entry records checksum error.	Operating System run-time error
00912	Exception jump table checksum error.	Operating System run-time error
00913	Checksum error: sort_mid_hd_tbl.	Operating System run-time error
00914	Bad algorithm: sort_mid_hd_tbl.	Operating System run-time error
00915	Missing token indicates that a CPU has become inactive.	Operating System run-time error
00916	Bad master flag.	Operating System run-time error
00920	32 ms frame clock missing.	Operating System run-time error
00921	One of the scheduler tables is corrupt.	Operating System run-time error
00930	Tune fifo checksum wrong.	Operating System run-time error
00931	Read/write ptr to tune fifo corrupt.	Operating System run-time error
00935	Checksum of shared memory control block wrong.	Operating System run-time error
00940	Two or more different headers for the same message ID.	Operating System run-time error
01000	Not all boards received.	Replace board as indicated by LED.
01001 through 01009	Missing board in slot X (1 through 9, corresponding to last digit of error code).	Replace board indicated by error code.
01032	Wrong boot ROM firmware revision.	Replace board as indicated by LED.
01033	Wrong boot ROM firmware revision in slot 1.	Replace board in slot 1.
01034	Wrong boot ROM firmware revision in slot 2.	Replace board in slot 2.

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
01035	Wrong boot ROM firmware revision in slot 3.	Replace board in slot 3.
01036	Wrong boot ROM firmware revision in slot 4.	Replace board in slot 4.
01037	Wrong boot ROM firmware revision in slot 5.	Replace board in slot 5.
01038	Wrong boot ROM firmware revision in slot 6.	Replace board in slot 6.
01039	Wrong boot ROM firmware revision in slot 7.	Replace board in slot 7.
01040	Wrong boot ROM firmware revision in slot 8.	Replace board in slot 8.
01041	Wrong boot ROM firmware revision in slot 9.	Replace board in slot 9.
01064	A CPU has insufficient MPB RAM.	Replace board indicated by LED.
01065	CPU in slot 1 has insufficient MPB RAM.	Replace board in slot 1.
01066	CPU in slot 2 has insufficient MPB RAM.	Replace board in slot 2.
01067	CPU in slot 3 has insufficient MPB RAM.	Replace board in slot 3.
01068	CPU in slot 4 has insufficient MPB RAM.	Replace board in slot 4.
01069	CPU in slot 5 has insufficient MPB RAM.	Replace board in slot 5.
01070	CPU in slot 6 has insufficient MPB RAM.	Replace board in slot 6.
01071	CPU in slot 7 has insufficient MPB RAM.	Replace board in slot 7.
01072	CPU in slot 8 has insufficient MPB RAM.	Replace board in slot 8.
01073	CPU in slot 9 has insufficient MPB RAM.	Replace board in slot 9.
01096	Extended test result absent.	Replace board indicated by LED.
01097	Extended test result from slot 1 absent.	Replace board in slot 1.
01098	Extended test result from slot 2 absent.	Replace board in slot 2.
01099	Extended test result from slot 3 absent.	Replace board in slot 3.
01100	Extended test result from slot 4 absent.	Replace board in slot 4.
01101	Extended test result from slot 5 absent.	Replace board in slot 5.
01102	Extended test result from slot 6 absent.	Replace board in slot 6.
01103	Extended test result from slot 7 absent.	Replace board in slot 7.
01104	Extended test result from slot 8 absent.	Replace board in slot 8.
01105	Extended test result from slot 9 absent.	Replace board in slot 9.
01128	Negative extended test result reported.	Replace board indicated by LED.
01129	Negative extended test result reported from slot 1.	Replace board in slot 1.
01130	Negative extended test result reported from slot 2.	Replace board in slot 2.
01131	Negative extended test result reported from slot 3.	Replace board in slot 3.
01132	Negative extended test result reported from slot 4.	Replace board in slot 4.

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
01133	Negative extended test result reported from slot 5.	Replace board in slot 5.
01134	Negative extended test result reported from slot 6.	Replace board in slot 6.
01135	Negative extended test result reported from slot 7.	Replace board in slot 7.
01136	Negative extended test result reported from slot 8.	Replace board in slot 8.
01137	Negative extended test result reported from slot 9.	Replace board in slot 9.
01160	No more unbuffered memory.	Replace board indicated by LED.
01161	No more unbuffered memory in slot 1.	Replace board in slot 1.
01162	No more unbuffered memory in slot 2.	Replace board in slot 2.
01163	No more unbuffered memory in slot 3.	Replace board in slot 3.
01164	No more unbuffered memory in slot 4.	Replace board in slot 4.
01165	No more unbuffered memory in slot 5.	Replace board in slot 5.
01166	No more unbuffered memory in slot 6.	Replace board in slot 6.
01167	No more unbuffered memory in slot 7.	Replace board in slot 7.
01168	No more unbuffered memory in slot 8.	Replace board in slot 8.
01169	No more unbuffered memory in slot 9.	Replace board in slot 9.
01192	Bad resource specification.	Replace board indicated by LED.
01193	Bad resource specification in slot 1.	Replace board in slot 1.
01194	Bad resource specification in slot 2.	Replace board in slot 2.
01195	Bad resource specification in slot 3.	Replace board in slot 3.
01196	Bad resource specification in slot 4.	Replace board in slot 4.
01197	Bad resource specification in slot 5.	Replace board in slot 5.
01198	Bad resource specification in slot 6.	Replace board in slot 6.
01199	Bad resource specification in slot 7.	Replace board in slot 7.
01200	Bad resource specification in slot 8.	Replace board in slot 8.
01201	Bad resource specification in slot 9.	Replace board in slot 9.
01224	Wrong CPU type.	Replace board indicated by LED.
01225	Wrong CPU type in slot 1.	Replace board in slot 1.
01226	Wrong CPU type in slot 2.	Replace board in slot 2.
01227	Wrong CPU type in slot 3.	Replace board in slot 3.
01228	Wrong CPU type in slot 4.	Replace board in slot 4.
01229	Wrong CPU type in slot 5.	Replace board in slot 5.
01230	Wrong CPU type in slot 6.	Replace board in slot 6.

Table 4-2. Operating System (16400) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
01231	Wrong CPU type in slot 7.	Replace board in slot 7.
01232	Wrong CPU type in slot 8.	Replace board in slot 8.
01233	Wrong CPU type in slot 9.	Replace board in slot 9.
01256	CPU is too slow.	Replace board indicated by LED.
01257	CPU is too slow in slot 1.	Replace board in slot 1.
01258	CPU is too slow in slot 2.	Replace board in slot 2.
01259	CPU is too slow in slot 3.	Replace board in slot 3.
01260	CPU is too slow in slot 4.	Replace board in slot 4.
01261	CPU is too slow in slot 5.	Replace board in slot 5.
01262	CPU is too slow in slot 6.	Replace board in slot 6.
01263	CPU is too slow in slot 7.	Replace board in slot 7.
01264	CPU is too slow in slot 8.	Replace board in slot 8.
01265	CPU is too slow in slot 9.	Replace board in slot 9.

Table 4-3. Operating System (16400) Non-Fatal Error Codes

Error Code	Description	Probable Cause/ Action
02000	Invalid command message.	
02010	PROM information request error.	
02100	Plugged system card is not used.	
02110	Test = True, not allowed for version released to production.	
02112	Number of errors received during one frame in the boot phase exceeded a certain limit.	
02120	EEPROM ID is other than requested.	
02130	MCT GEN conference taken from ROM.	
02131	MCT HW conference taken from ROM.	
02132	MCT SW conference taken from ROM.	
02133	MCT MOS conference taken from ROM.	
02150	Configuration supervisor switched off.	
02160	No configuration in MCT for a slave CPU (CPU goes back to boot ROM and assumes it is surplus).	
02600	Unexpected message in down receiver.	
02601	Invalid download command.	
02602	File NAK received.	
02603	Master receives unexpected message.	
02604	Timeout occurred on master.	
02605	Slave received an unexpected message during file transfer.	
02606	Slave received invalid file directory request command.	
02607	Slave received bad table file request command.	
02608	Timeout or file error when requesting a file.	
02609	Bad file directory acknowledge.	
02610	More data than expected.	
02611	Bad data message received.	
02615	Unexpected message received.	
02620	Unexpected message received.	
02625	Data act: more data received than expected.	
02626	Data act: file checksum wrong.	
02627	Unexpected message received.	
02628	Command checksum wrong.	
03232	Command checksum error.	

Table 4-4. Global Information Handler (16500) Fatal Error Codes

Error Code	Description	Probable Cause/ Action
12000	EEPROM missed.	Replace board as indicated by LED.
12011	EEPROM revision failed.	Replace board as indicated by LED.
13000	Headers missing.	Software/config error. Refer to paragraph 4.6.5.
13414	Enable failure.	Software/config error. Refer to paragraph 4.6.5.
13424	Disable failure.	Software/config error. Refer to paragraph 4.6.5.
13440	Real disable failure.	Software/config error. Refer to paragraph 4.6.5.
13580	Global information POI failure.	Software/config error. Refer to paragraph 4.6.5.
13690	Global information checksum failure.	Software/config error. Refer to paragraph 4.6.5.
20200	Calibration message checksum failure.	Software/config error. Refer to paragraph 4.6.5.
21000	Calibration message failure.	Software/config error. Refer to paragraph 4.6.5.
21500	Language failure.	Software/config error. Refer to paragraph 4.6.5.

Table 4-5. Recorder Manager (17004) Module Error Codes

Error Code	Description	Probable Cause/ Action
12000	Missing EEPROM block.	Software/config error. Refer to paragraph 4.6.5.
12100	Corrupted EEPROM block	Software/config error. Refer to paragraph 4.6.5.
13000	Missing message header	Software/config error. Refer to paragraph 4.6.5.
13200	No unbuffered memory configured	Software/config error. Refer to paragraph 4.6.5.
13410	Error occurred when enabling a routine	Software/config error. Refer to paragraph 4.6.5.
13420	Error occurred when disabling a routine	Software/config error. Refer to paragraph 4.6.5.
13440	Error occurred when disabling a realization	Software/config error. Refer to paragraph 4.6.5.
13490	Error occurred when sending EEPROM data	Software/config error. Refer to paragraph 4.6.5.
13520	Error occurred while writing buffered data	Software/config error. Refer to paragraph 4.6.5.
13640	Error occurred while getting message identification	Software/config error. Refer to paragraph 4.6.5.
13690	Checksum error in data	Software/config error. Refer to paragraph 4.6.5.
20006	No global information present	Software/config error. Refer to paragraph 4.6.5.
20011	No recorder hardware present	Software/config error. Refer to paragraph 4.6.5.
24602	No SDN buffered data available	Software/config error. Refer to paragraph 4.6.5.

Table 4-6. ECG (25000) Module Error Codes

Error Code	Description	Probable Cause/ Action
13400	Enable failure.	Software/config error. Refer to paragraph 4.6.5.
13401	Writing data to buffer failure.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13402	C 16 Cat failure.	
13403	Buffered data checksum failure.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
20000	Incorrect data size.	Software/config error. Refer to paragraph 4.6.5.
20001	Incorrect selection.	Software/config error. Refer to paragraph 4.6.5.
20002	No global information present.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.

Table 4-7. Heart Module (25001) Fatal Error Codes

Error Code	Description	Probable Cause/ Action
11000 through 11001	Active setting data lost at startup.	Software/config error. Refer to paragraph 4.6.5.
11100 through 11104	Active settings checksum error.	Software/config error. Refer to paragraph 4.6.5.
11200	Buffered data found corrupt at startup.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13000	Missing MAK header.	Software/config error. Refer to paragraph 4.6.5.
13001	Missing header.	Software/config error. Refer to paragraph 4.6.5.
13002	No pulse header found.	Software/config error. Refer to paragraph 4.6.5.
13003	No pulse CW header found.	Software/config error. Refer to paragraph 4.6.5.
13004	No CW headers found.	Software/config error. Refer to paragraph 4.6.5.
13200	Table size error.	Software/config error. Refer to paragraph 4.6.5.
13410	Error in route enable.	Software/config error. Refer to paragraph 4.6.5.
13411	Error in enabling conference mode route.	Software/config error. Refer to paragraph 4.6.5.
13450	Error in disabling a routine.	Software/config error. Refer to paragraph 4.6.5.
13440	Error in disabling a realization.	Software/config error. Refer to paragraph 4.6.5.
13540	Buffered data checksum error.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13580	No global information pointer received.	Software/config error. Refer to paragraph 4.6.5.
13640 through 13644	Get message ID error.	Software/config error. Refer to paragraph 4.6.5.
13650	Get header error.	Software/config error. Refer to paragraph 4.6.5.
15500	No valid EEPROM data.	Replace board as indicated by LED.

Table 4-7. Heart Module (25001) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
20000	Numerics message too large.	Software/config error. Refer to paragraph 4.6.5.
20002	Error in parameter response.	Software/config error. Refer to paragraph 4.6.5.
20003	Error in checksum for parameter ON/OFF.	Software/config error. Refer to paragraph 4.6.5.
20004	Error in checksum for change to low limit.	Software/config error. Refer to paragraph 4.6.5.
20005	Error in checksum for change to high limit.	Software/config error. Refer to paragraph 4.6.5.
20006	Wrong operation mode detected.	Software/config error. Refer to paragraph 4.6.5.
20007	Wrong power on mode detected.	Software/config error. Refer to paragraph 4.6.5.
20008	Wrong item number received.	Software/config error. Refer to paragraph 4.6.5.
20009	Bad selections on item 3.	Software/config error. Refer to paragraph 4.6.5.
20010	Bad selections on item 4.	Software/config error. Refer to paragraph 4.6.5.
20011	Too many selections for PULSE sources.	Software/config error. Refer to paragraph 4.6.5.
20012	Send error.	Software/config error. Refer to paragraph 4.6.5.
20013	Mismatch between the alarm state/alarm parameter and ECG alarms ON/OFF.	Software/config error. Refer to paragraph 4.6.5.

Table 4-8. Heart Module (25001) Non-Fatal Error Codes

Error Code	Description	Probable Cause/ Action
20001	Error in check-limits.	
20002	Error in parameter response.	

Table 4-9. Rack Manager (25010) Fatal Error Codes

Error Code	Description	Probable Cause/ Action
11200	Checksum verification of device status list failed during initialization.	Software/config error. Refer to paragraph 4.6.5.
11201	Checksum verification of interface information buffer failed during initialization.	Rack interface error. Refer to paragraph 4.6.3.
11300	Checksum verification of device status list failed during runtime.	Software/config error. Refer to paragraph 4.6.5.
11301	Checksum verification of interface information buffer failed during run time.	Rack interface error. Refer to paragraph 4.6.3.
13100	Size of device status list differs from size specified in module table.	Software/config error. Refer to paragraph 4.6.5.
12000	EEPROM block missing - EEPROM read request failed X times.	Rack interface error. Refer to paragraph 4.6.3.
12100	EEPROM block corrupt - Invalid configuration data found.	Rack interface error. Refer to paragraph 4.6.3.
13000	Header missing - headers for static link "FeLink 0" missing.	Software/config error. Refer to paragraph 4.6.5.
13001	Header missing - headers for static link "FeLink 1" missing.	Software/config error. Refer to paragraph 4.6.5.
13010	Header missing - other message headers missing.	Software/config error. Refer to paragraph 4.6.5.
20000	Routine activation error - system call "enable/disable rout" or "enable/disable real" failed.	Rack interface error. Refer to paragraph 4.6.3.
20100	Invalid pointer to the system-device information list passed from the OS.	Rack interface error. Refer to paragraph 4.6.3.
20101	Device status entries stored in the device status list don't correspond with the extended device tables after a Hot-start.	Rack interface error. Refer to paragraph 4.6.3.
20102	Front-end interface "0" device information request failed X times.	Rack interface error. Refer to paragraph 4.6.3.
20103	Optional frontend interface "1" device failed after a Hot or Warm start.	Rack interface error. Refer to paragraph 4.6.3.
20110	List that holds extended device tables "ext_dev_tbls" is too small.	Rack interface error. Refer to paragraph 4.6.3.
20120	No more room in the scan table to insert scan entries.	Rack interface error. Refer to paragraph 4.6.3.
20121	No longer possible to allocate receive/transmit buffer blocks in the shared memory of a frontend interface.	Rack interface error. Refer to paragraph 4.6.3.

Table 4-9. Rack Manager (25010) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
20122	Not possible to allocate receive/transmit buffer blocks for the automatic ID request output data.	Rack interface error. Refer to paragraph 4.6.3.
20200	Invalid number of polls.	Rack interface error. Refer to paragraph 4.6.3.
20201	No header found for ASW information message.	Rack interface error. Refer to paragraph 4.6.3.
20202	No header found for front-end control/status message.	Rack interface error. Refer to paragraph 4.6.3.
20203	Too many frontend messages found for a front-end device.	Rack interface error. Refer to paragraph 4.6.3.
20204	Too many transmit blocks defined for a front-end device.	Rack interface error. Refer to paragraph 4.6.3.
20205	Number of receive/transmit bytes to sort exceed the length of a message sort table retry.	Software/config error. Refer to paragraph 4.6.5.
20206	Description of poll structure of front-end device contains invalid message variable.	Rack interface error. Refer to paragraph 4.6.3.
20300	Receiver mainframe status message no longer received from front-end interface "0".	Rack interface error. Refer to paragraph 4.6.3.
20301	Receiver mainframe status message no longer received from front-end interface "1".	Rack interface error. Refer to paragraph 4.6.3.
20400	One or more checksums of static front-end manager tables are corrupt.	Rack interface error. Refer to paragraph 4.6.3.
20401	Invalid configuration data found.	Rack interface error. Refer to paragraph 4.6.3.
20402	Contents of "plugged devices" does not correspond to the number of front-end devices marked as PLUGGED in the device status list.	Rack interface error. Refer to paragraph 4.6.3.
20403	No valid pointer to global information block "get" command from OS.	Rack interface error. Refer to paragraph 4.6.3.
20500	Invalid slot number found in device status list.	Replace board as indicated by LED.
20501	Invalid interface number found in device status list.	Rack interface error. Refer to paragraph 4.6.3.
21000	No ECG-sync output source device found in device ID list.	Rack interface error. Refer to paragraph 4.6.3.
21010	Synchronization between two front-end interface devices failed.	Rack interface error. Refer to paragraph 4.6.3.

Table 4-9. Rack Manager (25010) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
21100	Receiver mainframe status message of invalid length received from front-end interface "0".	Rack interface error. Refer to paragraph 4.6.3.
21101	Receiver mainframe status message of invalid length received from front-end interface "1".	Rack interface error. Refer to paragraph 4.6.3.
21103	ID request output message of invalid length or invalid receiver mainframe slot received from front-end interface "0".	Rack interface error. Refer to paragraph 4.6.3.
21104	ID request output message of invalid length or invalid receiver mainframe received from front-end interface "1".	Rack interface error. Refer to paragraph 4.6.3.
21105	General status message of invalid length received from front-end interface "0".	Rack interface error. Refer to paragraph 4.6.3.
21106	General status message of invalid length received from front-end interface "1".	Rack interface error. Refer to paragraph 4.6.3.
21107	Error message of invalid length or invalid device ID received from frontend interface "0".	Rack interface error. Refer to paragraph 4.6.3.
21108	Error message of invalid length or invalid device ID received from frontend interface "1".	Rack interface error. Refer to paragraph 4.6.3.
21500	Invalid receiver mainframe number found in an ID request output buffer entry.	Rack interface error. Refer to paragraph 4.6.3.
21501	Device ID changed without a device unplugged status in-between.	Rack interface error. Refer to paragraph 4.6.3.
21502	No pointer to a device list entry defined for a plugged device.	Rack interface error. Refer to paragraph 4.6.3.
21503	Operating mode has been changed during runtime.	Software/config error. Refer to paragraph 4.6.5.
21504	Pointer to ECG sync output source entry has been changed during runtime.	Software/config error. Refer to paragraph 4.6.5.
21510	Length of new created global information message exceeds allowed maximum message length.	Software/config error. Refer to paragraph 4.6.5.

Table 4-10. Alarm Manager (25011) Fatal Error Codes

Error Code	Description	Probable Cause/ Action
11100 through 11104	Active settings corrupt during run-time.	EEPROM error. Refer to paragraph 4.6.5.
11200	Buffered data corrupt after hot start.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
11300 through 11304	Buffered data corrupt during run-time.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13000	Missing transmit header after power-on.	Software/config error. Refer to paragraph 4.6.5.
13001	Missing receive header after power-on.	Software/config error. Refer to paragraph 4.6.5.
13002	No NU header after power-on.	Software/config error. Refer to paragraph 4.6.5.
13003	No PS header after power-on.	Software/config error. Refer to paragraph 4.6.5.
13004	Inconsistent header list after power-on.	Software/config error. Refer to paragraph 4.6.5.
13005	Unused alert header after power-on.	Software/config error. Refer to paragraph 4.6.5.
13006	ECG message received without header.	Software/config error. Refer to paragraph 4.6.5.
13007	INOP header not found.	Software/config error. Refer to paragraph 4.6.5.
13008	Alarm header not found.	Software/config error. Refer to paragraph 4.6.5.
13009	MAK header missing after power-on.	Software/config error. Refer to paragraph 4.6.5.
13200	Alarm table overfill.	Software/config error. Refer to paragraph 4.6.5.
13201	INOP table overfill.	Software/config error. Refer to paragraph 4.6.5.
13202	Numeric enhancement table overfill	Software/config error. Refer to paragraph 4.6.5.
13203	Source table overfill.	Software/config error. Refer to paragraph 4.6.5.
13204	Stack table overfill.	Software/config error. Refer to paragraph 4.6.5.

Table 4-10. Alarm Manager (25011) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
13205	Limit table overfill.	Software/config error. Refer to paragraph 4.6.5.
13206	Parameter table overfill.	Software/config error. Refer to paragraph 4.6.5.
13410	Enable route error.	Software/config error. Refer to paragraph 4.6.5.
13411	Enable service route error.	Software/config error. Refer to paragraph 4.6.5.
13412	Enable conf. route error.	Software/config error. Refer to paragraph 4.6.5.
13420	Disable realization error.	Software/config error. Refer to paragraph 4.6.5.
13421	Disable route error.	Software/config error. Refer to paragraph 4.6.5.
13520	Data written to table of contents is wrong.	Software/config error. Refer to paragraph 4.6.5.
13521	Data written to table of contents is wrong.	Software/config error. Refer to paragraph 4.6.5.
13522	Buffered data in INOP table is corrupt.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13523	Buffered data in alarm table is corrupt.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13524	Buffered data in number table is corrupt.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13525 through 13527	Security data structure corrupt.	Software/config error. Refer to paragraph 4.6.5.
13530	Buffered data verification errors.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13580	Global info pointer error.	Software/config error. Refer to paragraph 4.6.5.
13640 through 13648	Message acquisition errors.	Software/config error. Refer to paragraph 4.6.5.
13650 through 13651	Header acquisition errors.	Software/config error. Refer to paragraph 4.6.5.

Table 4-10. Alarm Manager (25011) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
20000	Incorrect values for operation mode.	Software/config error. Refer to paragraph 4.6.5.
20001	Incorrect values for Power On mode.	Software/config error. Refer to paragraph 4.6.5.
20002	Incorrect sense values.	Software/config error. Refer to paragraph 4.6.5.
20003	Incorrect item number value.	Software/config error. Refer to paragraph 4.6.5.
20020	Alert table initialization failed.	Software/config error. Refer to paragraph 4.6.5.
20021	Source value table exceeds limits.	Software/config error. Refer to paragraph 4.6.5.
20800	Received alarm timeout.	Software/config error. Refer to paragraph 4.6.5.
20900	Received INOP timeout.	Software/config error. Refer to paragraph 4.6.5.
25500	No valid EEPROM data.	Replace card as indicated by LED.

