NORMARC 7050

MARKER BEACON

General Description

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PART I INTRODUCTION

1 GENERAL INFORMATION

This paragraph gives a description of a typical ILS installation and the Normarc Marker Beacon system. Conventions and abbreviations used in this manual are also given.

1.1 Introduction

This is an overview of Normarc's NM 7050 ILS marker beacons systems.

1.1.1 ILS Overview

A complete Instrument Landing System comprises:

- A *LOCALIZER* SYSTEM, producing a radio course to furnish lateral guidance to the airport runway.
- A GLIDE PATH SYSTEM, producing a radio course to furnish vertical guidance down the correct descent angle to the runway.
- MARKER BEACONS, to provide accurate radio fixes along the approach course.

The layout of a typical ILS airport installation is shown below.

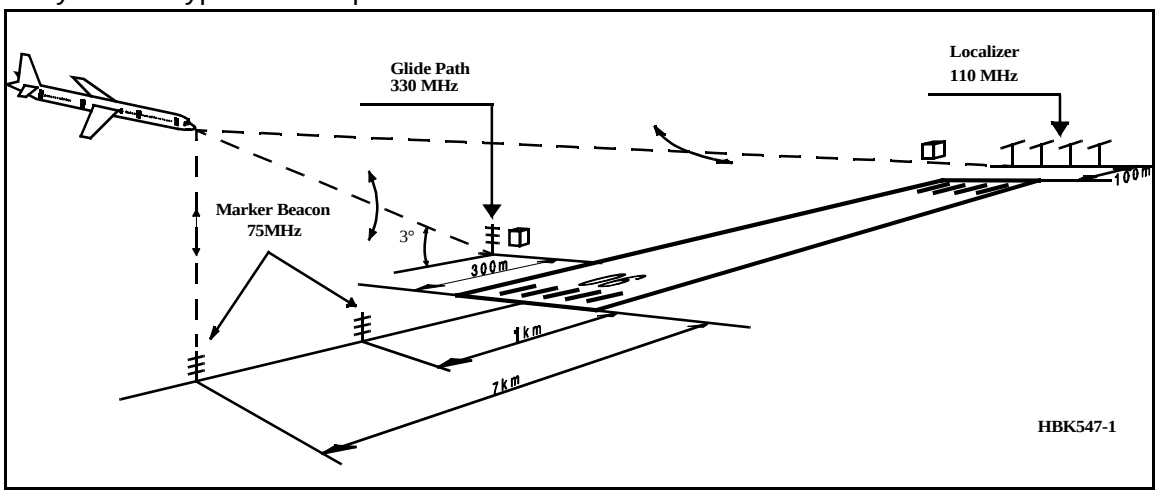

Figure 1-1Typical ILS airport installation

1.1.2 Marker Beacons Overview

The complete ILS marker beacons system comprises:

- A Marker Beacon transmitter/monitor cabinet
- A Marker Beacon antenna
- A remote control
- An Remote Maintenance Monitor (RMM) program to be installed on a PC
- Optional slave panel
- Optional backup battery

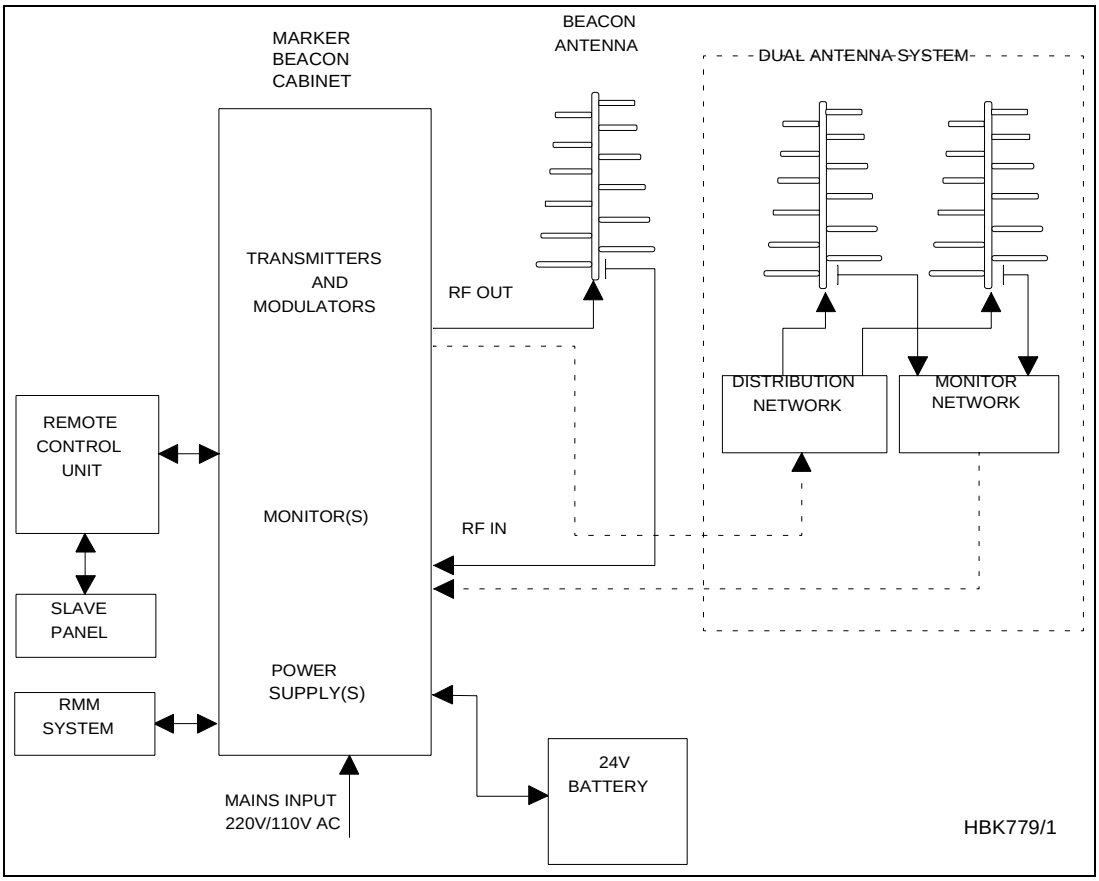

Figure 1-2 Marker beacon block diagram

1.1.3 Marker Beacons Description

The marker beacons are located vertically beneath the localizer course line at distance 150m (inner marker), 1km (middle marker) and 7km (outer marker) from the runway threshold.

The beacons radiate a 75MHz radio signal with an audio Morse code. The Morse code and modulation frequency differ for the outer, middle and inner marker. Outer marker transmits dash code 400Hz, middle marker transmits dash dot code 1300Hz and inner marker dot code 3000Hz.

1.2 Product Type Numbers

The Normarc product numbering system is based on the following three levels:

- System
- Assembly
- Module

Systems have type numbers starting with NM, for example NM7050. Systems consist of assemblies, modules and parts.

Assemblies have type numbers consisting of three letters, a three- or four- digit number and a letter, for example CAA 1370A. CAA is an abbreviation of CAbinet Assembly, 1370 is a running number, and the last letter is the variant designator. Assemblies can consist of assemblies, modules and parts.

Modules have type numbers consisting of two letters, a three- or four- digit number and a letter, for example MO 1374A. MO is an abbreviation of *MO*nitor, 1374 is a running number, and the last letter is the variant designator. Modules consist of parts.

1.3 Abbreviations

AC	:	Alternating Current
ADC	:	Analog to Digital Converter
AGC	:	Automatic Gain Control
CPU	:	Central Processing Unit
DAC	:	Digital to Analog Converter
DC	:	Direct Current
DM	:	Depth of Modulation
EEPROM	:	Electrically Erasable Programmable Read Only Memory
EMC	:	Electro Magnetic Compatibility
EMI	:	Electro Magnetic Interference
EPROM	:	Erasable Programmable Read Only Memory
FIFO	:	First In First Out
FPGA	:	Field Programmable Gate Array
I/F	:	Inter Face
ILS	:	Instrument Landing System
IM	:	Inner Marker
LED	:	Light Emitting Diode
LF	:	Low Frequency
LRU	:	Line Replaceable Unit
MCU	:	Monitor Combiner Unit
MM	:	Middle Marker
NAV	:	NAVigation signals
NF	:	Near Field
OM	:	Outer Marker
PC	:	Personal Computer
RAM	:	Random Access Memory
RF	:	Radio Frequency
RMM	:	Remote Maintenance Monitor
RMS	:	Remote Monitoring System
ROM	:	Read Only Memory
RTC	:	Real Time Clock
SC	:	Station Control
SRAM	:	Static Random Access Memory
STB	:	STandBy
SW	:	Soft Ware
TX	:	Transmitter

2 Physical organisation

This chapter describes the physical outline of the NM 7050

2.1 Configurations

2.1.1 Module and Assembly Location

The figures on the following pages show the locations of the modules in the main cabinet.