Table 4-11. Alarm Manager (25011) Non-Fatal Error Codes

Error Code	Description	Probable Cause/ Action
20100	Error in parameter ON/OFF response.	
20200	Error in source ID response.	
20300	Error in channel ID response.	
20400	Error in change to alarm limit response.	
20500	Error in alarm ON/OFF response.	
20600	Error in physical label response.	
20700	Response checksum error.	

Table 4-12. SDN (25020) Fatal Error Codes

Error Code	Description	Probable Cause/ Action
09000	Unspecified DLC error.	Software/config error. Refer to paragraph 4.6.5.
09001	DLC error - duplicated unit i.d. stamp.	SDN error. Refer to paragraph 4.6.4.
09002	DLC error - duplicated bed.	SDN error. Refer to paragraph 4.6.4
09003	DLC error - duplicated unit i.d. stamp.	SDN error. Refer to paragraph 4.6.4.
09105	Send APPL error.	Software/config error. Refer to paragraph 4.6.5.
09107	Group channel error.	SDN error. Refer to paragraph 4.6.4.
09108	Group SOUR error.	SDN error. Refer to paragraph 4.6.4.
11200	SDN data in buffered memory lost after hot start.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
12000	SDN EEPROM contents found missing.	SDN error. Refer to paragraph 4.6.4.
12150 through 12153	SDN EEPROM contents found corrupt.	SDN error. Refer to paragraph 4.6.4.
13000	Header missing.	Software/config error. Refer to paragraph 4.6.5.
13100	SDN data in buffered memory lost.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13410	Enable routine error.	Software/config error. Refer to paragraph 4.6.5.
13420	Disable routine error.	Software/config error. Refer to paragraph 4.6.5.
13470	Change to operational mode failure.	Software/config error. Refer to paragraph 4.6.5.
13490	Send contents of EEPROM message error.	Software/config error. Refer to paragraph 4.6.5.
13520	Error writing SDN data to buffered memory.	SDN error. Refer to paragraph 4.6.4.

Table 4-12. SDN (25020) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
13540	SDN buffered data checksum error.	SDN error. Refer to paragraph 4.6.4.
13590	Shared memory access error.	Replace board as indicated by LED.
13640	ID message acquisition failure.	Software/config error. Refer to paragraph 4.6.5.

Table 4-13. SDN (25020) Non-Fatal Error Codes

Error Code	Description	Probable Cause/ Action
09001	DLC error — illegal branch command.	
09002	DLC error — duplicated bed.	
09003	DLC error — illegal branch command and duplicated bed.	

Table 4-14. INOP Module (25100) Error Codes

Error Code	Description	Probable Cause/ Action
13001	Clear INOP log message header missing.	Software/config error. Refer to paragraph 4.6.5.
13002	Set INOP filters message header missing.	Software/config error. Refer to paragraph 4.6.5.
13003	INOP total message header missing.	Software/config error. Refer to paragraph 4.6.5.
13004	INOP data message header missing.	Software/config error. Refer to paragraph 4.6.5.
13005	ECG INOP message header missing.	Software/config error. Refer to paragraph 4.6.5.
13411 through 13417	INOP enable routine errors.	Software/config error. Refer to paragraph 4.6.5.
13421 and 13422	INOP disable routine errors.	Software/config error. Refer to paragraph 4.6.5.
13491	Data acknowledge message error.	Software/config error. Refer to paragraph 4.6.5.

Table 4-14. INOP Module (25100) Error Codes (continued)

Error Code	Description	Probable Cause/ Action
13492	INOP Total message error.	Software/config error. Refer to paragraph 4.6.5.
13493	INOP Filter message error.	Software/config error. Refer to paragraph 4.6.5.
13494	Clear INOP Log message error.	Software/config error. Refer to paragraph 4.6.5.
13521 and 13522	Error writing contents of buffered memory to INOP filters.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13523 through 13529	Error writing contents of buffered memory to INOP log.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13531	Bad INOP log data in buffered memory at start up.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13532	Bad INOP filter data in buffered memory at start up.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13533 through 13535	INOP log data requested from buffered memory is bad.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13641	Message ID acquisition error.	Software/config error. Refer to paragraph 4.6.5.
13691	INOP log checksum error.	Software/config error. Refer to paragraph 4.6.5.
13692	INOP filter checksum error.	Software/config error. Refer to paragraph 4.6.5.

Table 4-15. Service Module (25101) Fatal Error Codes

Error Code	Description	Probable Cause/ Action
13411	RS-232 interface enable error.	Check/replace RS-232 card—reboot instrument.
13412	Message send enable error.	Check/replace RS-232 card—reboot instrument.
13413	TEST STAT ENA	Check/replace RS-232 card—reboot instrument.
13414	RTN MAIN ENA	Check/replace RS-232 card—reboot instrument.
13415	BLD ILOG ENA	Check/replace RS-232 card—reboot instrument.
13416	CONFG ACK ENA	Check/replace RS-232 card—reboot instrument.
13417	ILOG DAT ACK ENA	Check/replace RS-232 card—reboot instrument.
13418	ILOG CLR ACK ENA	Check/replace RS-232 card—reboot instrument.
13419	ILOG TOT ACK ENA	Check/replace RS-232 card—reboot instrument.
13420	ILOG FLT ACK ENA	Check/replace RS-232 card—reboot instrument.
13421	CS RESET REQ ENA	Check/replace RS-232 card—reboot instrument.
13422	CS RESET ACK ENA	Check/replace RS-232 card—reboot instrument.
13423	RD SERNO ENA	Check/replace RS-232 card—reboot instrument.
13491	RD INOP BED MSG	Check/replace RS-232 card—reboot instrument.
13492	CLR INOP MSG	Check/replace RS-232 card—reboot instrument.
13493	RD INOP TOT MSG	Check/replace RS-232 card—reboot instrument.
13494	INOP FILT MSG	Check/replace RS-232 card—reboot instrument.
20000	SVC TASK ERR	Check/replace RS-232 card—reboot instrument.

Table 4-15. Service Module (25101) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
20100	SVC COMM ERR	Check/replace RS-232 card—reboot instrument.
20200	SVC CNFG ERR	Check/replace RS-232 card—reboot instrument.
20201	No alarm mode match.	EEPROM/Configuration error—See paragraph 4.6.5.
20202	NO ALRM RMDR MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20203	NO LD LBL MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20204	NO BW MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20205	NO FALLBACK MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20206	NO LD RECON MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20207	NO EXT MON MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20208	NO TRANS BTN MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20209	NO SELF TEST MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20210	NO DUMP ST MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20211	NO LANG MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20212	NO PATIENT SZ MATCH	EEPROM/Configuration error—See paragraph 4.6.5.
20220	NO VALID MSG	EEPROM/Configuration error—See paragraph 4.6.5.
20221	NO VALID ACK MSG	EEPROM/Configuration error—See paragraph 4.6.5.
20300	SVC INOP ERR	EEPROM/Configuration error—See paragraph 4.6.5.
20400	SVC SLOG ERR	EEPROM/Configuration error—See paragraph 4.6.5.

Table 4-15. Service Module (25101) Fatal Error Codes (continued)

Error Code	Description	Probable Cause/ Action
20500	SVC MISC ERR	Reboot instrument.
20501	OPMODE CHANGE ERR	Valid error - indicates time at which the Operational mode was changed.
20502	Receiver Mainframe Reset	Reset due to Central Station reset.
20600	SVC REC ERR	Check Central Station recorder and/or reboot mainframe.
20601	SVC REC CHK	Check Central Station recorder and/or reboot mainframe.

Table 4-16. User Interface (25102) Error Codes

Error Code	Description	Probable Cause/ Action
11001	Active settings found corrupt after hot start.	Software/config error. Refer to paragraph 4.6.5.
11201	ECG data in buffered memory found corrupt after hot start.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
11202	SDN data in buffered memory found corrupt after hot start.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
11203	Alarm data in buffered memory found corrupt after hot start.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
11204	Heart data in buffered memory found corrupt after hot start.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
11205	Service data in buffered memory found corrupt after hot start.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
12001	ECG EEPROM contents missing.	Replace board as indicated by LED.
12002	SDN EEPROM contents missing.	Replace board as indicated by LED.
12003	Alarm EEPROM contents missing.	Replace board as indicated by LED.
12004	Heart EEPROM contents missing.	Replace board as indicated by LED.

Table 4-16. User Interface (25102) Error Codes (continued)

Error Code	Description	Probable Cause/ Action
12005	Service EEPROM contents missing.	Replace board as indicated by LED.
12101	ECG EEPROM contents corrupt.	Replace board as indicated by LED.
12102	SDN EEPROM contents corrupt.	Replace board as indicated by LED.
12103	Alarm EEPROM contents corrupt.	Replace board as indicated by LED.
12104	Heart EEPROM contents corrupt.	Replace board as indicated by LED.
12105	Service EEPROM contents corrupt.	Replace board as indicated by LED.
13001	VC Open message header missing.	Software/config error. Refer to paragraph 4.6.5.
13002	VC close message header missing.	Software/config error. Refer to paragraph 4.6.5.
13003	MA APP message header missing.	Software/config error. Refer to paragraph 4.6.5.
13004	Reset message header missing.	Software/config error. Refer to paragraph 4.6.5.
13005	WV ANN message header missing.	Software/config error. Refer to paragraph 4.6.5.
13006	Bed control message header missing.	Software/config error. Refer to paragraph 4.6.5.
13007	PTN Chk message header missing.	Software/config error. Refer to paragraph 4.6.5.
13008	VTP APPL message header missing.	Software/config error. Refer to paragraph 4.6.5.
13009	VCP APPL message header missing.	Software/config error. Refer to paragraph 4.6.5.
13050	Recorder start message header missing.	Software/config error. Refer to paragraph 4.6.5.
13051	Stor Req message header missing.	Software/config error. Refer to paragraph 4.6.5.
13052	Stor Chk message header missing.	Software/config error. Refer to paragraph 4.6.5.
13053	Stor STOPN message header missing.	Software/config error. Refer to paragraph 4.6.5.

Table 4-16. User Interface (25102) Error Codes (continued)

Error Code	Description	Probable Cause/ Action
13054	Stor ANNREQ message header missing.	Software/config error. Refer to paragraph 4.6.5.
13055	Stor STOPCK message header missing.	Software/config error. Refer to paragraph 4.6.5.
13056	Data request message header missing.	Software/config error. Refer to paragraph 4.6.5.
13057	Read data CHK message header missing.	Software/config error. Refer to paragraph 4.6.5.
13059	RD TOTS CHK message header missing.	Software/config error. Refer to paragraph 4.6.5.
13060	INOP clear request message header missing.	Software/config error. Refer to paragraph 4.6.5.
13061	INOP clear check message header missing.	Software/config error. Refer to paragraph 4.6.5.
13062	Receiver revisions message header missing.	Software/config error. Refer to paragraph 4.6.5.
13063	Operational mode change request message header missing.	Software/config error. Refer to paragraph 4.6.5.
13064	Operational mode change acknowledge message header missing.	Software/config error. Refer to paragraph 4.6.5.
13410 through 13414	MUA message enable route error.	Software/config error. Refer to paragraph 4.6.5.
13420 through 13424	MUA message disable route error.	Software/config error. Refer to paragraph 4.6.5.
13440	Disable realization error.	Software/config error. Refer to paragraph 4.6.5.
13490	Send contents of EEPROM message error.	Software/config error. Refer to paragraph 4.6.5.
13491	Send ECG data message error.	Software/config error. Refer to paragraph 4.6.5.
13492	Send alarm data message error.	Software/config error. Refer to paragraph 4.6.5.
13493	Send heart data message error.	Software/config error. Refer to paragraph 4.6.5.

Table 4-16. User Interface (25102) Error Codes (continued)

Error Code	Description	Probable Cause/ Action
13494	Send SDN data message error.	Software/config error. Refer to paragraph 4.6.5.
13495	Send service data message error.	Software/config error. Refer to paragraph 4.6.5.
13496	Send VCP data message error.	Software/config error. Refer to paragraph 4.6.5.
13497	Send VTP data message error.	Software/config error. Refer to paragraph 4.6.5.
13498	Send GEN data message error.	Software/config error. Refer to paragraph 4.6.5.
13499	Send INOP data message error.	Software/config error. Refer to paragraph 4.6.5.
13520	Error writing ECG data to buffered memory.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13521	Error writing SDN data to buffered memory.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13522	Error writing alarm data to buffered memory.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13523	Error writing heart data to buffered memory.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13524	Error writing service data to buffered memory.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13525	Error writing active data to buffered memory.	Turbo Processor or 40 MHz CPC error. Refer to paragraph 4.6.1.
13541	ECG checksum failure.	Software/config error. Refer to paragraph 4.6.5.
13542	SDN checksum failure.	Software/config error. Refer to paragraph 4.6.5.
13543	Alarm checksum failure.	Software/config error. Refer to paragraph 4.6.5.
13544	Heart checksum failure.	Software/config error. Refer to paragraph 4.6.5.
13545	Service checksum failure.	Software/config error. Refer to paragraph 4.6.5.
13546	ACT VAL checksum failure.	Software/config error. Refer to paragraph 4.6.5.
13580	Shared memory access error.	Replace board as indicated by LED.

Table 4-16. User Interface (25102) Error Codes (continued)

Error Code	Description	Probable Cause/ Action
20001	Lead set not detected.	
20002	ECG control check missing.	Software/config error. Refer to paragraph 4.6.5.
20003	SDN control check missing.	Software/config error. Refer to paragraph 4.6.5.
20004	Alarm control check missing.	Software/config error. Refer to paragraph 4.6.5.
20005	Heart control check missing.	Software/config error. Refer to paragraph 4.6.5.
20006	Invalid message received.	Software/config error. Refer to paragraph 4.6.5.
20007	RVT display NCHK.	Software/config error. Refer to paragraph 4.6.5.
20100	MAS change to operational mode failed.	Software/config error. Refer to paragraph 4.6.5.
20101	MAS clear log failed.	Software/config error. Refer to paragraph 4.6.5.
20102	MAS data request failed.	Software/config error. Refer to paragraph 4.6.5.
20103	MAS RD TOTS timeout error.	Software/config error. Refer to paragraph 4.6.5.
20111	MAS RD DATA timeout error.	Software/config error. Refer to paragraph 4.6.5.
20119	MAS INOP clear error.	Software/config error. Refer to paragraph 4.6.5.
20120	MAS recorder stopped notification.	Refer to recorder configuration.
20136	MAS recorder stopped because XXX.	Refer to recorder configuration.
20152	MAS recorder stopped.	Refer to recorder configuration.
20168	MAS recorder stopped message header missing.	Software/config error. Refer to paragraph 4.6.5.
20169	MAS received message from invalid receiver number.	Software/config error. Refer to paragraph 4.6.5.
20170	MAS invalid CCB.	Software/config error. Refer to paragraph 4.6.5.

Table 4-17. Three-Channel ST (32734) Module Error Codes

Error Code	Description	Probable Cause/ Action
11000	Actual settings lost on hot start.	Software/config error. Refer to paragraph 4.6.5.
12100	Corrupted EEPROM block.	Software/config error. Refer to paragraph 4.6.5.
13000	Missing message header.	Software/config error. Refer to paragraph 4.6.5.
13200	No unbuffered memory configured.	Software/config error. Refer to paragraph 4.6.5.
13300	No buffered memory configured.	Software/config error. Refer to paragraph 4.6.5.
13410	Error occurred when enabling a routine.	Software/config error. Refer to paragraph 4.6.5.
13420	Error occurred when disabling a routine.	Software/config error. Refer to paragraph 4.6.5.
13440	Error occurred when disabling a realization.	Software/config error. Refer to paragraph 4.6.5.
20000	No global information present.	Software/config error. Refer to paragraph 4.6.5.
20001	Unsupported ECG wave received.	Software/config error. Refer to paragraph 4.6.5.
20003	Corrupted data structure.	Software/config error. Refer to paragraph 4.6.5.
20006	Checksum of response error.	Software/config error. Refer to paragraph 4.6.5.
20010	MUA control message error.	Software/config error. Refer to paragraph 4.6.5.
20011	MUA control message contains incorrect bed number.	Software/config error. Refer to paragraph 4.6.5.

4.6 Fault Isolation

The following paragraphs provide procedures that serve as a guide to isolate faults based on the preceding error codes. The procedures listed are to be followed until the error is eradicated. Once a corrective action is taken, a cold start should be performed on the receiver mainframe. It is not necessary to perform each step in a paragraph.

4.6.1 Turbo Processor or 40 MHz CPC Card Errors

If an error code indicates a Turbo Processor Card or 40 MHz CPC error, proceed as follows:

Step 1. If you have a 40 MHz CPC card, replace it. If you have a Turbo Processor Card proceed:

Step 2. the software revision between the Turbo Processor Card and the EPROM board agree. If not, upgrade the boards to the latest revision.

Step 3. Make sure the EPROM board is correctly mounted to the Turbo Processor Card.

Step 4. Replace the EPROM board.

Step 5. Replace the Turbo Processor Card.

Step 6. If problem still exists, proceed to Paragraph 4.6.2.

4.6.2 Utility CPU Errors

If an error code indicates a utility CPU error, proceed as follows:

Step 1. Make sure EEPROM chip is properly installed in the utility CPU function card.

Step 2. Make sure the software revision of the EEPROM chip and the utility CPU agree. If not, upgrade to latest software revision.

Step 3. Replace EEPROM chip.

Step 4. Replace utility CPU function card.

4.6.3 Rack Interface Errors

If an error code indicates a rack interface error, proceed as follows:

Step 1. Check receiver malfunction LEDs to determine if a problem exists with any of the receiver modules. Replace any faulty receiver modules as necessary.

Step 2. Make sure software revision of the rack interface function card is consistent with other function cards. If necessary, upgrade to latest software revision.

Step 3. Replace rack interface function card.

Step 4. If error still exists, refer to Paragraph 4.6.2.

4.6.4 SDN Errors

If an error code indicates an SDN function card error, proceed as follows:

Step 1. Make sure that any external devices communicating with SDN function card via the SDN are not malfunctioning.

Step 2. Make sure the external cables from the SDN are connected properly.

Step 3. Replace the SDN function card.

Step 4. If error still exists, refer to Paragraph 4.6.2.

Note

Unplugging the SDN cable from the receiver mainframe while it is running will generate a fatal error code. This error can be overcome by turning off power to the receiver mainframe and then turning it back on again.

4.6.5 Software/Configuration Errors

If an error code indicates a software or configuration error, proceed as follows:

Step 1. Make sure that the receiver mainframe is connected properly.

Step 2. Make sure the function card placement in the backplane is correct.

Step 3. Make sure all cables are connected correctly.

Step 4. Make sure software revisions of all cards are consistent. Replace any inconsistent cards.

Step 5. If you have the 40 MHz CPC card, go to step 6. If you have a Turbo Processor Card, replace Turbo Processor Card EPROM board.

Step 6. Replace utility CPU EEPROM chip.

Step 7. Replace one function card and perform a cold start on the receiver mainframe. Repeat this step on each function card until the problem is fixed.

5

Service

This section provides information and procedures to service the HP M1403A Digital UHF Telemetry System.

5.1 Preventive Maintenance

Recommended preventive maintenance consists of exterior cleaning of the cases, mechanical inspection, and electrical inspection, as needed. In addition, performance assurance and safety testing is recommended annually to assure continuity of telemetry system service (Section 3, Maintenance).

5.1.1 Cleaning

The Digital UHF telemetry System should be kept free of dust and dirt. Clean as required, with a lint-free cloth or a sponge moistened with soapy water. Refer to Paragraph 3-5 for disinfection and sterilization procedures.

Caution To avoid damage to the Digital UHF Telemetry System:

DO NOT ALLOW ANY LIQUID TO ENTER THE CASES. NEVER SUBMERGE ANY PART OF THE SYSTEM.

DO NOT POUR LIQUID ONTO ANY PART OF THE SYSTEM DURING CLEANING.

NEVER USE ABRASIVE MATERIAL (SUCH AS STEEL WOOL OR SILVER POLISH) OR STRONG SOLVENTS (SUCH AS ACETONE) TO CLEAN THE CASES.

DILUTE ANY CLEANING AGENTS BEFORE USE, ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS.

DO NOT ALLOW CLEANING AGENTS TO REMAIN ON ANY OF THE EQUIPMENT SURFACES. WIPE OFF IMMEDIATELY.

5.1.2 Mechanical Inspection

Inspect the Digital UHF Telemetry System for obvious physical damage. Check that all HP M1402A Receiver Modules are locked into place in the HP M1401A Receiver Mainframe. Also check that the fuse and selector switch panel cover is in place on the rear panel.

5.1.3 Electrical Inspection

Inspect the power cables and internal cabling for deteriorated, broken, pinched, or frayed insulation. Inspect external connectors for broken or missing parts.

5.1.4 Cooling Fan and Air Filter Check

Refer to Paragraph 3.1.5 for a cooling fan check; the associated air filter should be cleaned as suggested, every month. Instead of cleaning the filter, it can be replaced with HP Part Number M1401-02100.

5.1.5 Upgrading the Receiver Mainframe Software and EEPROM

The following procedures describe how to perform an EEPROM Upgrade and Software Upgrade to the M1401A Receiver Mainframe if you have a 40 MHz CPC card in your mainframe instead of the Turbo Processo Card. You should be able to identify your Receiver Mainframe as having the CPC card if you have an OMNICARE label affixed to the front right corner of the mainframe, or if you know you have Option C03 installed.

Note

Before using the HP CPC Programming Tool to upgrade the Receiver Mainframe, make a list of the user configuration settings that will be set to default values when performing a standard upgrade.

Before connecting the CPC Programming Tool to the Receiver Mainframe, the mainframe must be turned off. Failure to do this could cause the CPC Programming Card in the tool to be corrupted.

To Connect the CPC Programming Tool

To connect the CPC programming tool to the M1401A Receiver Mainframe, perform the following procedure:

1. Turn the monitor OFF.
2. Attach the banana-plug connector end of the ground wire to one of the two grounding jacks on the tool. Attach the alligator-clip end of the ground wire to the equipotential lug on the rear of the Receiver Mainframe..
3. Attach the either end of ribbon cable to the tool, then plug the other end of the cable into the Flash Upgrade service port connector located on the CPC card. Use a cross-tip screwdriver to remove the service port cover on the appropriate slot.
4. Make sure the CPC Programming Card to be used is the correct one and insert it into the tool.
5. Set switch 1 on the tool to the open (up) position and all others closed (down).
6. Press the Receiver Mainframe power switch to turn the unit ON. The Receiver Mainframe boots from the Flash card in the CPC Programming Tool and performs the upgrade. The upgrade takes about two minutes to complete. During the upgrade the LEDs on the CPC programming tool perform as follows:

STATUS	PASS	FAIL	Condition
ON	OFF	OFF	Initial Condition
ON	Blinking	OFF	Flash upgrade in progress
ON	ON	OFF	Flash upgrade completed

7. Disconnect the tool when the upgrade is finished.

5.2 Removal and Replacement Procedures

This section details all the removal and replacement procedures for the field replaceable parts of the HP M1403A Digital UHF Telemetry System. The procedures are grouped by individual product.

Each set of procedures is given as a series of simple steps together with exploded-view illustrations to highlight the disassembly and replacement procedures.

5.2.1 Preparation and Precautions

Provide a desk lamp for local illumination. For bench repair, provide a bench or tabletop at least 0.6 M x 1.2 M (2 feet by 4 feet). A shelf is handy for setting aside small or easily-damaged parts.

To avoid circuit damage, a conductive table mat and a conductive floor mat should be installed. Follow instructions provided with the mat to prevent injury (see WARNING). Except where noted, all part numbers provided are HP part numbers.

Warning

TO ENSURE ELECTRICAL SAFETY DURING DISASSEMBLY AND REASSEMBLY, REMOVE POWER TO THE RECEIVER MAINFRAME USING DISCONNECT PROCEDURE IN PARAGRAPH 5.2.1.2.

DO NOT REMOVE CASE TOP COVER WITH UNIT ENERGIZED; DO NOT REMOVE OR WORK ON THE POWER SUPPLY WITH THE UNIT ENERGIZED.

IF IT IS NECESSARY TO WORK ON THE UNIT WITH THE COVER OFF, WORK WITHOUT TOUCHING GROUNDED SURFACES.

NEVER APPLY POWER TO THE RECEIVER MAINFRAME ON AN UNPROTECTED CONDUCTIVE SURFACE, SUCH AS A BARE METAL TABLE. INSTEAD, PLACE THE RECEIVER MAINFRAME ON A SPECIAL MAT, AS DESCRIBED IN THE NEXT PARAGRAPH. THE ELECTRICAL CHARACTERISTICS OF THIS MAT SHOULD BE CHECKED FREQUENTLY AS INDICATED IN THE MANUFACTURER'S LITERATURE FOR CONTINUED PERSONNEL PROTECTION AND ANTI-STATIC QUALITIES.

Caution: To prevent component damage, do not handle integrated circuits, such as the VCXO Module, until the following conditions are satisfied.

5.2.1.1 Anti-Static Mats and Straps

A recommended anti-static table mat is Minnesota Mining and Manufacturing (3M Company 8210-series). This mat is 0.6 x 1.2 meters (2 ft x 4 ft), and has an isolation resistor in series with the ground wire of between 10^6 Ohms and 10^9 Ohms. A smaller mat may be used on site.

In addition to the table mat, the person disassembling the unit should:

1. Wear a conductive wrist strap (3M Company 2200-series) attached to the mat by a 1.2 meter (4-foot) wire, or
2. Stand on a floor mat with leather-soled or other conductive-soled shoes. The floor mat (3M Company 8200-series) is 1.2 meters x 1.8 meters (4 x 6 feet) also has an isolation resistor in series with its ground lead for personnel protection.

To protect circuit chips, press their pins into a pad of conductive foam. Integrated circuit chips, in general, should never be loose or they may be damaged by static discharge or their pins may become misaligned from mechanical damage.

Caution

To transport pc boards from place to place, they should be wrapped in protective plastic; wear non-conductive gloves while carrying them.

Before handling any circuit boards, firmly touch exposed metal on the instrument to equalize ground potentials. This precaution will prevent static discharge and protect logic components on the pc boards.

Handle pc boards by the edges only.

5.2.1.2 Disconnection Procedure

Before disassembling the receiver mainframe:

a. Turn off receiver mainframe by pushing power button so it stays out.

b. Detach power cord from receiver mainframe rear panel.

c. Remove any signal cables from receiver mainframe rear panel.

Before disassembling the transmitter, remove the battery.

5.3 HP M1400A/HP M1400B Transmitter

The field-replaceable parts and assemblies for the transmitter are listed in Table 6-4 and shown in Figure 5-1.

- Channel number label (not shown)
- Transmitter bottom cover assembly (includes battery contacts)
- Battery contacts
- Transmitter case assembly
- Transmitter motherboard assembly
- Transmitter top cover assembly
- Transmitter VCXO module
- O-Rings

Equipment Required for Service:

Transmitter disassembly tool (M1403-80000)

Water-soluble lubricating lotion (9310-6344)

Thin blunt tool such as a thin metal ruler

To remove battery contacts from assembled unit (paragraph 5.3.1.2, step a-2-b).

To start VCXO module removal (paragraph 5.3.1.4, step a-1).

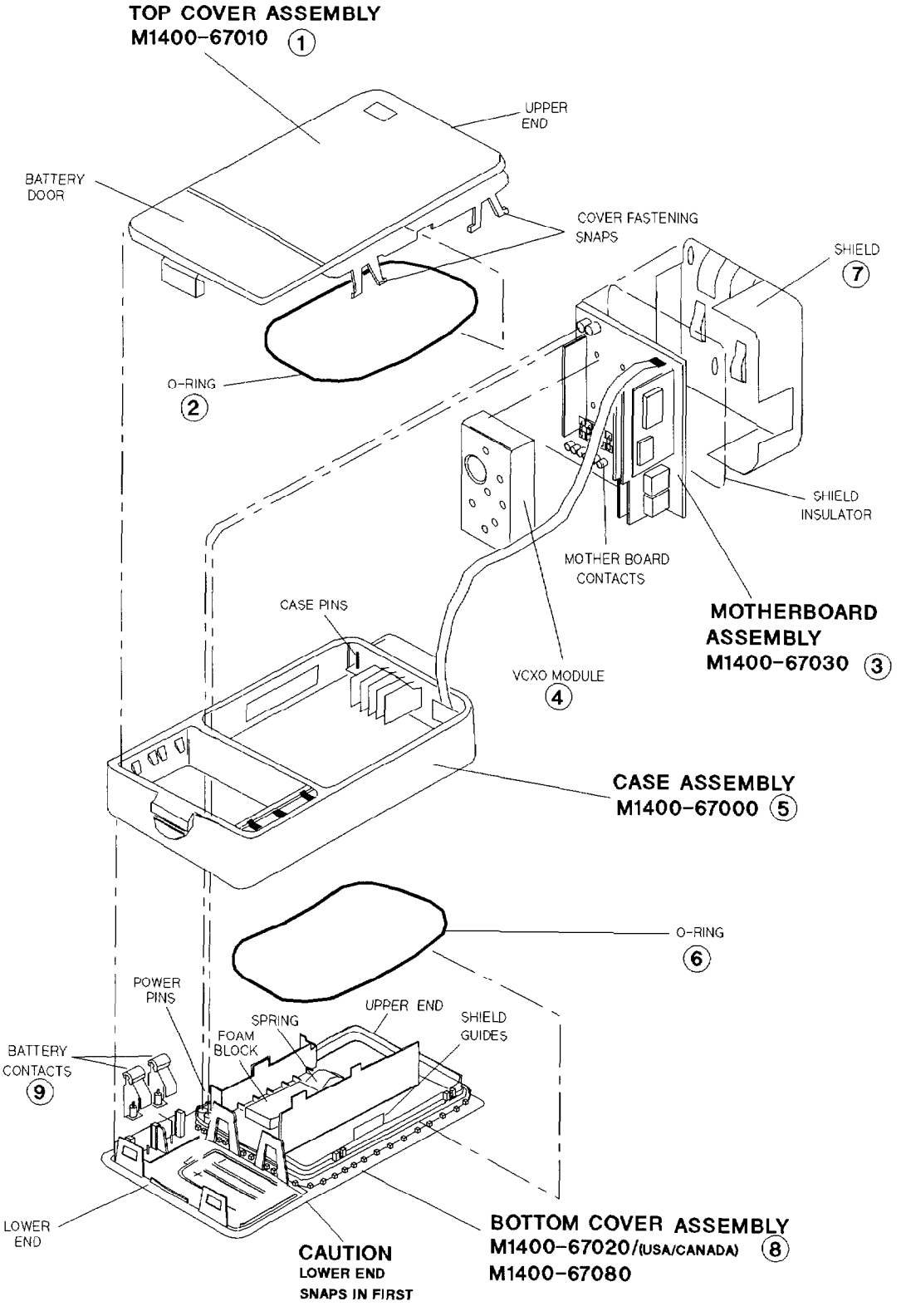


Figure 5-1. HP M1400A/HP M1400B Transmitter, Exploded View

5.3.1 Disassembly and Assembly Procedures

To service the HP M1400A/HP M1400B transmitter, perform the following procedures. To fully disassemble the transmitter, perform the procedures in the order given. Reference numbers in the procedures are keyed to the exploded view of the transmitter, Figure 5-1. Remove the battery before disassembly.

5.3.1.1 Transmitter Bottom Cover Assembly

The bottom cover must be removed before the top cover can be removed. For reference, the transmitter bottom cover has the ECG lead placement diagram.

a. **Disassembly.** Remove transmitter bottom cover assembly (8) as follows:

1. Open battery compartment door and remove the battery.
2. Carefully place transmitter disassembly tool (HP part number M1403-80000) over four fastening tabs inside battery compartment. Align tool recess with battery door latch.
3. Push on disassembly tool until bottom cover unsnaps.
4. Push bottom cover out of transmitter case assembly.

b. **Assembly.** Replace transmitter bottom cover assembly as follows:

1. Remove O-ring (6) from O-ring groove on bottom cover assembly (8) and discard it.
2. Squeeze about 1 cm drop of the lubricating lotion (HP pn 9310-6344) onto your finger and lubricate a NEW O-ring.

Caution

This lubrication keeps the O-ring from twisting when the cover is applied, assuring a water-tight seal. Do not use ultrasound transmission gel to lubricate the O-ring because it can deteriorate plastic parts.

Do not use excessive lotion as it might short out the motherboard or contaminate the ECG hybrids.

The O-ring must be re-lubricated if it is left out for an extended period of time.

Do not stretch the O-ring while lubricating it or installing it. A stretched O-ring could cause a gap between the top and center case.

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3. Place O-ring into O-ring groove. Note that ring does not surround battery compartment.

Caution

Perform steps 3 through 6 in the exact order given. The transmitter power pins can be broken or improperly set if the **lower end** (battery compartment end) of the bottom cover assembly is not pressed into place first, as shown in Figure 2.

To avoid shield damage, do not force assembly.

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4. Inspect bottom cover (8) by making sure two battery contact pins on bottom cover are straight so they will line up with their contacts when the cover is closed. Align the battery contact pins with the two connectors on the motherboard.
5. With the palm of your hand, press battery compartment end of bottom cover assembly into case assembly until it snaps into place.
6. With the palm of your hand, press upper end of bottom cover (8) (leadset connector end) into case assembly (5) until it snaps into place. No part of O-ring should be visible when cover is in place. If you can see the O-ring, you must remove the bottom and try again.

Transmitter Top Cover Assembly

The bottom cover must be removed before the top cover can be removed.

a. **Disassembly.** Remove transmitter top cover assembly (1) as follows:

Note This procedure requires a thin blunt tool such as a thin metal ruler.

1. Remove the transmitter bottom cover (8) by performing that procedure.
2. Place the blunt tool in the upper right corner of the transmitter case (the corner with the lead set connection block) between the retaining leg and the case. Push gently inward and down on the tool to free the case from the retaining leg. Repeat for the retaining leg in the upper left hand corner.
3. Hold onto the center of the case and pull the top cover off at the lead set connection block end.
4. Disconnect the nurse call button ribbon cable from connector on motherboard.
5. Pull motherboard and shield from the case.

Caution Replace the top cover with a new one if it is damaged during removal.

b. **Assembly.** Replace transmitter top cover assembly (1) as follows:

1. Plug nurse call button ribbon cable into connectors on motherboard.
2. Line up the six lead set connecting pins on the transmitter case assembly with the six connectors on the motherboard and snap the motherboard in place.
3. Remove the O-ring (2) from O-ring groove on top cover assembly (1). Discard the O-ring.
4. Squeeze about a 1 cm drop of the lubricating lotion (HP pn 9310-6344) onto your finger and lubricate a NEW O-ring.

Caution

This lubrication keeps the O-ring from twisting when the cover is applied, assuring a water-tight seal. Do not use ultrasound transmission gel to lubricate the O-ring because it can deteriorate plastic parts.

Do not use excessive lotion as it might short out the motherboard or contaminate the ECG hybrids.

The O-ring must be re-lubricated if it is left out for an extended period of time.

Do not stretch the O-ring while lubricating it or installing it. A stretched O-ring could cause a gap between the top and center case.

5. Place O-ring (2) into O-ring groove.
6. Place shield and shield insulator on top of top cover assembly.
7. Place top cover in place so the RFI shield rides along the outside of the electronic components on the motherboard.

8. Starting with upper left corner of the transmitter (the corner with the HP logo Figure 2), work in a clockwise fashion and use the heel of your hand to snap the four corners of the top cover (1) into transmitter case assembly (5).
9. Using both of your thumbs, press just above the battery compartment until a click is heard. No part of O-ring should be visible when cover is in place. If you can see the O-ring, you must remove the top cover and try again.
10. Remove any excess lubricant from outside of transmitter.

5.3.1.2 Battery Contacts

a. **Disassembly.** Remove battery contacts (9) as follows:

1. From bottom cover (unit disassembled):

   a) Using fingers, grasp battery contact and firmly pull it upward until it is free from connector post on transmitter bottom cover.

   b) Repeat step 1 for other battery contact.

2. With bottom cover assembled to case:

   a) Using fingers, move battery contact away from side of case slightly to release it from retainer catch on case.

   b) Using a small screwdriver, gently pry battery contact upward until it is free from connector post on transmitter bottom cover.

   c) Repeat step 1 for other battery contact.

b. **Assembly.** Replace battery contacts (M1400-60060) as follows:

1. Place battery contact (9) into groove of contact support in bottom cover battery area (8).
2. Press battery contact down in groove and onto connector post until it clicks into place.
3. Repeat steps 1 and 2 for other battery contact.

5.3.1.3 Transmitter VCXO Module

a. **Disassembly.** Remove transmitter voltage-controlled crystal oscillator (VCXO) module (4) as follows:

1. Remove transmitter bottom cover assembly (8).
2. Remove the transmitter top cover assenble (1).
3. With small flat-blade screwdriver, gently pry up on VCXO module (4) on the three accessible sides to loosen it.
4. Taking care not to bend the pins, grasp VCXO module lengthwise and lift module from motherboard (3).

b. **Assembly.** Replace the transmitter VCXO module as follows:

1. Align pins on VCXO module (4) with sockets on motherboard (3) and carefully plug VCXO module into motherboard.
2. Place motherboard and shield into top cover (1).

5.3.1.5 Transmitter Motherboard Assembly

No further procedures are required to remove and replace the motherboard (3).

5.3.1.6 Transmitter Case Assembly

No further procedures are required to remove and replace the case assembly (5).

5.4 HP M1401A Receiver Mainframe

The field-replaceable units for the receiver mainframe are as follows:

- Front Dress Cover (1)
- Top Cover (14)
- Receiver Module (17)
- Antenna Distribution Assembly (4)
- Receiver Backplane (16)
- Fan (3)
- Air Filter (2)
- Power Supply (8)
- Function Card Cover
- Rack Interface Board (7)
- Turbo Processor Card (11)
- SDN Interface Board (11)
- Utility CPU Board (11),(18)
- Analog Output Board (optional) (11)
- Analog Output Link Cable (optional) (22)
- 40 MHz CPC board (11)
- EEPROM Chip (19)
- EPROM Board
- Digital Backplane (12)
- Function Card Guide (6)
- Antenna to Receiver RF cable (20)
- Ribbon Cable, PS to Digital Backplane
- Ribbon Cable, PS to Receiver Backplane
- Receiver Cable, Receiver to Antenna Distribution Board
- Cable, Rack Interface to Receiver Backplane (21)
- Antenna Cable, Rear Panel to Antenna Distribution Board (5)
- Fuses (13)
- Power Rod (10)
- Foot (15)

Figure 5-2 shows the Service Map, located inside the Receiver Mainframe cover.

Figure 5-3 shows an exploded view of the receiver mainframe.

5.4.1 Removal Flow Diagram

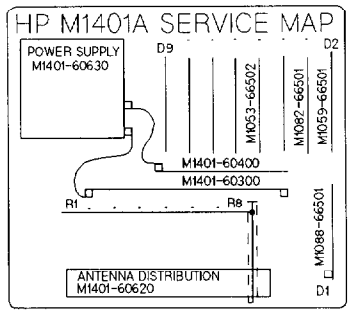
Figure 5-4 shows the removal flow diagram for the HP M1401A Receiver Mainframe. The flow diagram illustrates the order in which the mainframe must be disassembled. To use the flow diagram, the item to be removed should be located. Working from the START block, remove all of the items in the flow until the desired item has been removed.

All disassembly tasks in this section must be performed in the order shown in the flow diagram. Where paths are divided, the disassembly procedures can be performed in any order. Where paths join, all procedures above the juncture must be performed before proceeding further down the diagram.

HEWLETT PACKARD

RECEIVER MODULES

FREQUENCY RANGE	RECEIVER BD PART NUMBER	CLUSTERS
403.5 - 412.5 MHz	M1402-60010	D1-D2-D3-D4
412.5 - 421.5 MHz	M1402-60020	D5
421.5 - 430 MHz	M1402-60030	D6
430 - 440 MHz	M1402-60040	D7
440 - 450 MHz	M1402-60050	D8-D9
450 - 460 MHz	M1402-60060	
460 - 470 MHz	M1402-60070	
470 - 480 MHz	M1402-60080	
480 - 490 MHz	M1402-60090	
490 - 502 MHz	M1402-60100	
502 - 512 MHz	M1402-60110	



PARAMETER		SETTING
CARDIOTACH		FACTORY DEFAULT (OTHER OPTIONS) ADULT (NEONATAL)
ALARM LIMIT	HIGH LOW	150 50
BANDWIDTH		MON (DIAG, PACE, EXRC)
LEAD SELECTION 4 ELECTRODE	ECG A ECG B	I (I, II, III, aVR, aVL, aVF) II (I, II, III, aVR, aVL, aVF, OFF)
LEAD LABEL 5 ELECTRODE	ECG A ECG B	II (I, II, III, MCL, V, ECG) MCL (I, II, III, MCL, V, ECG, OFF)
LEAD FALLBACK		ON (OFF)
EXTENDED MONITORING		ON (OFF)
ALARM SUSPEND TIME		3 MINUTES (INDEFINITE)
ALARM REMINDER		ON (OFF)
TRANSMITTER BUTTON		BOTH (RECORD, NURSE CALL, DISABLED)
LANGUAGE		ENGLISH (FRENCH, GERMAN, SPANISH, DUTCH, ITALIAN)
AUTO SELF TEST		ON (OFF)
SELF-TEST STRIP		FATAL, (NON-FATAL, FATAL/NON-FATAL, OFF)
SDN UNIT NUMBER		1 (2, 3, 4, 5, 6)
SDN BRANCH NUMBER RECEIVER #		BRANCH # (0=OFF)
1-8		1-8, (9-16, 17-24)
1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8

Figure 5-2. HP M1401A Receiver Mainframe, Service Map

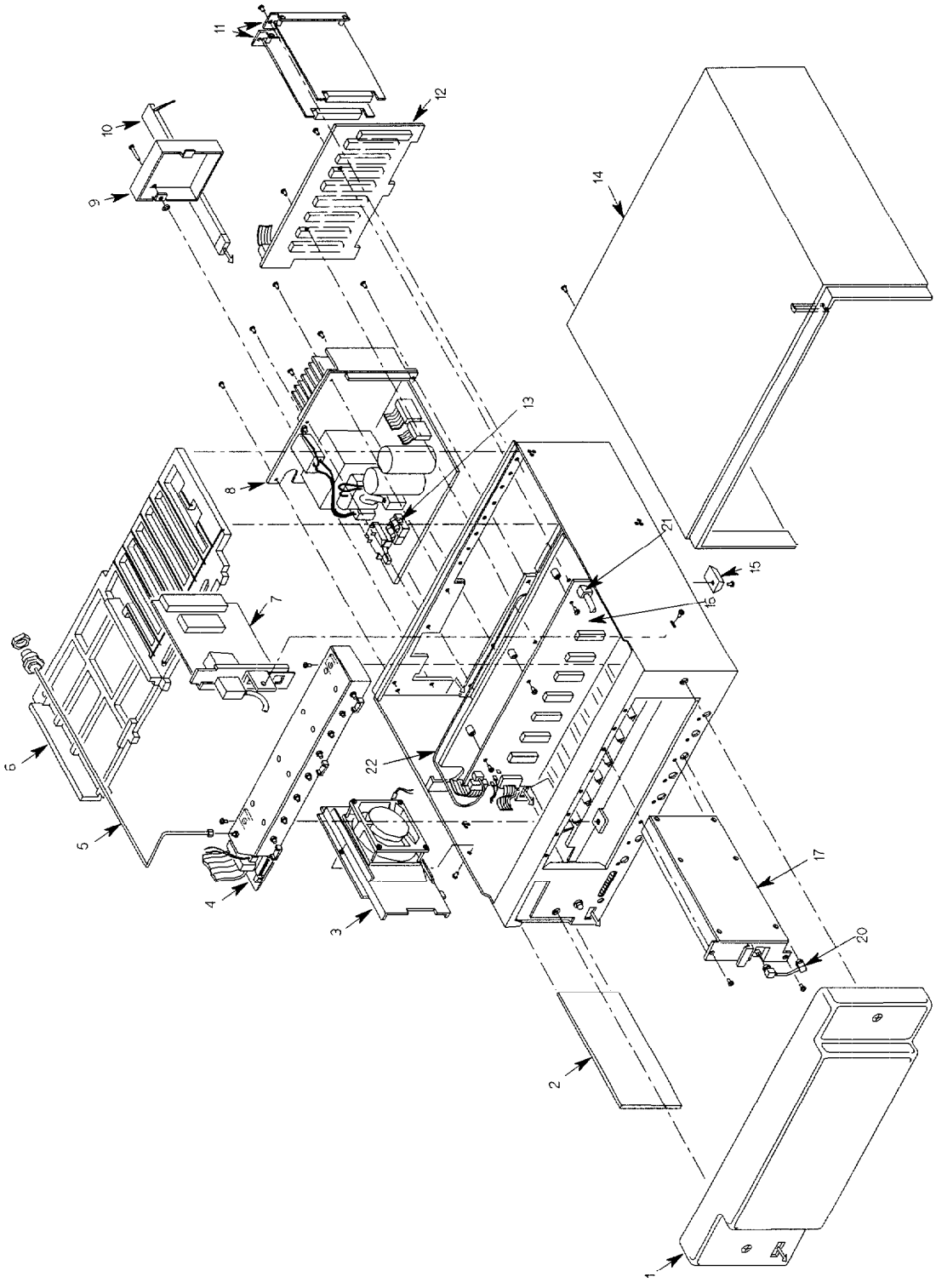


Figure 5-3. (Part 1 of 2) HP M1401A Receiver Mainframe, Exploded View

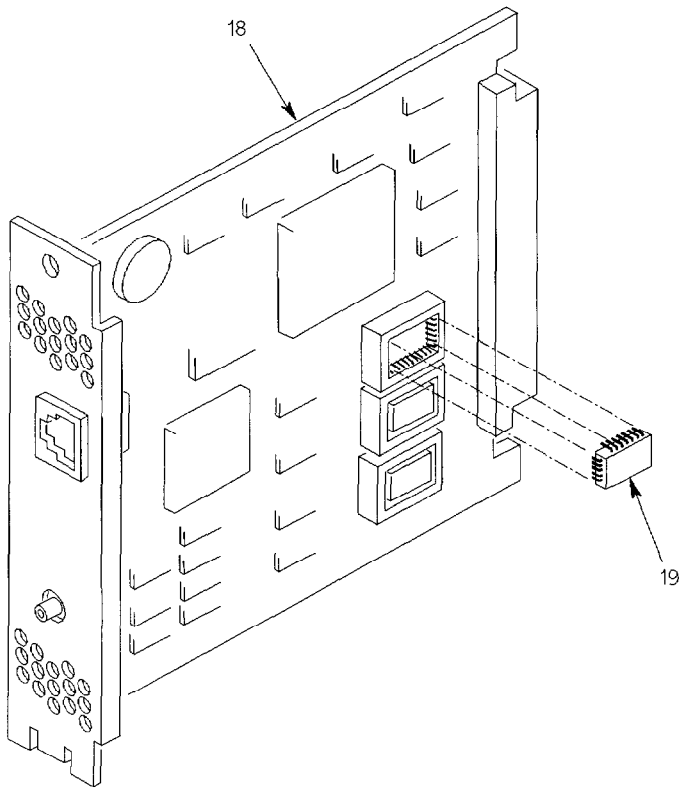


Figure 5-3. (Part 2 of 2) HP M1059-68501 Utility CPU Board

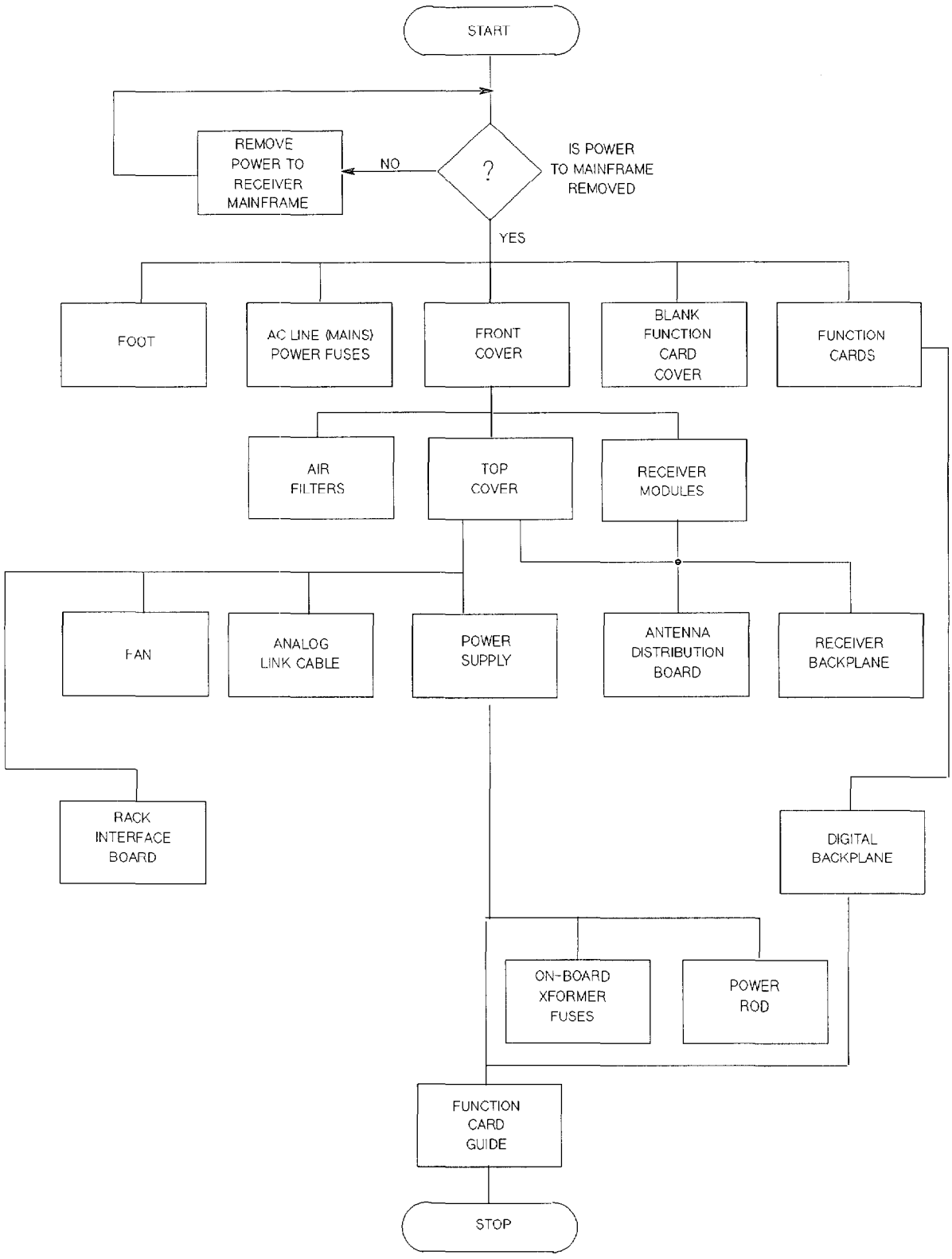


Figure 5-4. Removal Flow Diagram—HP M1401A Receiver Mainframe

5.4.2 Procedures

To disassemble the receiver mainframe, perform the following procedures. Numbers in parentheses refer to callouts on Figure 5-3 (Part 1 of 2).

5.4.2.1 Dress Cover

a. **Removal.** The procedure for removing the dress cover (1) is as follows:

1. Loosen two quarter turn screws.
2. Remove dress cover from receiver mainframe.

b. **Replacement.** The procedure for replacing the dress cover is as follows:

1. Place dress cover over front of receiver mainframe.
2. Tighten two quarter-turn screws to secure dress cover to receiver mainframe.

5.4.2.2 Top Cover

a. **Removal.** The procedure for removing the top cover (14) is as follows:

1. Remove two screws which secure top cover to rear of receiver mainframe chassis.
2. Slide top cover off receiver mainframe.

b. **Replacement.** The procedure for replacing the top cover is as follows:

1. Slide top cover over receiver mainframe.
2. Engage mainframe tabs in cover slots.
3. Secure top cover to receiver mainframe using two screws.

5.4.2.3 Receiver Module

a. **Removal.** The procedure for removing the receiver module (17) is as follows:

1. Disconnect RF cable SMC connector from front of receiver mainframe. Use two wrenches to keep the cable from twisting.
2. Remove two screws which secure receiver module to receiver mainframe.
3. Slide receiver module from receiver mainframe.
4. Repeat steps 1 through 3 for each receiver module.

b. **Replacement.** The procedure for replacing the receiver module is as follows:

1. Slide receiver module into slot in receiver mainframe. Make sure the connector on rear of receiver module plugs into connector on receiver backplane.

Note

Performing steps 2 and 3 in the order given allows the receiver module to float and makes it easier to align the semi-rigid RF cable.

---

2. Connect semi-rigid RF cable SMC connector to receiver module and to the antenna distribution PCB.
3. Secure receiver module to receiver mainframe using two screws.
4. Repeat steps 1 through 3 for each receiver module.

5.4.2.4 Power Fuses

a. **Removal.** The procedure for removing the power fuses is as follows:

1. Remove the one screw that secures the fuse panel cover, and pivot the cover in the slot until you can lift it off.
2. Using a flat-tipped screwdriver, turn fuse cap a quarter-turn counter-clockwise. The fuse cap should spring slightly from receiver mainframe rear panel.
3. Pull fuse cap and fuse from receiver mainframe rear panel.
4. Pull fuse from cap and note fuse rating.
5. Repeat steps 2 through 4 for the other fuse.

b. **Replacement.** The procedure for replacing the power fuses is as follows:

1. Place a fuse of correct value in fuse cap.
2. Place fuse with fuse cap into receptacle in receiver mainframe rear panel.
3. Using a flat-tipped screwdriver, secure fuse cap in place by turning it a quarter-turn clockwise.
4. Repeat steps 1 through 3 for other fuse.
5. Replace the fuse panel cover (1 screw).

5.4.2.5 Antenna Distribution Board

a. **Removal.** The procedure for removing the antenna distribution board (4) is as follows:

Note Before performing the following procedure, remove top cover and all receiver modules.

---

1. Remove two screws which secure antenna distribution board to bottom of receiver mainframe chassis.
2. Remove receiver backplane-to-antenna distribution board ribbon cable from connector on antenna distribution board.
3. Remove antenna cable from connector on antenna distribution board, using a 1/4-inch open-end wrench.
4. Remove malfunction LED cable.
5. Remove antenna distribution board from receiver mainframe.
6. Remove RF cable SMC connector from receiver module (20).

b. **Replacement.** The procedure for replacing the antenna distribution board is as follows:

1. Place antenna distribution board in receiver mainframe so that eight BNC connectors fit through holes on receiver mainframe chassis..
2. Connect antenna cable to connector on antenna distribution board.
3. Connect receiver backplane-to-antenna distribution board ribbon cable to connector on antenna distribution board.
4. Secure antenna distribution board to receiver mainframe chassis using two screws.
5. Connect RF cable SMC connectors to receiver module (20).

5.4.2.6 Receiver Backplane

a. **Removal.** The procedure for removing the receiver backplane (16) is as follows:

1. Remove three screws securing receiver backplane to receiver mainframe chassis.
2. Disconnect power supply to receiver backplane ribbon cable from connector on receiver backplane.
3. Disconnect receiver backplane-to-antenna distribution board ribbon cable from connector on receiver backplane.
4. Disconnect rack interface-to-receiver backplane ribbon cable from connector on receiver backplane.
5. Disconnect fan leads from receiver backplane (if required).
6. Remove receiver backplane from receiver mainframe.

b. **Replacement.** The procedure for replacing the receiver backplane is as follows:

1. Place receiver backplane in receiver mainframe.
2. Secure receiver backplane to receiver mainframe chassis using three screws.
3. Connect power supply-to-receiver backplane ribbon cable to connector on receiver backplane.
4. Connect receiver backplane-to-antenna distribution board ribbon cable to connector on receiver backplane.
5. Connect rack interface-to-receiver backplane cable to connector on receiver backplane.
6. Connect fan leads to receiver backplane (if required).

5.4.2.7 Fan

Note Depending upon what model of power supply you have, the fan power leads are connected either to the power supply itself, or to the receiver backplane.

If you are replacing the receiver mainframe fan, and you receive a model 3160-0816 fan as a replacement part, you must also have an M2604-60000 power supply. If you do not, you must replace the power supply, or you cannot connect the fan.

Caution Do not run the receiver mainframe without the fan installed. This could serious damage to the components of the receiver mianframe.

a. **Removal.** The procedure for removing the fan (3) is as follows:

1. Remove one screw securing fan to receiver mainframe chassis.
2. Disconnect fan leads from the power supply or form receiver backplane, depending upon which pwer supply you have.
3. Remove fan from receiver mainframe.

b. **Replacement.** The procedure for replacing the fan is as follows:

1. Place fan into receiver mainframe. Tabs on bottom of fan assembly should engage slots in chassis.

2. Secure fan to receive mainframe chassis using one screw.
3. Connect fan leads to receiver backplane or to the power supply, depending upon which model of fan you are installing. If the replacement fan is a model 3160-0816, it can only operate with a model M2604-60000 power supply. Replace the power supply if required. DO NOT RUN THE RECEIVER MAINFRAME WITHOUT THE FAN.

5.4.2.8 Air Filter

a. **Removal.** The procedure for removing the air filter (2) is as follows:

1. Slide air filter out of slot in receiver mainframe chassis.

b. **Replacement.** The procedure for replacing the air filter is as follows:

1. Slide replacement air filter into slot on left of receiver mainframe chassis.

5.4.2.9 Power Supply

a. **Removal.** The procedure for removing the power supply (8) is as follows:

1. Remove six screws securing power supply to rear of receiver mainframe chassis (Figure 5-5).
2. Remove one screw securing transformer cover (9) to power supply.
3. Disconnect:
   a. Ribbon cable from power supply to digital backplane.
   b. Ribbon cable from power supply to receiver backplane.
   c. Nut that attaches antenna cable to rear panel.
   d. Slide power supply out through rear of receiver mainframe.

b. **Replacement.** The procedure for replacing the power supply is as follows:

1. Place power supply in receiver mainframe through rear panel. Make sure power button arm lines up with power supply ON/OFF switch.

Caution Ensure that ribbon cables are clear of power supply fan blades.

---

2. Connect:
   a. Ribbon cable from power supply to digital backplane.
   b. Ribbon cable from power supply to receiver backplane.
   c. Nut that attaches antenna cable to rear panel.
3. Secure power supply to rear of receiver mainframe chassis using six screws.
4. Secure transformer cover to power supply using one screw.

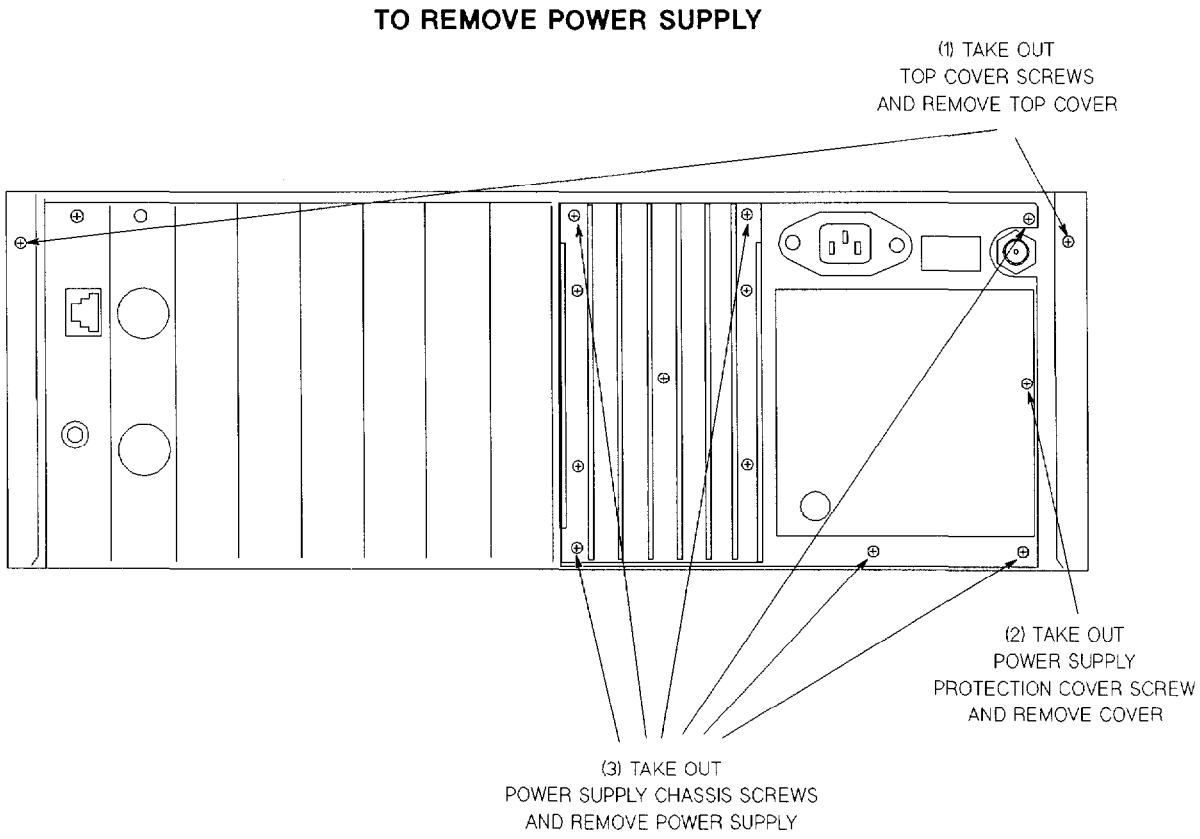


Figure 5-5. Power Supply Removal

5.4.2.10 On-board Transformer Fuses

a. **Removal.** The procedure for removing the on-board transformer fuses (13) is as follows:

1. Using a flat-tip screwdriver, gently lift fuse from fuse clips.
2. Remove fuse from power supply and note fuse rating.
3. Repeat steps 1 and 2 for other fuse.

b. **Replacement.** The procedure for replacing the transformer on-board fuses is as follows:

1. Place a fuse of proper rating into fuse clips.
2. Press on fuse until fuse snaps into fuse clips.
3. Repeat steps 1 and 2 for other fuse.

5.4.2.11 Rack Interface Board

a. **Removal.** The procedure for removing the rack interface board (7) is as follows:

1. Remove one screw securing rack interface board mounting bracket to right side of receiver mainframe chassis.
2. Disconnect rack interface-to-receiver backplane cable from connector on receiver backplane.
3. Remove rack interface board and mounting bracket from receiver mainframe.

b. **Replacement.** The procedure for replacing the rack interface board is as follows:

1. Place rack interface board with mounting bracket in its mounting location in receiver mainframe.
2. Connect rack interface-to-receiver backplane cable to connector on receiver backplane.
3. Secure rack interface board mounting bracket to right side of receiver mainframe chassis.

5.4.2.12 Blank Function Card Cover

a. **Removal.** The procedure for removing the function card cover is as follows:

1. Remove one screw and washer securing blank function card cover to receiver mainframe chassis and remove blank function card cover.
2. Repeat step 1 for each blank function card cover.

b. **Replacement.** The procedure for replacing the blank function card cover is as follows:

1. Place blank function card cover over blank function card slot.
2. Secure blank function card cover to receiver mainframe chassis using one screw and washer.

5.4.2.13 Function Cards

a. **Removal.** The procedure for removing a function card (11) from the rear of the receiver mainframe is as follows:

1. Remove one screw and washer securing function card mounting bracket to receiver mainframe chassis.
2. Disconnect any cables from connectors on function card.
3. Pull function card from function card guide out rear of receiver mainframe.

b. **Replacement.** The procedure for replacing a function card is as follows:

1. Push function card into function card guide through rear of receiver mainframe. Press firmly on top and bottom of function card until it is in place.
2. Connect any cables to connectors on function card.
3. Secure function card mounting bracket to receiver mainframe chassis using one screw and washer.

5.4.2.14 EPROM Board

a. **Removal.** The procedure for removing the EPROM board is as follows:

1. Remove Turbo Processor function card by performing procedures in paragraph 5.4.2.13.
2. Remove 4 cross-hatch screws on BOTTOM of Turbo Processor Card that attach to EPROM board.
3. Grasp EPROM at edge where its pins connect it to the Turbo Processor Card.
4. Withdraw EPROM pins from Turbo Processor Card and separate boards.

b. **Replacement.** The procedure for replacing the EPROM boards is as follows:

1. Position EPROM board into connectors on Turbo Processor Card.
2. Apply equal pressure across the board until connector pins are firmly seated.
3. Secure EPROM to Turbo Processor Card with 4 cross-hatch screws.

5.4.2.15 EEPROM Chip

a. **Removal.** The procedure for removing the EEPROM chip (19) is as follows:

1. Remove utility CPU function card (18) by performing procedures in paragraph 5.4.2.13.
2. Using a chip extraction tool (P/N M1186-45001), remove the EEPROM chip from the utility CPU board.

b. **Replacement.** The procedure for replacing the EEPROM chip is as follows:

1. Align dot on EPROM chip with arrow in EEPROM plug on utility CPU board.
2. Press EEPROM chip until it snaps into place.

5.4.2.16 Analog Link Cable

a. **Removal.** The procedure for removing the Analog Link cable (22) is as follows:

1. Unplug connector attaching cable to Analog Output board.
2. Unplug connector attaching cable to receiver backplane.
3. Remove cable.

b. **Replacement.** The procedure for replacing the Analog Link cable is as follows:

1. Connect end of Analog Link cable with two-row connector, to mating socket on receiver backplane. The connector is keyed so that it will plug in only one way.
2. Connect end of Analog Link cable with one-row connector, to connector on Analog Output board. The connector is keyed so that it will plug in only one way.

3. Route the Analog Link cable so that it rests in the U-shaped wire-run guide, and lies flat across the top edge of the other function boards.
4. Make a service bend in the cable, looping it toward the receiver backplane, and wedge the cable loop into the space between the Analog Output board and the board to its right.

5.4.2.17 Power Rod

a. **Removal.** The procedure for removing the power rod (10) is as follows:

1. Slide power rod out through rear of receiver mainframe chassis.

b. **Replacement.** The procedure for replacing the power rod is as follows:

1. From rear of receiver mainframe, slide power rod through slots in receiver mainframe chassis center wall and front panel of receiver mainframe chassis until tension is felt on power rod spring lever. Make sure power rod lines up with power supply ON/OFF switch.

5.4.2.18 Digital Backplane

a. **Removal.** The procedure for removing the digital backplane (12) is as follows:

1. Remove two screws securing digital backplane to receiver mainframe chassis center wall.
2. Remove ribbon cable from digital backplane.
3. Remove digital backplane from receiver mainframe.

b. **Replacement.** The procedure for replacing the digital backplane is as follows:

1. Place digital backplane in its mounting location in receiver mainframe.
2. Attach ribbon cable to digital backplane.
3. Secure digital backplane to receiver mainframe chassis using two screws.

5.4.2.19 Antenna Cable (Rear panel to antenna distribution board)

a. **Removal.** The procedure for removing the antenna cable (6) is as follows:

1. At rear panel of receiver mainframe, remove hex-nut securing antenna cable to receiver mainframe chassis.
2. Disconnect antenna cable from antenna distribution board.
3. Pull cable forward to clear opening in receiver mainframe chassis, then lift cable free of receiver mainframe.

b. **Replacement.** The procedure for replacing the antenna cable is as follows:

1. Insert antenna cable BNC connector from inside of receiver mainframe through antenna cable mounting hole.
2. Secure antenna cable to receiver mainframe chassis using hex-nut.
3. Secure antenna cable to chassis using tie wrap.
4. Connect antenna cable to antenna distribution board.

5.4.2.20 Function Card Guide

a. **Removal.** The procedure for removing the function card guide (6) is as follows:

1. Lift function card guide from receiver mainframe.

b. **Replacement.** The procedure for replacing the function card guide is as follows:

1. Align five protrusions on front of function card guide with slots on bottom of receiver mainframe center chassis wall.
2. Slide protrusions into slots on bottom of receiver mainframe center chassis wall and fit function card guide into receiver mainframe so that it rests flat on bottom of receiver mainframe chassis floor.

5.4.2.21 Foot

a. **Removal.** The procedure for removing the foot (15) is as follows:

1. From underneath the receiver mainframe, remove one screw securing foot to receiver mainframe chassis and remove foot.
2. Repeat step 1 for other three feet.

b. **Replacement.** The procedure for replacing foot is as follows:

1. From underneath receiver mainframe, secure foot to receiver mainframe chassis using one screw.
2. Repeat step 1 for other three feet.

5.5 HP M1402A Receiver Module

The field-replaceable units for the receiver module are as follows:

- Receiver Shield (6)
- Short Receiver Gasket (4)
- Loop Receiver Gasket (5)
- Receiver VCXO Module (3)
- Receiver Microcontroller (7)

Part numbers for each assembly are given in Section 6. Figure 5-6 shows an exploded view of the receiver module.

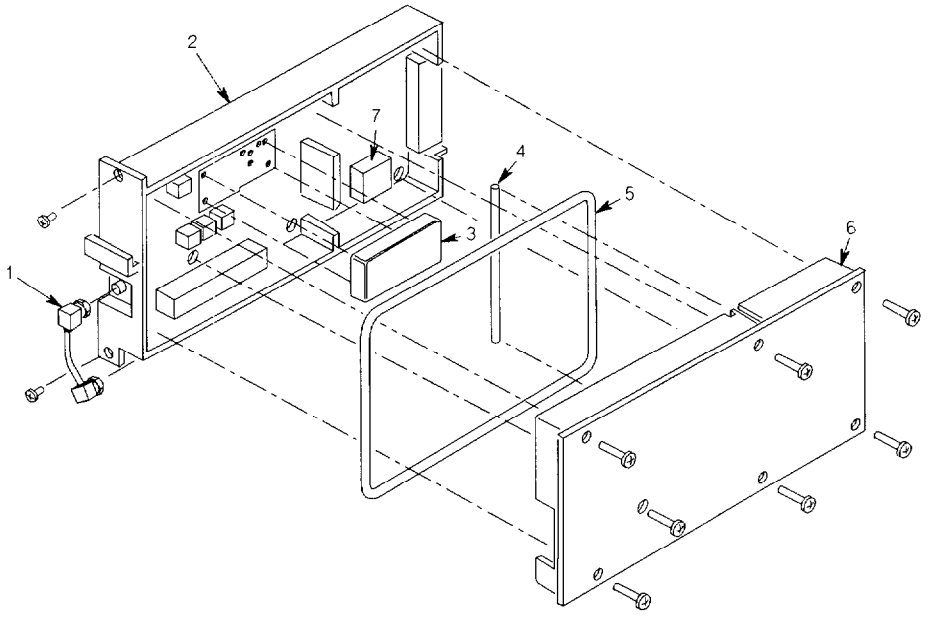


Figure 5-6. HP M1402A Receiver Module, Exploded View

5.5.1 Removal Flow Diagram

Figure 5-7 shows the removal flow diagram for the HP M1402A Receiver Module. The flow diagram illustrates the order in which the receiver module must be disassembled. To use the flow diagram, the item to be removed should be located. Working from the START block, remove all of the items in the flow until the desired item has been removed.

All disassembly tasks in this section must be performed in the order shown in the flow diagram. Where paths are divided, the disassembly procedures can be performed in any order. Where paths join, all procedures above the juncture must be performed before proceeding further down the diagram.

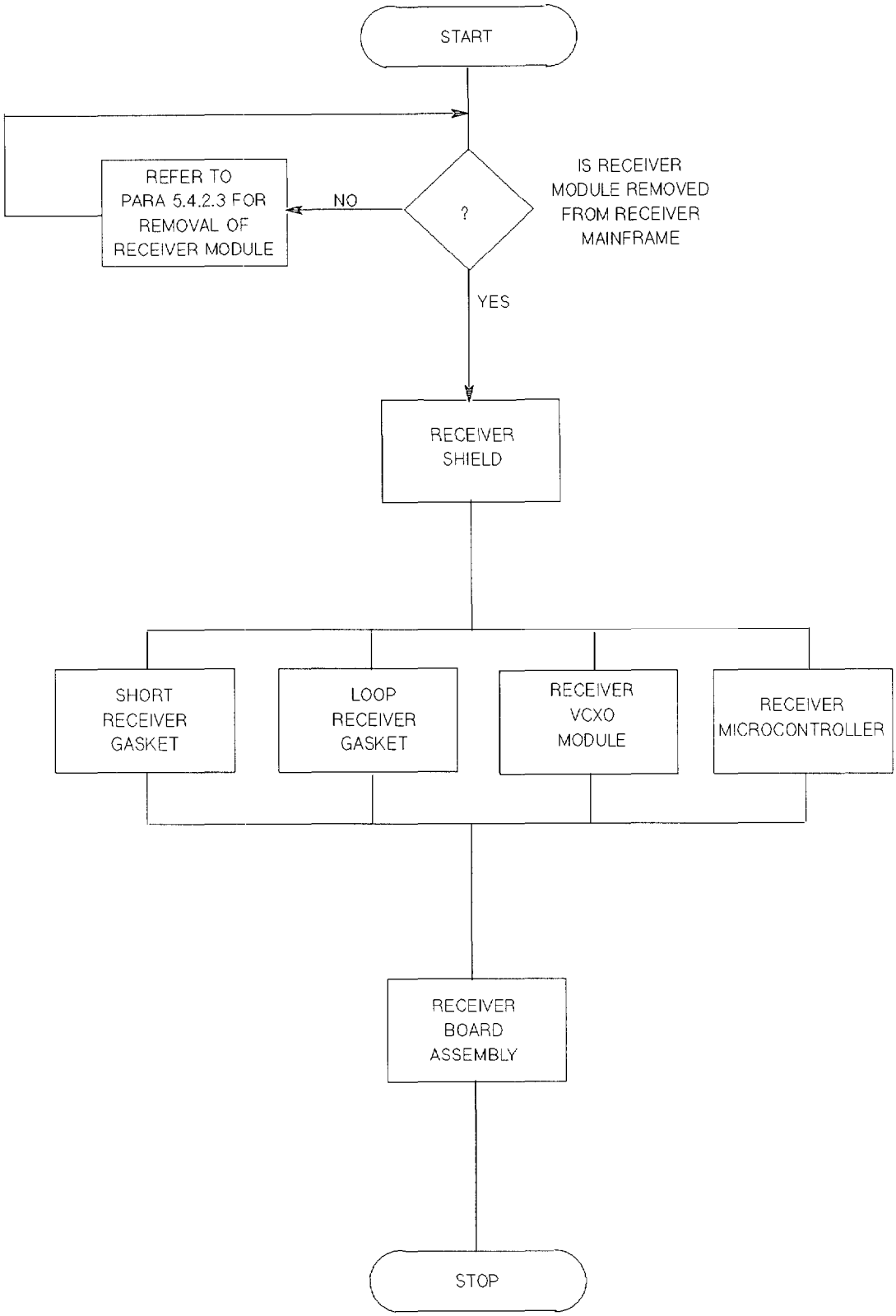


Figure 5-7. Removal Flow Diagram—HP M1402A Receiver Module

5.5.2 Procedures

To disassemble the receiver module, perform the following procedures using Figure 5-7 as a guide. Numbers in parentheses refer to callouts on Figure 5-6.

5.5.2.1 Receiver Shield

a. **Removal.** The procedure for removing the receiver shield (6) is as follows:

1. Remove seven screws securing receiver shield to receiver module, and remove receiver shield.

b. **Replacement.** The procedure for replacing the receiver shield is as follows:

1. Place receiver shield on receiver module and partially tighten seven screws.
2. Completely tighten the seven screws working from front to back of receiver, to assure even seating of gasket.

5.5.2.2 Short Receiver Gasket

a. **Removal.** The procedure for removing the short receiver gasket (4) is as follows:

1. Wash hands to remove finger oils. Use detergent-type cleaner without Lanolin (typical washroom soaps are lanolized).
2. Remove short receiver gasket from receiver shield. Use no tools.

b. **Replacement.** The procedure for replacing the short receiver gasket is as follows:

1. Rest short receiver gasket on top of groove in receiver shield cover.
2. Press ends of gasket into groove.
3. Work towards the middle to press the rest of the gasket in place. Work out any unevenness.

5.5.2.3 Loop Receiver Gasket

a. **Removal.** The procedure for removing the loop receiver gasket (5) is as follows:

1. Tap top cover on hand to dislodge the loop receiver gasket so it comes away from the receiver shield. Use no tools.
2. Wash hands to remove finger oils. Use detergent-type cleaner without Lanolin (typical washroom soaps are lanolized).
3. Using fingers, lift loop receiver gasket from receiver shield. Attempt to keep gasket clean.

b. **Replacement.** The procedure for replacing the circular receiver gasket is as follows:

1. Fit circular receiver gasket around round receiver shield fitting, and push circular receiver gasket until it rests flat against receiver shield.

5.5.2.4 Receiver VCXO Module

a. **Removal.** The procedure for removing the receiver VCXO module (3) is as follows:

1. Unplug and remove receiver VCXO module from receiver module motherboard. To facilitate removing the module, place fingers lengthwise on the module and wiggle it until it comes free.

Caution Avoid pivoting VCXO module during removal to avoid pin damage.

---

b. **Replacement.** The procedure for replacing the receiver VCXO module is as follow:

1. Align pins on VCXO module with sockets on motherboard and carefully plug receiver VCXO module into motherboard.

5.5.2.5 Receiver Microcontroller

a. **Removal.** The procedure for removing the receiver microcontroller is as follows:

1. Using chip extraction tool (p/n 8710-1995), remove microcontroller from module socket. The tines of the extraction tool fit into slots at corners diagonal from each other, and the head of the extraction tool should be flat and flush against the chip.

b. **Replacement.** The procedure for replacing the receiver microcontroller is as follows:

1. Align dot on microcontroller with arrow in firmware socket in module.
2. Press microcontroller until it snaps into place.

5.5.2.6 RF Cable

a. **Removal.** The procedure for removing the RF cable (1) is as follows:

1. Disconnect RF cable (1) from front of receiver.

b. **Replacement.** The procedure for replacing the RF cable is as follows:

1. Connect RF cable to front of receiver.

Note Semi-rigid cable may be bent slightly to adjust to proper dimension. Care must be taken to avoid rotation of connector head during tightening to avoid stressing the cable. To do this, use a small open-end wrench to hold the connector head while tightening the nut. Do not overtighten.

5.5.2.7 Receiver Board Assembly

a. **Removal.** The procedure for removing the receiver board assembly is as follows:

1. Remove the gold nut and washer securing the receiver board assembly (2).
2. Remove the receiver board assembly from the receiver module.

b. **Replacement.** The procedure for replacing the receiver board assembly is as follows:

1. Place the reciever board assembly into the receiver module.
2. Secure the receiver board assembly in place using the gold nut and washer.

6

Replaceable Parts

6.1 Introduction

This section contains information for ordering replaceable parts and assemblies for the HP M1403A Digital UHF Telemetry System. It provides general information on parts identification and ordering. The parts are listed in tables by major subassemblies. Each table contains the following information:

- HP new part number
- HP exchange part number (if applicable)
- Description of part
- Total quantity used in subassembly

Refer to the exploded views in chapter 5 and to Figure 6-1 for part and assembly identification.

6.1.1 Ordering New Parts

To order a replacement part, first identify the faulty component or assembly from the information provided in the exploded views or Figure 6-1. Look up the component or assembly in the appropriate table for the end item to which it belongs, and record the entire part number. Using the part number, the desired part can be ordered from the nearest Hewlett-Packard Sales Office or the HP Support Materials Organization (telephone 1-800-227-8164 in U.S.A., Canada and Mexico; from elsewhere in the world, dial the access code for U.S.A., then 916-785-8095).

All pc boards available as exchange boards are available as new boards.

6.1.2 Unlisted Parts

To order a part not listed in any of the tables, provide the following information:

a. Model number of the instrument.

b. Complete serial number of the instrument (including the serial number prefix code from the serial number plate), where, in XXXXX-00000, XXXXX is the prefix code and 00000 is the actual serial number. The last digit of this prefix code, which may be A=USA, G=Germany, etc., denotes the country of manufacture.

c. Description of the part, including function, location, color, and any numbers appearing on the part.

Wires and wiring harnesses are not considered to be replaceable parts, even if they are attached to a pc assembly. Designated internal cables may be ordered separately (Figure 6-1).

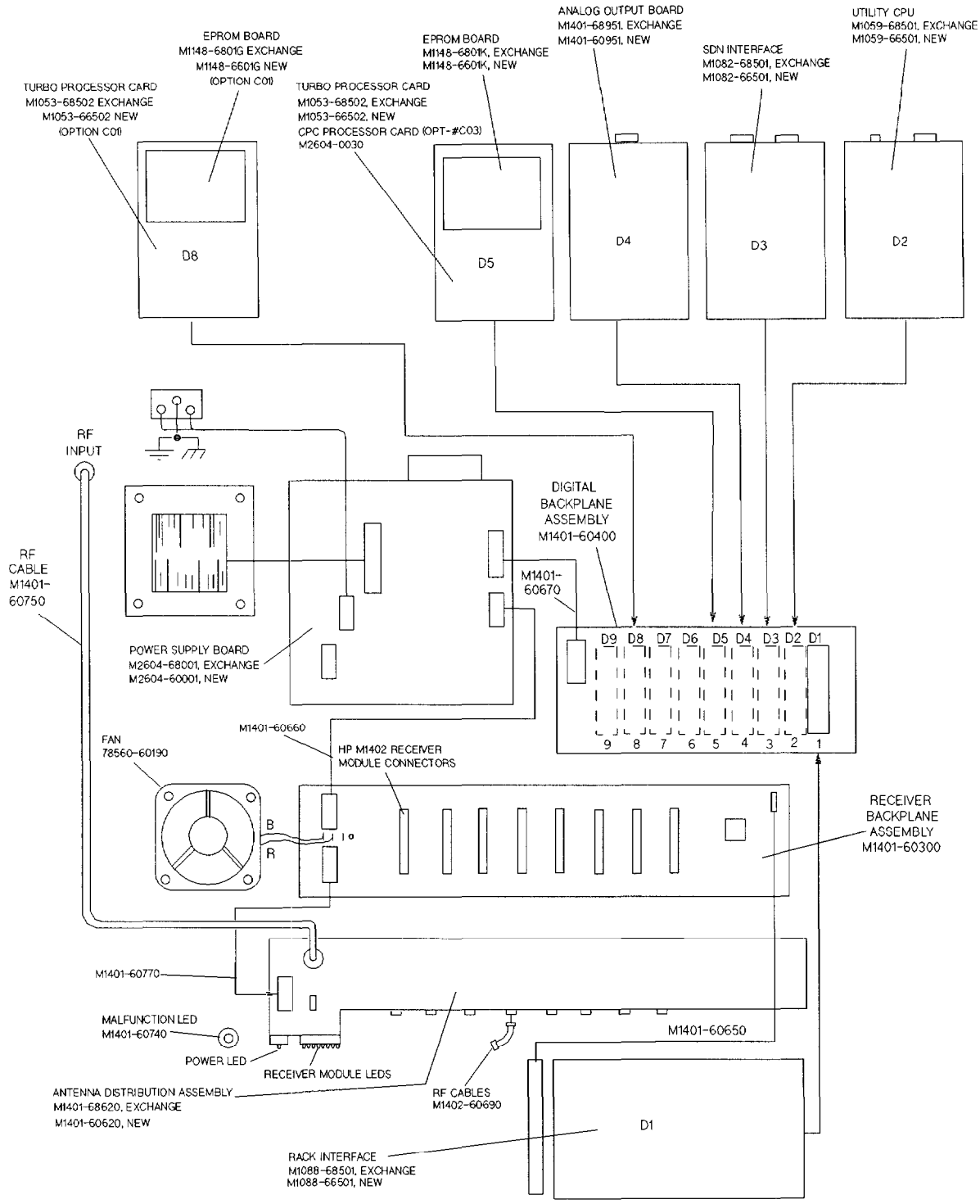


Figure 6-1. PC Board Identification and Cabling

6.1.3 Exchange Program

This instrument contains boards that are available both as new and exchange assemblies. Not all boards are part of the exchange program, however. Defective boards may be exchanged for factory-rebuilt boards or replaced with new boards. Both new and exchange assemblies are available from the nearest Hewlett-Packard Sales Office or the HP Support Materials Organization ("6.1.1 Ordering New Parts").

Table 6-1. Products

Description	Product Number
Transmitter	HP M1400A
Transmitter	HP M1400B
Receiver Module	HP M1402A
Receiver Mainframe	HP M1401A
Active Antenna/Combiner	HP M1408A
Line Amplifier	HP M1406A
Multiple Unit Power Supply	HP M1407A

Table 6-2. Receiver Module Exchange Assemblies (M1402A)

Description	Exchange Part No.	New Part No.
NOTE: Receiver boards are returned without VCXO Modules.		
Receiver Board Assembly 403.5 - 412.5 MHz	M1402-68301	M1402-60301
Receiver Board Assembly 412.5 - 421.5 MHz	M1402-68302	M1402-60302
Receiver Board Assembly 421.5 - 430.5 MHz	M1402-68303	M1402-60303
Receiver Board Assembly 430 - 440 MHz	M1402-68304	M1402-60304
Receiver Board Assembly 440 - 450 MHz	M1402-68305	M1402-60305
Receiver Board Assembly 450 - 460 MHz	M1402-68306	M1402-60306
Receiver Board Assembly 460 - 470 MHz	M1402-68307	M1402-60307
Receiver Board Assembly 470 - 480 MHz	M1402-68308	M1402-60308
Receiver Board Assembly 480 - 490 MHz	M1402-68309	M1402-60309
Receiver Board Assembly 490 - 502 MHz	M1402-68310	M1402-60310
Receiver Board Assembly 502 - 512 MHz	M1402-68311	M1402-60311

Table 6-3. Receiver Mainframe Exchange Assemblies (M1401A)

Description	Exchange Part No.	New Part No.
Power Supply	M1401-68631	M1401-60631
Power Supply	M2604-68001	M2604-60001
Antenna Distribution Assembly	M1401-68620	M1401-60620
EPROM Board	M1148-6801K	M1148-6601K
Turbo Processor Card	M1053-68501	M1053-66501
SDN Interface Board	M1082-68501	M1082-66501
SDN Interface Board ReSic	M1082-68502	M1082-66502
Rack Interface Board	M1088-68501	M1088-66501
Utility CPU Board	M1059-68501	M1059-66501
NOTE: Return without EEPROM.		

Table 6-4. Receiver Module Replaceable Parts (M1402A)

Description	New Part No.	Reference Designator
Receiver VCXO Module	M1402-61opt; (opt=option no.)	3 (module)
Receiver Microcontroller	M1402-84002	7 (module)
Receiver Shield	M1402-60540	2 + 6 (module)
Receiver Gasket – short	M1402-01900	4 (module)
Receiver Gasket – circular	M1402-01800	5 (module)
Screw, shield	0515-1452	
Screw	0515-0389	

Table 6-5. Transmitter Replaceable Parts (HP M1400A/HP M1400B)

Description	New Part No.
Transmitter Motherboard Assembly	M1400-67030
Motherboard Battery Clips	1252-3267
Transmitter VCXO Module—2 mw Transmitter VCXO Module—4 mw	M1400-61opt; M1400-62opt; (opt=option no.)
Transmitter Case Assembly	M1400-67000
Transmitter Top Cover Assembly	M1400-67010
Transmitter Bottom Cover Assembly: M1400A English/U.S.A. M1400A AAMI M1400A IEC M1400B English/U.S.A. M1400B AAMI M1400B IEC	 M1400-67020 M1400-67040 M1400-67050 M1400-67080 M1400-67060 M1400-67070
Nurse Call Button Overlay	M1400-83010
Transmitter Hook	M1400-40040
Motherboard Sockets	1252-3267
Battery Contacts	M1400-60060
Battery Spring	M1400-60012
Battery	1420-0340
Labels - channel 001 - channel 049 Labels - channel 001 - channel 014 Labels - channel 015 - channel 028 Labels - channel 029 - channel 042 Labels - channel 043 - channel 070 Labels - channel 071 - channel 098 Labels - channel 099 - channel 196 Labels - channel 197 - channel 294 Labels - channel 295 - channel 389 Labels - channel 390 - channel 399, channel 001 - channel 049 Labels - channel 751 - channel 780 Labels - channel 811 - channel 820 Labels - channel 501 - channel 530 Labels - channel 531 - channel 628 Labels - channel 629 - channel 726 Labels - channel 727 - channel 750 ------channel 781 - channel 810 ------channel 821 - channel 823 ------channel 850 - channel 875 Labels - channel 876 - channel 900	M1400-83020 M1400-83011 M1400-83012 M1400-83013 M1400-83014 M1400-83016 M1400-83017 M1400-83018 M1400-83019 M1400-83020 M1400-83021 M1400-83023 M1400-83024 M1400-83025 M1400-83026 M1400-83027 M1400-83028
Water Soluble Lotion	9310-6344
Latch (Leadset)	M1400-40040
Shield	M1400-00070
Insulator	M1400-00080

Table 6-6. Receiver Mainframe Replaceable Parts (M1401A)

Description	New Part No.	Reference Designator
Digital Backplane	M1401-60400	12
Receiver Backplane	M1401-60300	16
Fan 24V (for receiver mainframes with power supply M1401-60631)	78560-60190	3
Fan 12V (for receiver mainframes with power supply M2604-60001)	78560-60190	3
Air Filter	M1401-02100	2
Fuse - 1 AT 100/120 V ac	2110-0782	13
- 0.4 AT 220/240 V ac	2110-0536	13
EEPROM	M1059-85903	19
Dress Cover	M1401-60680	1
Blank Function Card Cover	M1046-04130	
Function Card Guide	M1401-40020	6
Power Rod	M1401-40010	10
Foot	5041-4264	15
Transformer Cover	M1401-02800	9
Fan Mounting Bracket	M1401-60700	
Receiver Module Guide	M1401-01400	
Receiver Mainframe Chassis	M1401-60600	
M1401A Product Label	M1401-83020	
Semi-rigid, RF cable	M1402-60690	1 (module) or 20 (main)
Ribbon cable, Power supply to digital backplane	M1401-60670	
Ribbon cable, Power supply to receiver backplane	M1401-60660	
Ribbon cable, Receiver backplane to Antenna distribution board	M1401-60770	
Cable, Rack interface to Receiver backplane	M1401-60650	21
Antenna cable, Rear panel to antenna distribution board	M1401-60750	5
Receiver Mainframe Top Cover	M1401-01200	14
Label - Service Configuration	M1401-83030	
Label - Receiver/Service	M1401-83050	

Table 6-7. Active Antenna/Combiner Replaceable Parts

Description	New Part No.
Base, Active Antenna/Combiner (HP M1408A)	M1408-60000
Wall Mount	M1404-60001
Flexible antenna - 406–450 MHz	0950-2029
Flexible antenna - 450–512 MHz	0950-2028

Table 6-8. Line Amplifier Replaceable Parts (M1406A)

Description	New Part No.
Line amplifier	M1406-67000
Mounting Bracket	M1406-00060

Table 6-9. Multiple Unit Power Supply Replaceable Parts (M1407A)

Description	New Part No.
Power Tee	M1407-67000
Mounting bracket	M1407-00060
Power module - 120 V ac	0950-2038
Mounting bracket	M1407-00030
Power module - 230 V ac	0950-2079
Mounting bracket	M1407-00050

Table 6-10. Wall and Rack Mount Replaceable Parts

Description	New Part No.
Screw, 10-32 x 0.5 inch	2680-0055
Screw, 10-32 x 0.5 inch (with plastic washer)	2190-0702
Screw, M3 x .5 x 8 mm	0515-1079
Screw, M3 x 10 mm	0515-0169
Screw, M3.5 x 6 mm	0515-0168
Screw, M3.5 x 10 mm	0515-1091
Screw, M5 x 6 mm	0515-0116
Screw, M5 x 10 mm	0515-1546

Table 6-11. Miscellaneous Antenna System Replaceable Parts

Description	New Part No.
Two-way splitter/combiner (HP 78103A)	0960-0323
Spacer	M1415-00003
Four-way splitter/combiner (HP 78104A)	0960-0324
Spacer	M1415-00004
Attenuator box w/bracket	M1409-60000
Mounting bracket	M1409-00010
Attenuator, 2 dB	0699-3463
Attenuator, 3 dB	0699-3464
Attenuator, 4 dB	0699-3465
Attenuator, 5 dB	0699-3462
Attenuator, 6 dB	0699-3461
Attenuator, 7 dB	0699-3467
Attenuator, 8 dB	0699-3466
DC blocking capacitor	HP 10240B
75-ohm terminator with DC block (Amphenol 35650-1009)	1250-2403
BNC (m) to BNC (m) adapter	1250-0216
RG-6U Antenna cable (non-plen, 1 ft)	M1413-60100
RG-6U Antenna cable (non-plen, 5 ft)	M1413-60105
RG-6U Antenna cable (non-plen, 10 ft)	M1413-60101
RG-6U Antenna cable (non-plen, 62 ft)	M1413-60103
RG-6U Antenna cable (non-plen, 139 ft)	M1413-60102
RG-6U Antenna cable, special (non-plen, specified to order)	M1413-60109
RG-11U Antenna cable, special (non-plen, specified to order)	M1413-60119
RG-6U Antenna cable (plenum, 62 ft)	M1414-60103
RG-6U Antenna cable (plenum, 139 ft)	M1414-60102
RG-6U Antenna cable, special (plenum, specified to order)	M1414-60109
RG-11U Antenna cable, special (non-plen, specified to order)	M1414-60119

6.1.4 Analog Output Option Replaceable Parts

Table 6-12 lists replaceable parts for equipment associated with the Analog Output Option J01 (Patient Monitor/Holter Interface).

Table 6-12. Analog Output Option Replaceable Parts

Description	New Part No.	Exchange Part No.
Analog output board assembly	M1401-60951	M1401-68951
Analog link cable	M1401-60751	
Analog trunk cable	M1401-60752	
Output connector box assembly	M1401-60961	
Output connector box power module (US/CAN)	82241-60001 (prior to April 1997) 0950-3221 (after April 1997)	
Output connector box power module (EUROPE)	82241-60002 (prior to April 1997) 0950-3221 (after April 1997)	
Output connector box power module (UK)	82241-60003 (prior to April 1997) 0950-3221 (after April 1997)	
Output connector box power module (AUST)	82241-60004 (prior to April 1997) 0950-3221 (after April 1997)	
Output connector box power module (S AFRICA)	82241-60005 (prior to April 1997) 0950-3221 (after April 1997)	
Output connector box power module (JAPAN)	82241-60006 (prior to April 1997) 0950-3221 (after April 1997)	
Analog output cable, non-plenum, 50'	M1401-60761	
Analog output cable, non-plenum, 100'	M1401-60762	
Analog output cable, non-plenum, 250'	M1401-60763	
Analog output cable, non-plenum, 500'	M1401-60764	
Analog output cable, plenum, 50'	M1401-60765	
Analog output cable, plenum, 100'	M1401-60766	
Analog output cable, plenum, 250'	M1401-60767	
Analog output cable, plenum, 500'	M1401-60768	
Holter attenuator	78599AI-#K76	
Bedside attenuator	78599AI-#K75	
Bedside/SDN attenuator	78599AI-#K81	
Bedside monitor cable, 3/4-wire, 8-pin	M1401-60753	
Bedside monitor cable, 3/4-wire, 12-pin	M1401-60754	
Bedside monitor cable, 5-wire, 8-pin	M1401-60755	
Bedside monitor cable, 5-wire, 12-pin	M1401-60756	

6.1.5 ST Segment Analysis and Two-Channel Delayed Recording Option Replaceable Parts

Table 6-13 lists replaceable parts for equipment associated with the ST Segment Analysis and Two-Channel Delayed Recording Option C01.

Table 6-13.
ST Segment Analysis and Two-Channel Delayed Recording Option Replaceable Parts

Description	New Part No.	Exchange Part No.
EPROM Board	M1148-6811A	M1148-6611A
Turbo Processor Card	M1053-68502	M1053-66502

6.1.6 40 MHz CPC Card Option C03 Replaceable Parts

All M1401A Receiver Mainframes with Option C03 installed, or with upgrade kit M1440A-#OPT C03 installed, have a 40 MHz CPC card instead of the Turbo Processor PCB. If the ST option is installed too, the 40 MHz CPC card replaces both Turbo Processor PCBs. The power supply for the M1401A with Option C03 installed is either M1401-60631 or M2604-60000, but if you order a replacement fan, only the M2600-60001 is available and only that part is included in the following table.

Table 6-14. 40 MHz CPC Card Option C03 Replaceable Parts

Description	New Part No.	Exchange Part No.
40 MHz CPC Card	M2604-60010	M2604-68010
EEPROM	M2604-84001	N/A
Power Supply	M2604-60001	M2604-68001
OmniCare Label	M1401-83070	N/A

6.1.7 Receiver Backplane Assembly M1401-60300 Pinouts

Although the HP repair method for these instruments is board exchange, power pinouts and component identification are provided for Receiver Backplane Assembly M1401-60300 (Figure 6-2). This backplane assembly is available only as a new, replacement board.

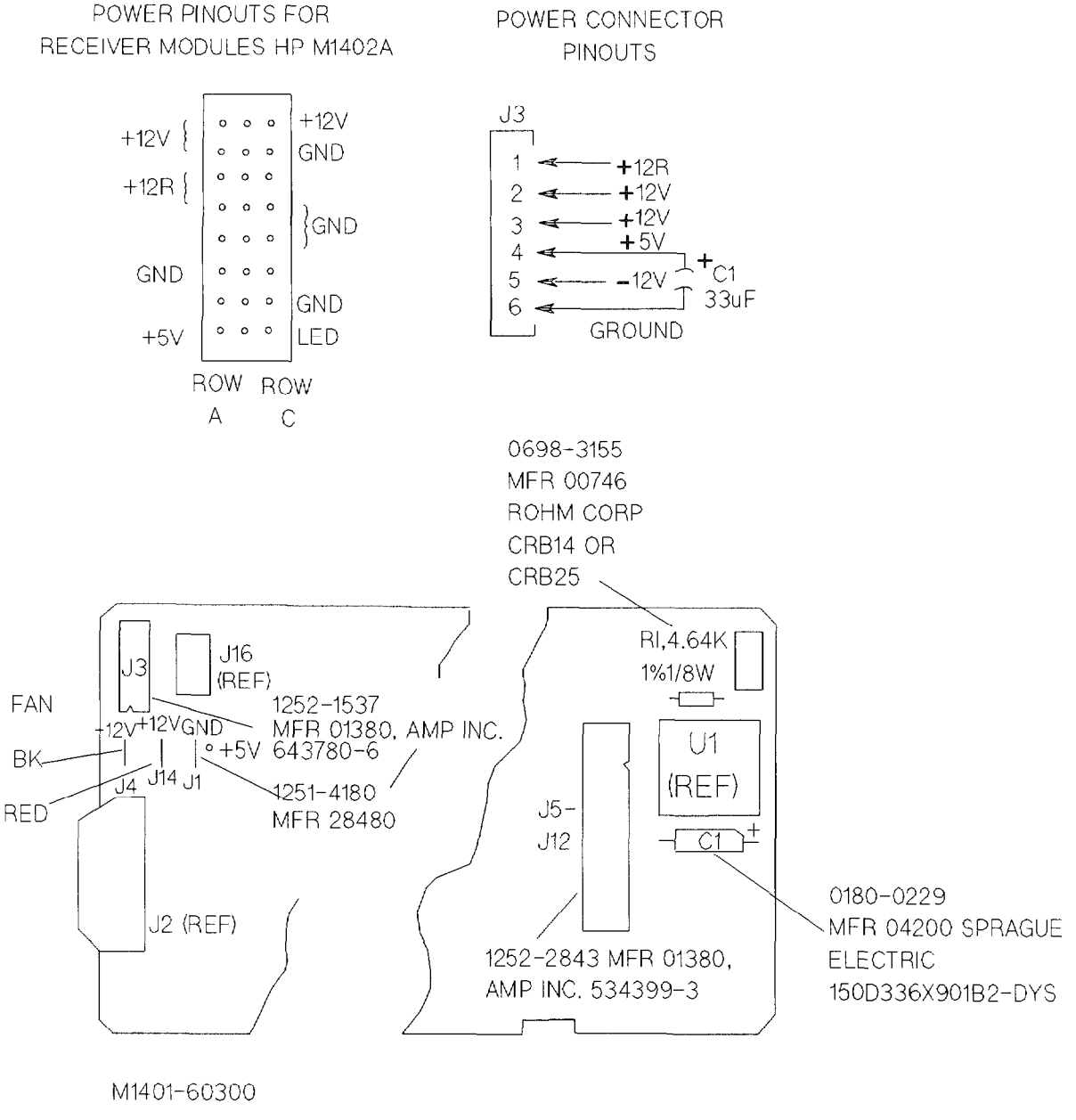


Figure 6-2. Receiver Backplane Assembly M1401-60300, Replaceable Parts and Pinouts

6.1.8 Digital Backplane Assembly M1401-60400, Connector Pinouts

Although the HP repair method for these instruments is board exchange, power pinouts and component identification are provided for Digital Backplane Assembly M1401-60400 (Figure 6-3). This backplane assembly is available only as a new, replacement board.

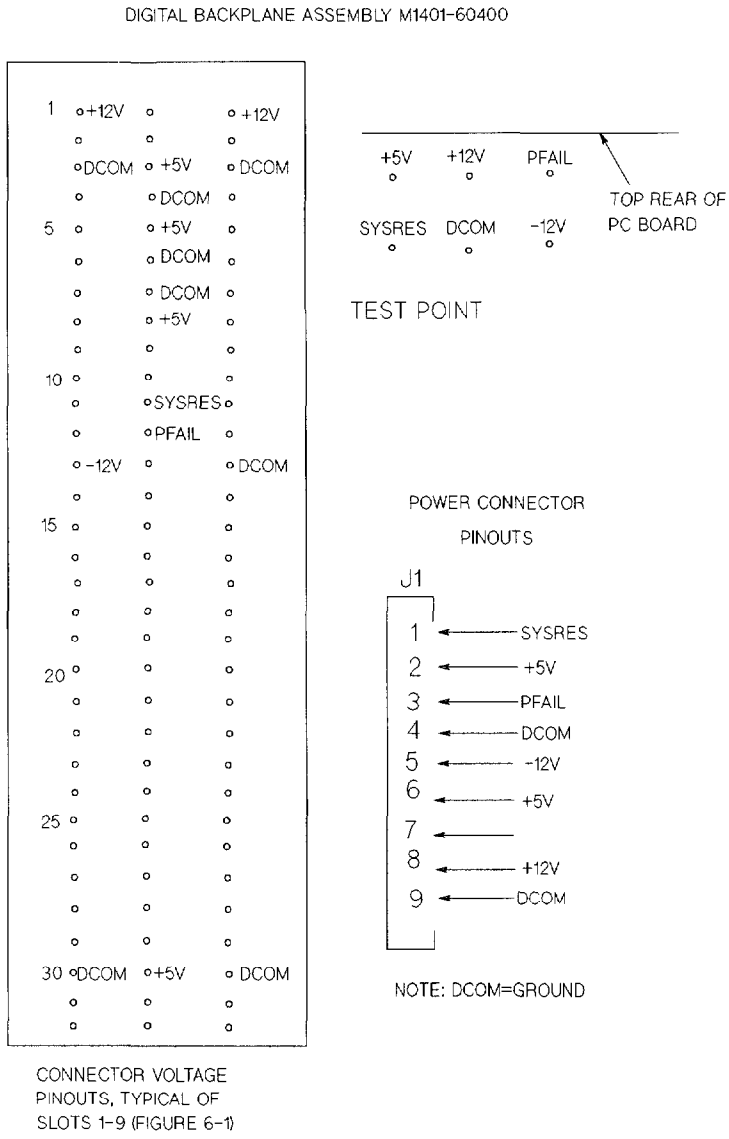


Figure 6-3. Digital Backplane Assembly M1401-60400, Connector Pinouts

A

HP M1403J DIGITAL UHF TELEMETRY SYSTEM

General

This appendix describes the maintenance of the HP M1403J Digital UHF Telemetry System. It only documents the differences between the M1403J system and the M1403A version of the Digital UHF Telemetry System. Where the systems are the same, reference is made back to the core document. For an overview of the Digital UHF Telemetry System, refer to *Chapter 1 - GENERAL INFORMATION.*

Differences Between Models

The main differences between the M1403J and the M1403A systems exist in the M1400J and the M1400A/B transmitters. The main differences between the transmitters are:

- The M1400J transmitter outputs 1 milliwatt power maximum.
- One of the analog hybrid boards has been removed from the M1400J transmitter and replaced by an ID/test board. This board was designed to meet Japanese agency testing requirements and is not used for maintenance or troubleshooting applications.
- The M1400J only uses the three-lead patient cable.

Specifications

This section lists the electrical and mechanical specifications of the M1400J Transmitter and M1402J Receiver Module only. The other components of the M1403J Digital UHF Telemetry System are identical to the specifications presented in paragraph 1.2 of the Service Manual.

Table A-1. Specifications

HP M1400J Transmitter	
RF Power Output	0 dBm (1 milliwatt) nominal.
Carrier Frequency Range	420 to 449.7 MHz (exact frequency fixed by option).
Radio Channel Spacing	25 kHz
Modulation Type	Digital, frequency-shift keying.
Power	Zinc air battery supplied with transmitter (any standard-size 9-volt battery may be used). Multi-level battery condition indication at central station: Weak battery indication: Occurs at 7.0 V, nominal. Replace battery indication: Occurs at 6.6 V, nominal.
Battery Current	4.5 mA, nominal.
Battery Types and Typical Life Expectancy	Zinc air (supplied): 8 days Lithium: 5 days Mercury: 4.5[1] Alkaline: 3 days Carbon-zinc: 1.5 days
Weak Battery Warning Time	At least one hour.
Dimensions (H x W x D)	4.65 x 2.62 x 1.09 in (118 x 67 x 28 mm).
Weight	6.9 oz (195 g), with battery.
Case Material	High-impact ABS/polycarbonate and polypropylene.
Color	Parchment White.
Operating Temperature Range	32 to 113°F (0 to 45°C).
Storage Temperature	−40 to +158°F (−40 to +70°C).
Altitude	*Operating*, up to 15,000 ft (4,570 m); *Storage*, up to 50,000 ft (15,220 m).
Defibrillator Protection	Transmitter ECG input protected against 400 joules discharge into a 50-ohm load.
Shock Resistance	Withstands a 4 ft (1.2 m) drop to vinyl-covered concrete surface with only possible cosmetic damage.

1 Mercury batteries are not recommended: Hazardous waste disposal requirements.

Table A-1. Specifications (continued)

Receiver Module HP M1402J	
Carrier Frequency Range	420 - 449.7 MHz (exact frequency fixed by option).
Impedance	50 ohms nominal.
Frequency Tuning	Crystal-controlled.
Channel RF Bandwidth Channel spacing	10 kHz. 25 kHz.
Image Rejection	–75dB
Built-in Test	Valid telemetry detected.
Operating Temperature Range	32 to 131°F (0 to 55°C).
Storage Temperature	–40 to +158°F (–40 to +70°C).
Altitude	*Operating*, up to 15,000 ft (4570 m); *Storage*, up to 50,000 ft (15,220 m).
ECG Channel Differential Input	 Defibrillator protected.
Input Impedance	Greater than 10 megohms (below 60 Hz).
Input Dynamic Range	±8 mV.
DC Offset Range	±400 mV
Common Mode Rejection Ratio	Greater than 80 dB (differential input).
Bandwidths (selectable) -3 dB nominal; -4 dB max	Monitoring: 0.5 to 40 Hz. Diagnostic: 0.05 to 100 Hz. Paced: 0.5 to 100 Hz. Exercise: 5.0 to 40 Hz. ST: 5.0 to 40 Hz.
Gain Accuracy	±5%, at 77°F (25°C).
ECG Amplification	Central-station selectable gain of 250, 500, 1000, 2000, 4000.
Noise at ECG Output	10 μV rms (40 μV peak-to-peak), referred to input, with each ECG lead connected to the same point through a 51 kilohm resistor in parallel with a .047 μF capacitor.
Calibration	1 mV pulse on central station recordings.
ECG Output	Compatible with Hewlett-Packard Serial Distribution Network (SDN) and Optional Analog Output.
Cardiotach Accuracy	±3 beats per minute, ±2% of heart rate for constant rate input. At fewer than 15 bpm, the heart rate indication is 0.
Alarm Range Adult	Central-station selectable, in 5 bpm increments. High: 20 - 250 bpm. Low: 15 - 245 bpm.
Alarm Accuracy	±1 bpm of displayed value.
Alarm Delay	4 seconds.
Displayed Cardiotach Update	1 second, nominal.
Display Range	15 - 300 bpm.

Ordering Information

HP M1403J System Options

The standard system is specified by HP M1403J and one option between A01 and A08. Each system consists of one or more transmitters with matched receiver modules and one mainframe with SDN system output. Order ECG cables separately.

A01	1 Channel System, includes 1 transmitter, 1 receiver module, and 1 mainframe.
A02	2 Channel System, includes 2 transmitters, 2 receiver modules, and 1 mainframe.
A03	3 Channel System, includes 3 transmitters, 3 receiver modules, and 1 mainframe.
A04	4 Channel System, includes 4 transmitters, 4 receiver modules, and 1 mainframe.
A05	5 Channel System, includes 5 transmitters, 5 receiver modules, and 1 mainframe.
A06	6 Channel System, includes 6 transmitters, 6 receiver modules, and 1 mainframe.
A07	7 Channel System, includes 7 transmitters, 7 receiver modules, and 1 mainframe.
A08	8 Channel System, includes 8 transmitters, 8 receiver modules, and 1 mainframe.

Separate Instrument Options

A10	Replacement transmitter
A11	Additional transmitter with receiver module, matched pair

Output Options

C01	ST Segment Analysis/Two-Channel Delayed Recording
J01	Patient Monitor/Holter Recorder Interface

ECG Cable Options

K01	Disposable pouch accessory kit
K20	3-lead patient cable with snap connector (USA)
K21	3-lead patient cable with grabber connector (USA)
K30	3-lead patient cable with snap connector (IEC)
K31	3-lead patient cable with grabber connector (IEC)

Frequency Options

Order UHF telemetry channels starting at the beginning of a block of sequential channels, for example, (12) or (11 to 19). Proceed through consecutive channel numbers unless there is a specific reason not to do so.

Note

This table lists frequencies used with the M1403J Digital UHF Telemetry system. Transmitter HP M1400J with 1 milliwatt output is the only transmitter authorized for use in Japan, regardless of frequency.

When ordering frequency options, it is important that the M1403J system be specified. This will prevent the ordering of M1403A systems by mistake. The M1403A system contains the M1400A/B transmitters which are not authorized for use in Japan.

Table A-2. System Frequency Options (JAPAN)

Option Number	Channel Frequency	Country of Use	Option Number	Channel Frequency	Country of Use
1	420.0625	JAPAN	36	420.9375	JAPAN
2	420.0875	JAPAN	37	420.9625	JAPAN
3	420.1125	JAPAN	38	420.9875	JAPAN
4	420.1375	JAPAN	39	421.0125	JAPAN
5	420.1625	JAPAN	40	424.5000	JAPAN
6	420.1875	JAPAN	41	424.5250	JAPAN
7	420.2125	JAPAN	42	424.5500	JAPAN
8	420.2375	JAPAN	43	424.5750	JAPAN
9	420.2625	JAPAN	44	424.6000	JAPAN
10	420.2875	JAPAN	45	424.6250	JAPAN
11	420.3125	JAPAN	46	424.6500	JAPAN
12	420.3375	JAPAN	47	424.6750	JAPAN
13	420.3625	JAPAN	48	424.7000	JAPAN
14	420.3875	JAPAN	49	424.7250	JAPAN
15	420.4125	JAPAN	50	424.7500	JAPAN
16	420.5375	JAPAN	51	424.7750	JAPAN
17	420.4625	JAPAN	52	424.8000	JAPAN
18	420.4875	JAPAN	53	424.8250	JAPAN
19	420.5125	JAPAN	54	424.8500	JAPAN
20	420.5375	JAPAN	55	424.8750	JAPAN
21	420.5625	JAPAN	56	424.9000	JAPAN
22	420.5875	JAPAN	57	424.9250	JAPAN
23	420.6125	JAPAN	58	424.9500	JAPAN
24	420.6375	JAPAN	59	424.9750	JAPAN
25	420.6625	JAPAN	60	425.0000	JAPAN
26	420.6875	JAPAN	61	425.0250	JAPAN
27	420.7125	JAPAN	62	425.0500	JAPAN
28	420.7375	JAPAN	63	425.0750	JAPAN
29	420.7625	JAPAN	64	425.1000	JAPAN
30	420.7875	JAPAN	65	425.1250	JAPAN
31	420.8125	JAPAN	66	425.1500	JAPAN
32	420.8375	JAPAN	67	425.1750	JAPAN
33	420.8625	JAPAN	68	425.2000	JAPAN
34	420.8875	JAPAN	69	425.2250	JAPAN
35	420.9125	JAPAN	70	425.2500	JAPAN

Table A-2. System Frequency Options (JAPAN) (continued)

Option Number	Channel Frequency	Country of Use	Option Number	Channel Frequency	Country of Use
71	425.2750	JAPAN	112	429.5875	JAPAN
72	425.3000	JAPAN	113	429.6125	JAPAN
73	425.3250	JAPAN	114	429.6375	JAPAN
74	425.3500	JAPAN	115	429.6625	JAPAN
75	425.3750	JAPAN	116	429.6875	JAPAN
76	425.4000	JAPAN	117	429.7125	JAPAN
77	425.4250	JAPAN	118	440.5750	JAPAN
78	425.4500	JAPAN	119	440.6000	JAPAN
79	425.4750	JAPAN	120	440.6250	JAPAN
80	425.5000	JAPAN	121	440.6500	JAPAN
81	425.5250	JAPAN	122	440.6750	JAPAN
82	425.5500	JAPAN	123	440.7000	JAPAN
83	425.5750	JAPAN	124	440.7250	JAPAN
84	425.6000	JAPAN	125	440.7500	JAPAN
85	425.6250	JAPAN	126	440.7750	JAPAN
86	425.6500	JAPAN	127	440.8000	JAPAN
87	425.6750	JAPAN	128	440.8250	JAPAN
88	425.7000	JAPAN	129	440.8500	JAPAN
89	425.7250	JAPAN	130	440.8750	JAPAN
90	425.7500	JAPAN	131	440.9000	JAPAN
91	425.7750	JAPAN	132	440.9250	JAPAN
92	425.8000	JAPAN	133	440.9500	JAPAN
93	425.8250	JAPAN	134	440.9750	JAPAN
94	425.8500	JAPAN	135	441.0000	JAPAN
95	425.8750	JAPAN	136	441.0250	JAPAN
96	425.9000	JAPAN	137	441.0500	JAPAN
97	425.9250	JAPAN	138	441.0750	JAPAN
98	425.9500	JAPAN	139	441.1000	JAPAN
99	429.2625	JAPAN	140	441.1250	JAPAN
100	429.2875	JAPAN	141	441.1500	JAPAN
101	429.3125	JAPAN	142	441.1750	JAPAN
102	429.3375	JAPAN	143	441.2000	JAPAN
103	429.3625	JAPAN	144	441.2250	JAPAN
104	429.3875	JAPAN	145	441.2500	JAPAN
105	429.4125	JAPAN	146	441.2750	JAPAN
106	429.4375	JAPAN	147	441.3000	JAPAN
107	429.4625	JAPAN	148	441.3250	JAPAN
108	429.4875	JAPAN	149	441.3500	JAPAN
109	429.5125	JAPAN	150	441.3750	JAPAN
110	429.5375	JAPAN	151	441.4000	JAPAN
111	429.5625	JAPAN	152	441.4250	JAPAN

Table A-2. System Frequency Options (JAPAN) (continued)

Option Number	Channel Frequency	Country of Use	Option Number	Channel Frequency	Country of Use
153	441.4500	JAPAN	194	445.4500	JAPAN
154	441.4750	JAPAN	195	445.4750	JAPAN
155	441.5000	JAPAN	196	448.6875	JAPAN
156	441.5250	JAPAN	197	448.7125	JAPAN
157	444.5250	JAPAN	198	448.7375	JAPAN
158	444.5500	JAPAN	199	448.7625	JAPAN
159	444.5750	JAPAN	200	448.7875	JAPAN
160	444.6000	JAPAN	201	448.8125	JAPAN
161	444.6250	JAPAN	202	448.8375	JAPAN
162	444.6500	JAPAN	203	448.8625	JAPAN
163	444.6750	JAPAN	204	448.8875	JAPAN
164	444.7000	JAPAN	205	448.9125	JAPAN
165	444.7250	JAPAN	206	448.9375	JAPAN
166	444.7500	JAPAN	207	448.9625	JAPAN
167	444.7750	JAPAN	208	448.9875	JAPAN
168	444.8000	JAPAN	209	449.0125	JAPAN
169	444.8250	JAPAN	210	449.0375	JAPAN
170	444.8500	JAPAN	211	449.0625	JAPAN
171	444.8750	JAPAN	212	449.0875	JAPAN
172	444.9000	JAPAN	213	449.1125	JAPAN
173	444.9250	JAPAN	214	449.1375	JAPAN
174	444.9500	JAPAN	215	449.1625	JAPAN
175	444.9750	JAPAN	216	449.1875	JAPAN
176	445.0000	JAPAN	217	449.2125	JAPAN
177	445.0250	JAPAN	218	449.2375	JAPAN
178	445.0500	JAPAN	219	449.2625	JAPAN
179	445.0750	JAPAN	220	449.2875	JAPAN
180	445.1000	JAPAN	221	449.3125	JAPAN
181	445.1250	JAPAN	222	449.3375	JAPAN
182	445.1500	JAPAN	223	449.3625	JAPAN
183	445.1750	JAPAN	224	449.3875	JAPAN
184	445.2000	JAPAN	225	449.4125	JAPAN
185	445.2250	JAPAN	226	449.4375	JAPAN
186	445.2500	JAPAN	227	449.4625	JAPAN
187	445.2750	JAPAN	228	449.4875	JAPAN
188	445.3000	JAPAN	229	449.5125	JAPAN
189	445.3250	JAPAN	230	449.5375	JAPAN
190	445.3500	JAPAN	231	449.5625	JAPAN
191	445.3750	JAPAN	232	449.5875	JAPAN
192	445.4000	JAPAN	233	449.6125	JAPAN
193	445.4250	JAPAN	234	449.6375	JAPAN

Theory of Operation

This section provides the operational theory of the HP M1403J Digital UHF Telemetry System. With the exception of the transmitters, the system operates indentically as the HP M1403A system. This chapter only presents the operational differences between the M1400A/B and the M1400J transmitters.

Overall Functional Description

Refer to Chapter 2 of the service manual for an overall functional description of the system.

ECG Monitoring Capabilities

Refer to Chapter 2 of the service manual for the ECG Monitoring Capabilites of the system.

Note

Since there is only a single lead of ECG, fallback and extended monitoring modes do not apply to the M1403J system. Therefore, section 2.1.3 of the service manual does not apply.

HP M1400J Transmitter

The HP M1400J Transmitter is a battery powered (9-volt) transmitter worn by the patient. It acquires the ECG data of the patient via the 3-leadset, amplifies and digitizes the data, and broadcasts the digital data at UHF to the receiver module in a receiver mainframe.

The transmitter transmits one ECG channel.

The transmitter consists of three subassemblies:

- electrode lead set
- RF module
- transmitter motherboard assembly

Figure A-1 shows a block diagram of the M1400J transmitter.

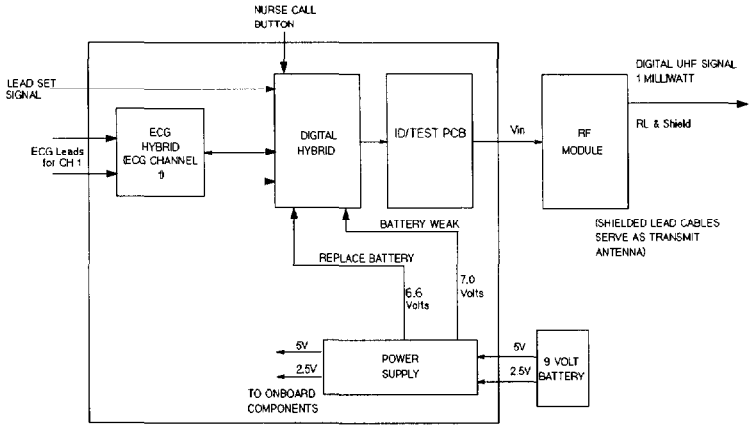


Figure A-1. Block Diagram of HP M1400J Transmitter

Electrode Lead Set

The electrode leadset provides connection from the inputs of the transmitter to the electrodes on the body of the patient. The system only supports the three-electrode lead set.

The three-electrode lead set, whose label is also configured at installation for each receiver mainframe, sources one ECG lead on ECG A. ECG B must be turned off at the central station by the user when the three-electrode lead set is used. Failure to do so results in a lead INOP. The three-electrode lead set connects to the reference pin and only ECG Channel 1 on the transmitter. The leadset detect pin is open circuited.

RF Module

The RF module is a voltage-controlled crystal oscillator (VCXO) operating at ultra-high frequency. It has a crystal frequency of one-quarter of the broadcast frequency. The crystal's fourth harmonic is selected and amplified twice. The digital bit stream from the digital hybrid is used to modulate the carrier frequency. The first section lists the actual broadcast

specifications of the RF module. The shielded cable of the electrode lead set serves as the broadcast antenna for the transmitter.

Transmitter Motherboard Assembly

The transmitter motherboard assembly contains the entire electronics assembly for the transmitter. It is built to withstand pulses up to 4000V between any combination of inputs. This prevents a discharge path for defibrillation pulses. To shield the transmitter circuits as much as possible, all signal foils are run on the inner layers. The transmitter motherboard is comprised of the motherboard itself, one ECG hybrid PCB, one ID/test PCB, a digital hybrid PCB, and a power supply hybrid PCB.

ECG Hybrid PCB. The ECG hybrid PCB provides the basic measurement circuitry of the transmitter. It performs the following functions:

- Acquisition and preamplification of ECG signal
- Bandpass filtering
- Analog-to-Digital conversion of the ECG signal
- Leads off detection circuit
- Pace pulse detection circuit

For a detailed description of the circuits on the ECG hybrid PCB, refer to Chapter 2 of the service manual.

Digital Hybrid PCB. The digital hybrid PCB contains the digital control and formatting circuits of the transmitter. It also contains an oscillator for baseband frequency control. The digital hybrid PCB performs the following functions:

- Provides buffering and processing for the patient call button, leadset detect pin, battery weak and replace battery signals, and unique transmitter ID code.
- Compresses and encodes the digital output of the A/D converter into a serial digital bit stream for transmission.
- Provides processing for analog detection circuits on the ECG hybrid PCB.
- Provides timing signals for all digital operations of the transmitter.

The transmitter houses one digital hybrid PCB which handles the ECG channel. For a detailed description of the circuits on the digital hybrid PCB, refer to Chapter 2 of the service manual.

Test/ID PCB. The test/ID PCB generates a unique ID code sequence when power is applied to the transmitter (battery insertion). The ID code provides positive identification of the transmitter so that it can be tracked as an aid to identifying interference sources.

The test/ID PCB also routes power to the RF module of the transmitter.

An additional function of the PCB is to provide waveforms required for regulatory testing. This function does not pertain to operation or any maintenance aspects of the transmitter.

Power Supply Hybrid PCB. The power supply provides regulated 5V and 2.5V from the 9V battery, and monitors battery condition. The power supply provides battery weak notification when the 9-volt battery reaches a voltage level of 7.0 volts. This signals the transmitter has less than an hour of monitoring time available. The power supply also provides replace battery notification when the battery voltage reaches 6.6 volts. The transmitter is inoperative until the battery is replaced.

Transmitter Signal. For a detailed description of the transmitter signal, refer to Chapter 2 of the service manual.

HP M1402J Receiver Module

For a detailed description of the Receiver Module, refer to Chapter 2 of the service manual.

HP M1401A Receiver Mainframe

For a detailed description of the Receiver Mainframe, refer to Chapter 2 of the service manual.

Dynamic UHF Antenna System

For a detailed description of the antenna system, refer to Chapter 2 of the service manual.

Maintenance and Troubleshooting

For maintenance and troubleshooting of the M1403J system, refer to the applicable chapters of the service manual.

Replaceable Parts

This section contains information for ordering replaceable parts and assemblies for the HP M1403J Digital UHF Telemetry System. With the exception M1400J Transmitter and the M1402J Receiver Module, the information and part numbers contained in Chapter 6 of the service manual can be used to order new parts, and can also be used in conjunction with the exchange program.

Table A-3 lists the products for the M1403J system.

Table A-4 lists the replaceable parts for the M1402J Receiver Module. Refer to Chapter 6 of the service manual for a list of the receiver module exchange parts.

Table A-5 lists the replaceable parts for the M1400J Transmitter. There are no exchange parts for the transmitter.

Table A-3. Products

Description	Product Number
Transmitter	HP M1400J
Receiver Module	HP M1402J
Receiver Mainframe	HP M1401A
Active Antenna/Combiner	HP M1408A
Line Amplifier	HP M1406A
Multiple Unit Power Supply	HP M1407A

Table A-4. Receiver Module Replaceable Parts (M1402J)

Description	New Part No.	Reference Designator
Receiver VCXO Module	M1402-63opt; (opt=option no.)	3 (module)
Receiver Microcontroller	1821-0315	7 (module)
Screw, mounting	0515-1452	
Receiver shield	M1402-60540	2 + 6 (module)
Gasket - Short	M1402-01900	4 (module)
Gasket - Circular	M1402-01800	5 (module)

Table A-5. Transmitter Replaceable Parts (HP M1400J)

Description	New Part No.
Transmitter Motherboard Assembly	M1400-67100
Transmitter VCXO Module—1 mw	M1400-63opt; (opt=option no.)
Transmitter Case Assembly	M1400-67000
Transmitter Top Cover Assembly	M1400-67010
Transmitter Bottom Cover Assembly: M1400J IEC	M1400-67090
Battery Contacts	M1400-60060
Battery Spring	M1400-60012
Labels - channel 001 - channel 049	M1400-83020
Labels - channel 001 - channel 014	M1400-83011
Labels - channel 015 - channel 028	M1400-83012
Labels - channel 029 - channel 042	M1400-83013
Labels - channel 043 - channel 070	M1400-83014
Labels - channel 071 - channel 098	M1400-83016
Labels - channel 099 - channel 196	M1400-83017
Labels - channel 197 - channel 234	M1400-83018
Water Soluble Lotion	9310-6344

B

HP Viridia Digital Transmitter Detailed Functional Description

Objectives

Upon successful completion of this section you will be able to do the following:

1. Describe the purpose and function of the HP Viridia Digital Transmitter.
2. Describe the operation of the transmitter to the block diagram level. You will be able to list and describe each of the functional areas of the transmitter.
3. List the battery requirements and explain any limitations on the use of the batteries.
4. List the leadsets that can be used with the transmitter and describe their effect on telemetry ECG monitoring.

Concepts

The following explains some of the concepts contained in this section:

Leads - A specific electrode or array of electrodes used to record changes in electrical potential created by the activity of the heart. The transmitter uses standard electrode placement to monitor the following leads: I, II, III, aVR, aVL, aVF, MCL, and V.

Pace Pulse - On an ECG waveform, the marks indicating the starting of cardiac depolarization and contraction generated by an artificial pacemaker. The pace pulse is an indication of when the pacemaker fired.

Cardiotach - The measurement of the heart rate.

Digital Transmitter

The digital transmitter is a battery powered (9-volt) transmitter worn by the patient. It acquires the ECG and SpO_2 data of the patient via the ECG leadset and transducer, amplifies and digitizes the data, and broadcasts the digital data at UHF to the receiver module in a receiver mainframe. SpO_2 processing occurs in the transmitter. ECG processing takes place in the receiver mainframe, or at the bedside (analog output).

The patient can be connected to a three-wire or five-wire leadset. With the three-wire leadset, only one lead is transmitted (lead II is the default) and leads I, II, or III can be selected.

When the five-wire leadset is used, the transmitter transmits three leads. From these three leads the following seven derived leads can be viewed and two can be selected (one primary, one secondary for monitoring purposes at the central station) I, II, III, aVR, aVL, aVF, MCL, and V.

When SpO_2 is monitored, the data is received via a transducer, processed by a dedicated SpO_2 circuit within the transmitter, and sent as part of the broadcast as part of the data packet.

The transmitter consists of four functional areas:

- electrode lead set
- SpO_2 transducer
- case assembly
- main PCB, which contains the following subsections
  a. analog section comprising the ECG front end circuitry
  b. digital section
  c. RF section, including the synthesizer
  d. power supply
- SpO_2 circuitry

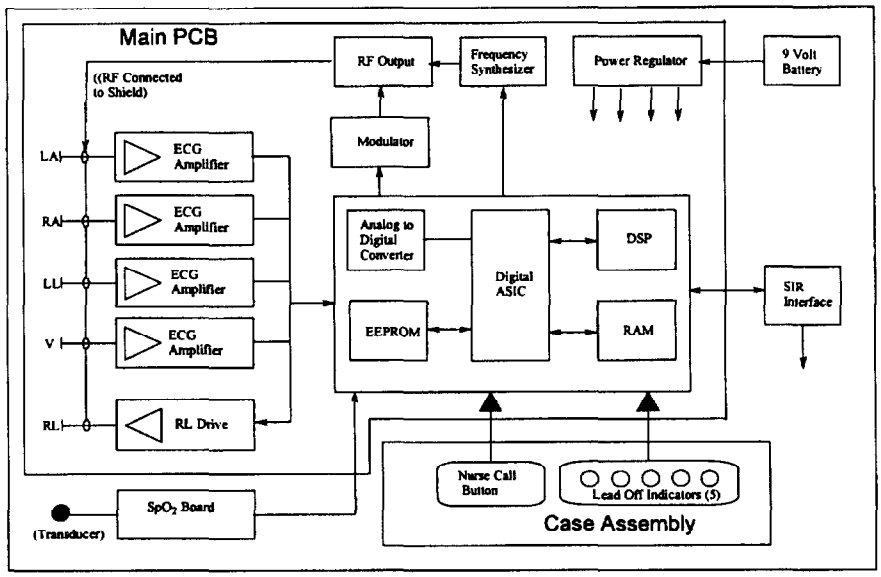


Figure B-1. Block Diagram of HP Viridia Digital Transmitter

Electrode Lead Set

The electrode lead set provides connection from the inputs of the transmitter to the electrodes on the body of the patient. Each lead has its own front end circuitry in the transmitter that routes the signal from each lead to the processing circuits of the transmitter. The transmitter sources an active lead for each connection. Each signal is then combined to generate the transmitted leads.

The system supports two lead set configurations: three-electrode and five-electrode.

Three-Electrode Leadset

The three-electrode leadset broadcasts one lead (lead II is the default) of ECG for display at the Central Station. The selection of leads for display using the three electrode leadset are driven by whether the **lead select** function is enabled or disabled in the transmitter.

Lead Select Enabled - With lead select enabled, the cardiotach lead which is broadcast can be selected using the Wave Viewer tool. In this mode, the broadcast cardiotach lead can be selected from Leads I, II, or III. The lead label is automatically changed at the Central Station when the lead is changed.

Lead Select Disabled - When lead select is disabled, the broadcast cardiotach lead is set at Lead II. The only way you can change this is by changing the electrode placement on the patient to non-standard configuration. When doing this, you place the leads that normally monitor lead II over the limb lead you which to monitor. This means you can monitor Leads I, II or MCL as your cardiotach lead. When you do this, you have to change the lead label at the Central Station to the lead which you are broadcasting.

Five-Electrode Leadset

With the five-electrode leadset, three leads are broadcast: II, III, and MCL. From these three leads, the software in the receiver mainframe can reconstruct the remaining five leads: I, aVR, aVL, aVF, and a true V lead. You can select which leads you want to view at the Central Station.

Case Assembly

The case assembly provides protection to the internal electronics of the transmitter. It also contains the nurse call button and the leads off LEDs.

Nurse Call Button

The nurse call button is a membrane switch that toggles a bit in the transmitted message to ON when the switch is pressed. Electrically, the nurse call button has two positions:

Off (not pressed)

On (pressed)

The Nurse Call button can be configured in the receiver mainframe to do the following when it is pressed:

1. Generate a yellow level nurse call alarm at the Central Station.
2. Generate a recording at the Central Station
3. Generate both a nurse call alarm and a recording at the Central Station.
4. Do nothing.

Once the alarm or recording has been started, it can only be stopped at the Central Station. Pressing the button on the transmitter again does not effect the alarm or the recording.

Leads Off LEDs

The leads off LEDs extinguish whenever one of the leads fall off of the patient, or if the circuitry for that lead is defective. There is one LED for each lead, and they are shown in the diagram on the transmitter in the standard lead placement.

Main PCB

The Main PCB contains the ECG signal acquisition and processing circuits, and the main processing and signal transmitting circuits for the transmitter. The Main PCB can be broken down into four functional areas:

- Analog Section
- Digital Section
- RF Section
- Power Supply

ECG Analog Section

The ECG analog section of the transmitter comprises the ECG front end circuitry. It consists of an analog to digital converter for each of the five input electrodes [V-lead, right arm (RA), left leg (LL), left arm (LA) and the reference (RL)]. The output circuit of the right leg drive (RLD) sums the outputs of the four other electrode inputs to generate one output that is used for improving the common mode rejection performance. The RLD output can be switched to drive any of the four input electrodes.

The ECG front end circuitry for each input electrode performs the following functions:

- Acquisition and preamplification of ECG signal
- Bandpass filtering and conditioning of the signal
- Initial analog to digital conversion of the ECG signal

Each analog to digital converter consists of the following subcircuits:

- input buffer amplifier
- low frequency summing amplifier
- integrating analog to digital converter

The signal acquisition circuits acquire physiological signals from the patient, provide basic preamplification of the signals, filter the signals, and convert the signals from analog to digital form.

The circuitry for each electrode is the same. Resistors of the input buffer amplifier provide input protection for the front end Is. An operational amplifier sets the noise performance of the incoming ECG signal by filtering out unwanted noise on the input leads. A low frequency feedback summation amplifier provides preamplification and further conditioning of the incoming ECG signal. The final stage of the analog section is a pulse width modulated A/D converter. This is the first stage of the analog to digital conversion of the ECG signal. The second stage takes place in the digital section.

Transmitter Digital Section

The digital section of the transmitter consists of a gate array, digital signal processor (DSP), and memory. The gate array provides interfaces to the DSP from the following circuits:

- ECG front end
- 3/5 wire leadset switch
- nurse call button
- leads off LEDs
- Control lines for the frequency synthesizer
- SpO_2 circuits
- Serial infrared (IR) port to Wave Viewer
- RF output circuit
- Power Supply control
- Memory Section

The gate array consists of latches and logic control gates which control the flow of information to the DSP. The DSP then processes the signal from each interface and includes it into the transmitted message. The following paragraphs describe the each interface controlled by the gate array and processed by the DSP.

ECG Front End Interface

The gate array receives the output for each of the four input electrodes and routes the signal to the DSP for the following:

- Final analog to digital conversion of each lead signal.
- Checks for Leads -Off conditions
- Processing of the leads to be transmitted
- Pace pulse detection and processing

Lead Sense Circuit

The transmitter senses whether a three-wire or five-wire leadset is being used. The transmitter has two pressure sensitive switches that change from a high impedance to a low impedance when the pressure of the RL or V lead wire is inserted into the connector.

Note

When you replace the patient leadsets, it is very important that you connect them properly. Incorrect connection can cause the transmitter to detect the wrong leadset or no leadset as being used.

Nurse Call Button

The Nurse Call Button on the Case Assembly has a direct connection to the Digital Section of the Main PCB. Refer to the previous section or the User's Guide for your central station for more information on the nurse call button.

Leads Off LEDs

When the leads are properly connected to the patient, the LEDs on the transmitter case assembly are illuminated corresponding to the color of the lead in a standard placement. When the Digital Section of the Main PCB senses a lead off condition, it extinguishes the appropriate LED on the Case Assembly via a direct line.

Serial Infrared Port

The transmitter communicates to the Wave Viewer using the serial infrared port (SIR). This port connects to the DSP via a three wire UART.

Power Supply Control

The transmitter monitors the operation of the power supply and controls its operation as appropriate. The digital section of the transmitter performs the following controlling functions for the power supply:

- **Battery type sensing** - The transmitter works with all 8.4- and 9-volt batteries (alkaline, zinc-air, carbon zinc, and lithium) except when SpO_2 is being used. When you are using SpO_2, you cannot use zinc-air batteries. If a zinc-air battery is used with SpO_2, a "Wrong Battery Type" INOP is sent to the Central Station, and the SpO_2 circuit is shut down. ECG continues to function normally.
- **Low Voltage and Replace Battery Circuit** - If the battery voltage falls below 6.6 volts, a low battery signal is generated and transmitted to the central station as an inop. If the voltage falls below 5.9 volts, the dead battery signal is generated and sent to the central station as an inop.

Memory Section

A serial EEPROM stores the program for the DSP. The program is loaded at power up using a small set of instructions contained within the ASIC. The DSP runs the program out of internal DSP RAM. The EEPROM stores several variables so that configuration information is kept when the battery is removed. The external RAM is used as a communication buffer area.

Power Supply

The power supply provides all of the voltages for use by the transmitter. It consists of two linear low dropout regulators of three and five volts. This provides the 5V and 2.5V needed for the operation of the transmitter. Power to the regulators is derived from an 8.4- or 9-volt battery. To protect against battery reversal, power for the battery is delivered to a pair of back to back MOSFETs. Comparators sense and warn of low and replace battery conditions via the power supply control circuitry of the digital section. The replace battery indication is sent to the DSP to control shutdown so that the necessary housekeeping and replace battery message may be transmitted prior to shutdown.

RF Section

The RF section is a programmable frequency synthesized local oscillator operating at ultra-high frequency. A temperature compensated crystal oscillator provides the reference frequency. The digital bit stream from the DSP is used to modulate the carrier frequency. This data is applied to the synthesizer voltage controlled oscillator (VCO). The VCO output drives a common-emitter bipolar transistor output stage. The Output stage filter provides spurious filtering and transforms the 50 Ohm nominal impedance of the antenna circuit to present the optimum impedance to the output stage collector for high efficiency. The shielded cable of the electrode lead set serves as the broadcast antenna for the transmitter.

SpO_2 Module

The SpO_2 module of the transmitter consists of the SpO_2 board and the SpO_2 transducer which attaches to the patient's finger. The measurement is based on the phenomena that oxygenated blood has different absorption in red and infrared light wavelengths, related to the oxygenation of the blood.

The red and infrared LEDs in the SpO_2 sensor emit light which is detected by the photo diode after passing through the patient's skin. The received signal is analog and digitally processed. The result of this signal processing is a pulsatile raw wave for the red and infrared absorption. The algorithm in the Main CPU on the SpO_2 board calculates the SpO_2, pulse rate, and perfusion value in numeric representation for the given raw wave.

The red and infrared LED signals are 90° out of phase. At the receiving photo diode, the sum of both signals is analog processed and digitally demodulated. This method, based on the theory of quadrature modulation produces signals that are highly resistant to disturbance noise (ambient light) and consumes less power than other methods.

Detailed SpO_2 Circuit Description

The transducer routes the input current from the photodiode to the photo amplifier on the SpO_2 board. The photo amplifier performs the following functions:

- Converts the input currents to output voltages
- First order, low bandpass filters the input signals to eliminate incoming disturbances of higher frequencies

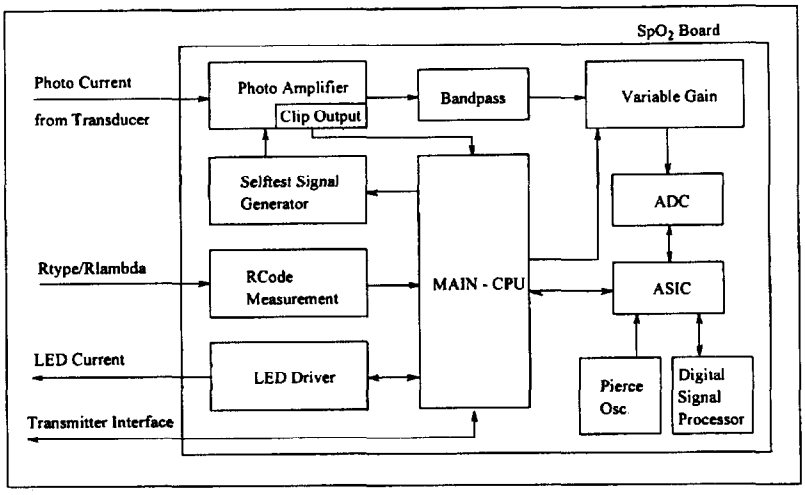


Figure B-2. SpO_2 Board Block Diagram

The photo amplifier is implemented as a differential amplifier to provide balanced input characteristics and to suppress incoming disturbances.

A clipping detection circuit is connected to the output of the photo amplifier, and serves as a controlling stage for the photo amplifier. By using a comparator connected as an inverting Schmitt Trigger, clipping of the photo amplifier signal caused by ambient light (for example) is detected. The output of this stage is connected to the front end controlling firmware of the Main CPU to generate an INOP alarm in case of excessive clipping. The comparator circuitry contains a hysteresis loop to avoid jittering of the output signal.

The modulated signals coming from the photo amplifier pass through a third order Butterworth bandpass filter. This serves as an antialiasing filter and filters out all disturbance frequencies outside a passband centered on the modulation frequency. The variable gain amplifier amplifies the signal form the bandpass filter and routes the signal to the analog to digital converter (ADC). The output of the ADC is sent to the digital ASIC.

ASIC

The digital ASIC works as an interface between the DSP and the main processing CPU. In addition, the digital ASIC acts as an interface to the ADC and contains all frequency generators for the ADC clock, the sampling frequency, and the modulation frequency and the necessary glue logic.

Digital Signal Processor (DSP)

The DSP communicates via the digital ASIC with the ADC and main processing CPU. It demodulates and filters the incoming ADC signals and transmits the output signals to the main processing CPU.

Main Processing CPU

The main processing CPU performs the processing for the SpO_2 signals. It communicates via the digital ASIC with the DSP and contains the front end controlling firmware for the LED driver circuit, the RCode measurement circuit, the variable gain stage, the clipping detection, the power supply, and the self-test circuit. The main processing CPU also provides communication interface to the transmitter controller.

LED Driver

The LED driver circuit generates the LED current using two transistor current sources receiving a constant voltage input from the power supply. A bridge consisting of four transistors allows the LED current to be switched alternatively for individually driving the red and infrared LEDs of the sensor. To enable the different driving times of the LEDs, the main processing CPU controls the transistors in the bridge.

Self-Test Circuit

The self-test signal circuit performs a self-test of the SpO_2 measurement device before patient signal processing begins. The main processing CPU produces a pulse-width modulated signal which is analog low pass filtered to a sine wave and converted to a photo current signal. During self-test, the connections of the photoamplifier to the photodiode of the sensor are interrupted by switches and the self-test signal is fed into the input of the photoamplifier.

RCode Measurement Circuit

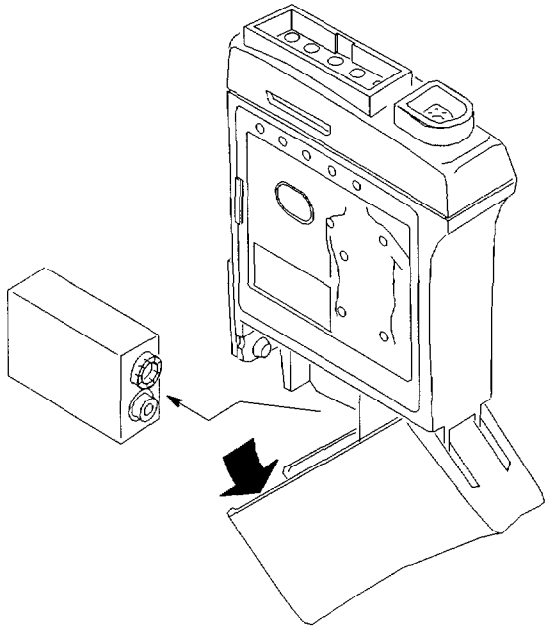
The RCode measurement circuit identifies which sensor is being used by measuring coding resistors. The main processing CPU reads the measurement through a reference resistor and an amplifier stage.

Disassembling the Transmitter

The Transmitter should be returned to the factory for replacement if the transmitter is faulty. In the factory, the transmitter is assembled using an adhesive (RTV) that makes the transmitter water-tight, that is, during normal use, water cannot get into the internal electronics compartment of the transmitter. The water-tight effectiveness of the transmitter can only be tested under factory settings. If you disassemble the transmitter, the adhesive seal will be broken and the transmitter will no longer be water-tight. Do not attempt to test the water-tight seal of the transmitter if you disassemble it. **HP recommends returning faulty transmitters to the factory for replacement.**

All water-tight claims are voided if you disassemble the transmitter.

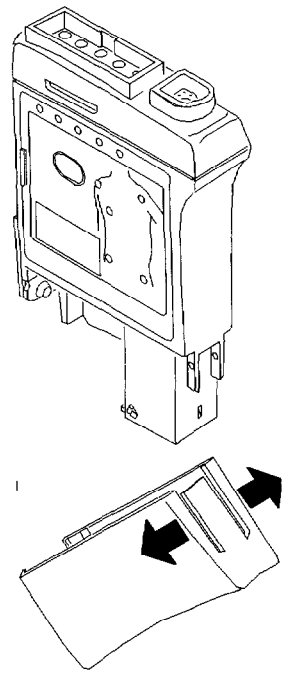
To Remove the Battery



To remove the battery for replacement or further disassembly, you simply swing the battery door down and pull the battery out.

To Replace the Battery

With the battery door in the down (open) position, align the terminals of the battery correctly with the battery contacts and snap the battery into place. Close the battery door.



To Remove the Battery Door (M2601-40013)

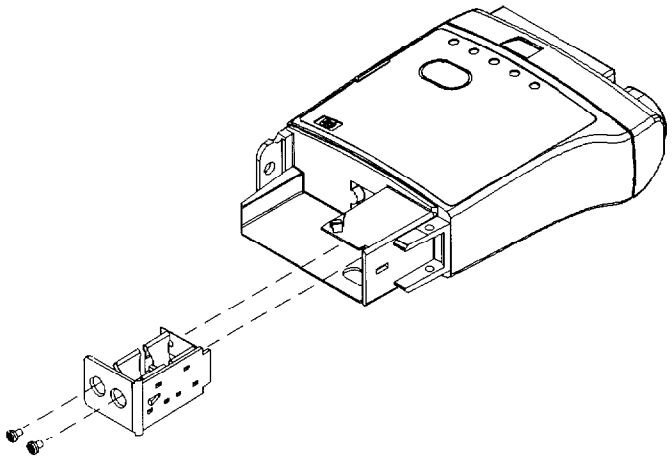
Step 1. Remove the battery.

Step 2. Pry one side of the battery door (M2601-40013) until the retaining pin is clear of its hole. The battery door now unclips from the transmitter case assembly.

To Replace the Battery Door

Step 1. Place one of retaining pins into its retaining hole. Gently pull the other side of the battery door until the other retaining pin can be paced into its retaining hole, and snap the battery door into place.

Step 2. Re-install the battery and close the battery door.

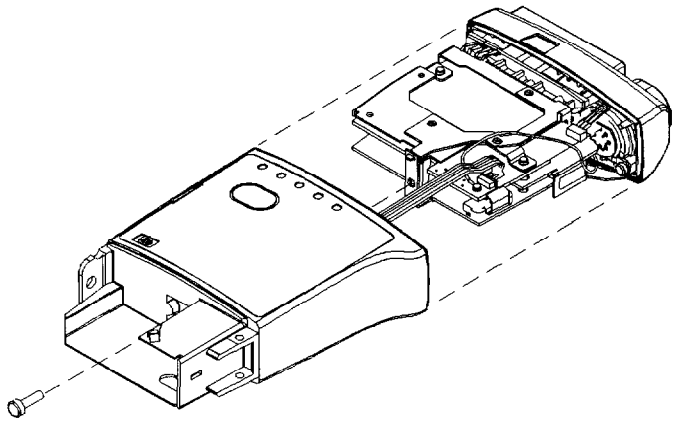


To Remove the Battery Contact Assembly (M2601-60008)

Step 1. Remove the battery.
Step 2. Remove the battery door.
Step 3. Remove the two screws securing the battery contact assembly (M2601-60008) to the Transmitter Case assembly.
Step 4. Push in on the retaining tab and slide the battery contact assembly from the bottom of the transmitter case assembly.

To Replace the Battery Contact Assembly

Step 1. Slide the battery contact into the bottom of the transmitter case assembly until the retaining tab snaps into place.
Step 2. Using a magnetic crosstip screwdriver, secure the battery contact assembly to the transmitter case assembly using two screws.
Step 3. Re-install the battery door.
Step 4. Re-install the battery.



To Remove the Transmitter Case Assembly (M2601-60400)

Step 1. Remove the battery.

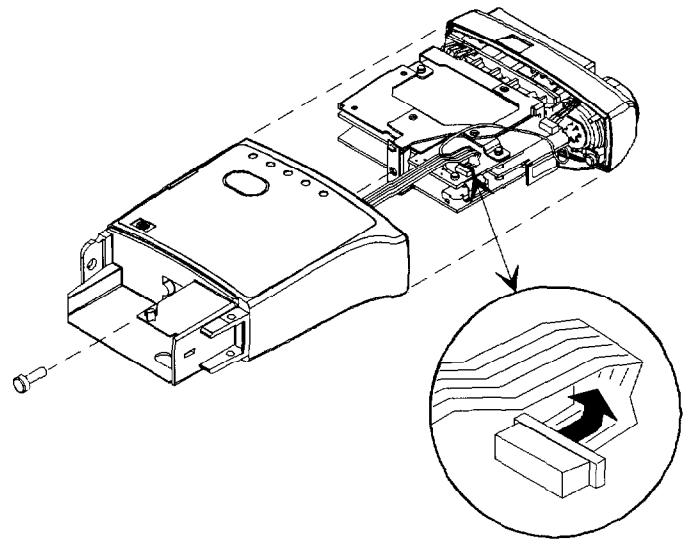
Step 2. Remove the battery door assembly.

Step 3. Remove the screw securing the transmitter case assembly to the transmitter's internal electronics.

Caution

When performing step 4, pull the connector assembly from the transmitter slowly and gently. DO NOT pull the two pieces apart quickly and forcefully. There is a ribbon cable that connects the front panel of the case assembly to the digital board that can break if the two pieces are not treated carefully.

Step 4. From the top of the transmitter, pull the transmitter's top assembly until the ribbon cable from the digital board to the transmitter's front panel is accessible.



Step 5. The ribbon cable connector is a collar connector. Slide the collar forward, then hinge the collar upward to remove the ribbon cable from the connector.

Step 6. The transmitter case assembly can be separated from the transmitter's internal electronics assembly.

To Replace the Transmitter Case Assembly

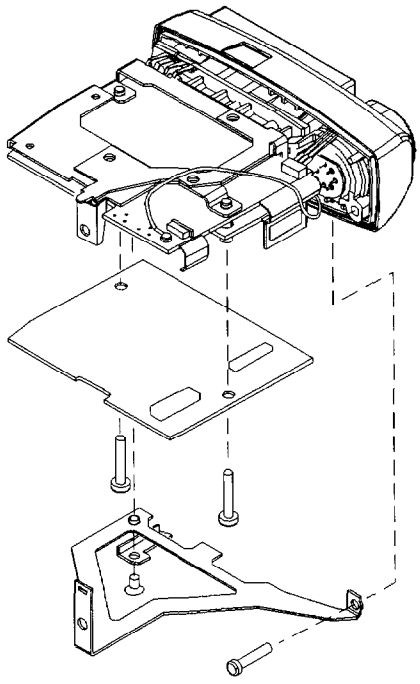
Step 1. Place the ribbon cable from the transmitter's front panel assembly into the collar connector on the transmitter's main board. Hinge the collar downward, then back to secure the ribbon cable in place.

Step 2. Slide the transmitter case assembly over the internal electronics until it butts up against the transmitter top assembly.

Step 3. Secure the transmitter case assembly in place using one screw. Use a torque wrench and set the torque of this screw to 6 inch-pounds.

Step 4. Re-install the battery door assembly.

Step 5. Re-install the battery.

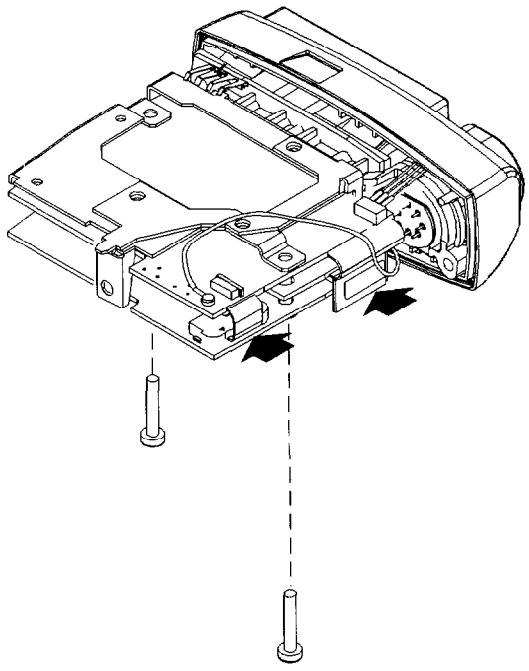


To Remove the Main Cage Brace

Step 1. Remove the battery.
Step 2. Remove the battery door assembly.
Step 3. Remove the transmitter case assembly.
Step 4. Remove two screws to remove the main cage brace from the transmitter's electronics assembly.

To Replace the Main Cage Brace

Step 1. Align the retaining bracket with its mounting holes and secure it in place using two screws. Use a torque wrench and set the torque of these screws to 2 inch-pounds.
Step 2. Re-install the transmitter case assembly.
Step 3. Re-install the battery door.
Step 4. Re-install the battery.

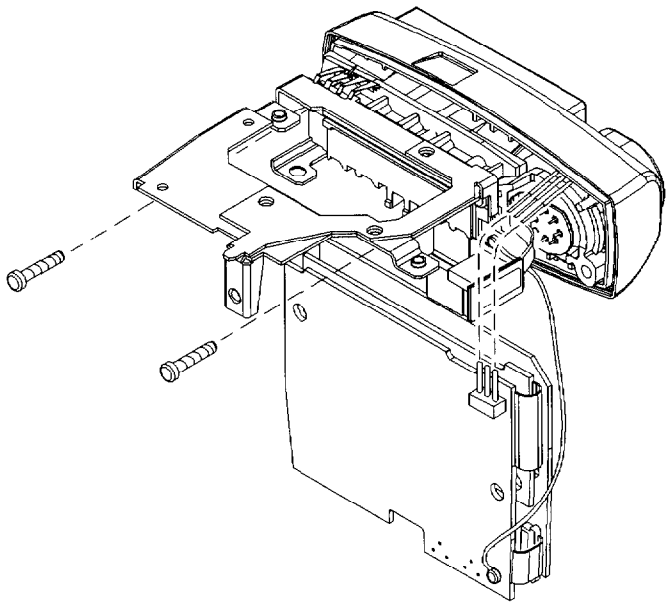


To Remove the SpO_2 Board Assembly

Step 1. Remove the battery.
Step 2. Remove the battery door assembly.
Step 3. Remove the battery contact assembly.
Step 4. Remove the transmitter case assembly.
Step 5. Remove the retaining bracket.
Step 6. Remove the two screws securing the SpO_2 board to the main board.
Step 7. Disconnect the SpO_2 connector cable from the side of the SpO_2 board.
Step 8. The next cable is connected to the SpO_2 board by a clamp connector. Slide the collar back, then hinge it up to release the ribbon cable from the SpO_2 board.
Step 9. SpO_2 board is now free from the transmitter's internal electronics assembly.

To Replace the SpO_2 Assembly

Step 1. Connect the cable to the SpO_2 board by placing the cable into the clamp connector, hinging the collar downward and forward.
Step 2. Connect the SpO_2 connector cable to the side of the SpO_2 board.
Step 3. Secure the SpO_2 board to the main board using two screws. Use a torque wrench and set the torque of these screws to 2 inch-pounds.
Step 4. Re-install the retaining bracket.
Step 5. Re-install the transmitter case assembly.
Step 6. Re-install the battery contact assembly.
Step 7. Re-install the battery door assembly.
Step 8. Re-install the battery.



To Remove the Transmitter Main Board

Step 1. Remove the battery.
Step 2. Remove the battery door assembly.
Step 3. Remove the transmitter case assembly.
Step 4. Remove the Main Cage Brace.
Step 5. Remove the SpO_2 Board.
Step 6. Grab the 3/5 lead switch connector gently with needlenose pliers for support and gently disconnect the connector assembly from the main board.
Step 7. Disconnect the blue RF cable from the transmitter main board assembly.
Step 8. Remove the two screws securing the main board to the transmitter top assembly.

To Replace the Transmitter Main Board

Step 1. Secure the main board to the transmitter top assembly using two screws. Use a torque wrench and set the torque of these screws to 2 inch-pounds.

Step 2. Connect the blue RF cable to the main board. You may need to use the flat side of a flathead screwdriver to push the connector down all the way.

Step 3. Grab the 3/5 lead switch connector gently with needlenose pliers for support and gently insert the plug on the main board into its connector.

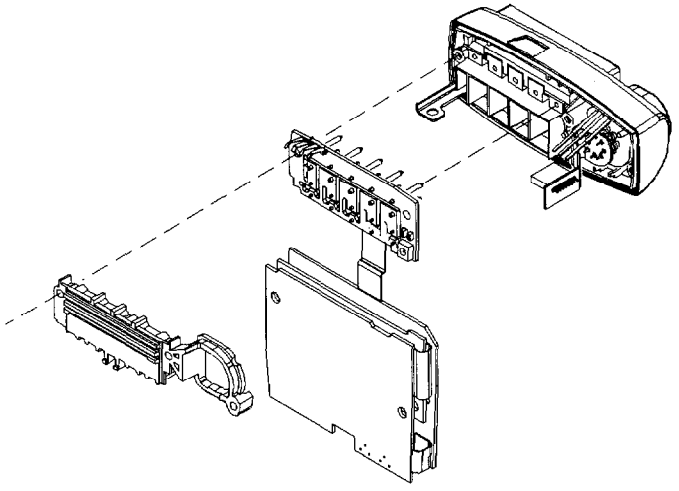
Step 4. Re-install the SpO_2 board.

Step 5. Re-install the Main Cage Brace.

Step 6. Re-install the transmitter case assembly.

Step 7. Re-install the battery door assembly.

Step 8. Re-install the battery.



Step 9. Pull the gray plastic support brace from the top assembly.

Step 10. Remove the main board from the transmitter top assembly.

Ordering Parts for the HP Viridia Digital Transmitter

This section gives you the part numbers for the subassemblies of the transmitter.

A Note on Ordering Parts for the Transmitter

The HP Viridia Digital Transmitter should be returned to the factory for replacement if the transmitter is faulty. In the factory, the transmitter is assembled using an adhesive (RTV) that makes the transmitter water-tight, that is, during normal use, water cannot get into the internal electronics compartment of the transmitter. The water-tight effectiveness of the transmitter can only be tested under factory settings. If you disassemble the transmitter, the adhesive seal will be broken and the transmitter will no longer be water-tight. Do not attempt to test the water-tight seal of the transmitter if you disassemble it. **HP recommends returning faulty transmitters to the factory for replacement.**

All water-tight claims are voided if you disassemble the transmitter.

In any troubleshooting module that isolates faults in the transmitter to the lower subassembly level, you can replace the transmitter once you have isolated the fault to the transmitter. Subassembly part information is provided to support you if you decide you want to replace parts inside of the transmitter.

Refer to the exploded view for part identification. The column "Ref. Des." corresponds to the reference designator on the figure.

Table B-1. Digital Transmitter Exchange and New Assemblies

Ref. Des.	Description	Exchange Part No.	New Part No.
N/A	Exchange Transmitter (ECG/SpO_2)	M2601-68507	N/A
N/A	Exchange Transmitter (ECG only)	M2601-68207	N/A
1	Battery Door		M2601-40004
2	Battery Contact Assembly		M2601-60008
Not Shown	Battery Contact Screw (stainless steel)		0515-2759
3	Transmitter Case Assembly (AAMI)		M2601-60400
3	Transmitter Case Assembly (IEC)		M2601-60401
4	Top Cage Brace		M2601-00601
5	Main PCB Assembly		M2601-60070
6	SpO_2 Board Assembly		M2601-66000
6*	Blank Plastic Board (If SpO_2 is not installed in transmitter)		M2601-40024
7	SpO_2 Connector		M2601-60006
8	SpO_2 Gasket		M2601-40011
Not Shown	SpO_2 Connector Plug		M2601-40013
9	Transmitter End Housing		M2601-40001
10	O-ring		M2601-40008
11	3/5 Leadset Detect Switch		M2601-60004
12	Wedge		M2601-40009
13	Support Brace		M2601-40005
14	Bottom Cage Brace		M2601-00604
15	Main case screw		5966-5017
Not Shown	RF Cable (blue)		8120-6790
Not Shown	SpO_2 Connector Plug (for units that are ECG only)		M2601-40013

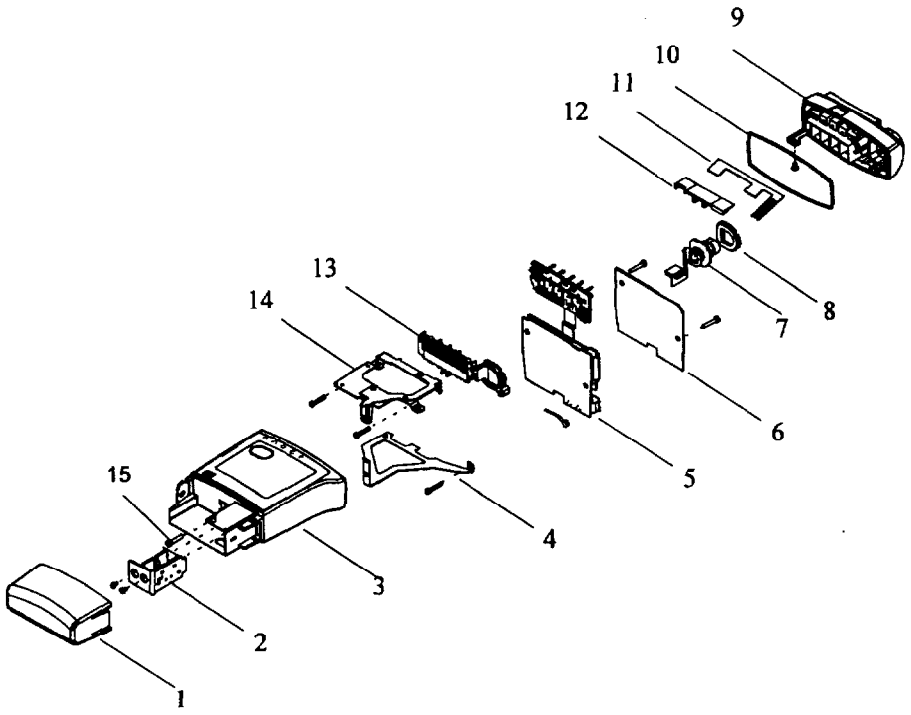


Figure B-3. Digital Transmitter Exploded View

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