Figure 2-1 shows the front panel of the cabinet, with the control panel, on/off switch and local PC connection.

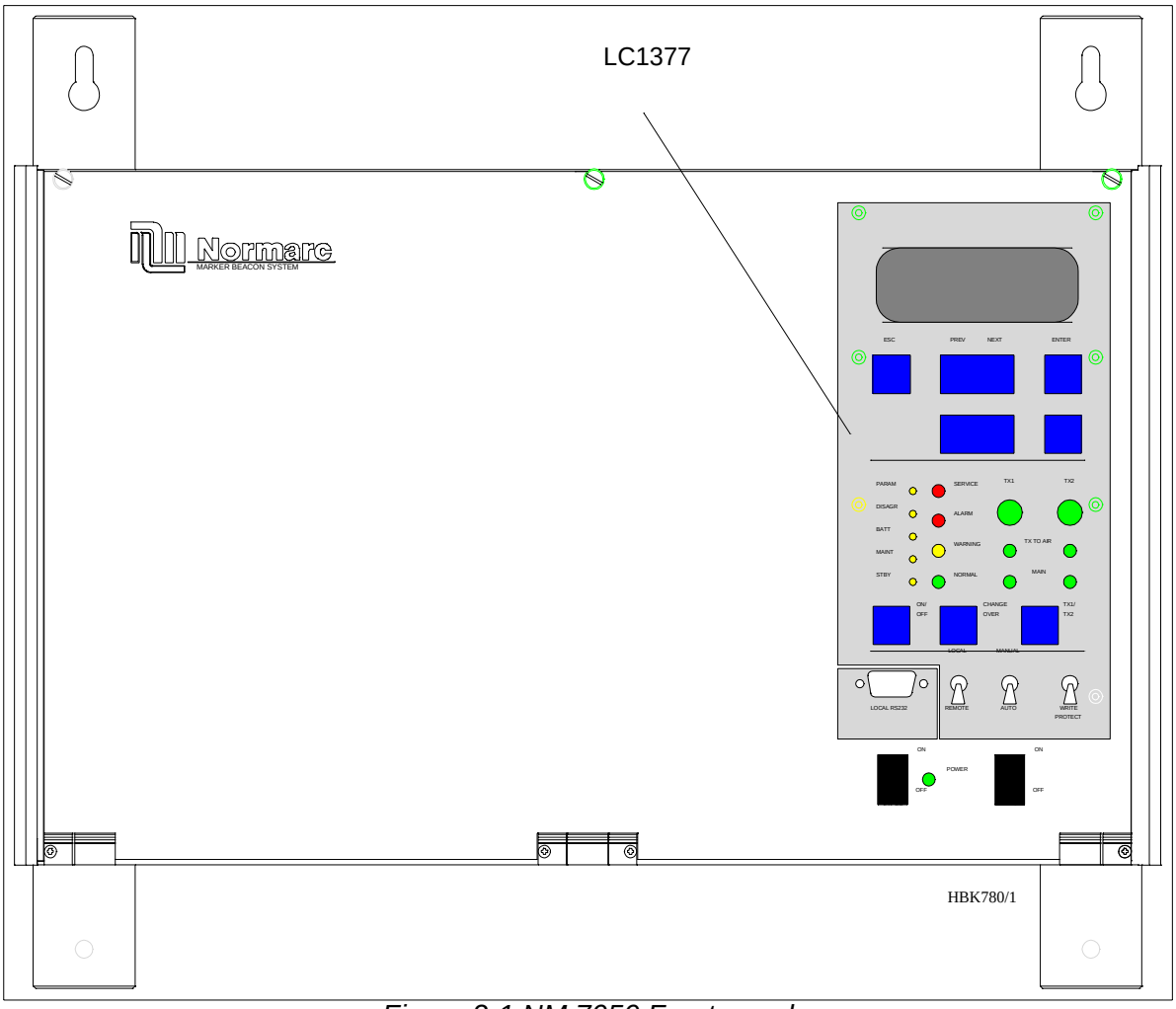

Figure 2-1 NM 7050 Front panel

Figure 2-2 shows the open cabinet in front view with indication of plug in board location.

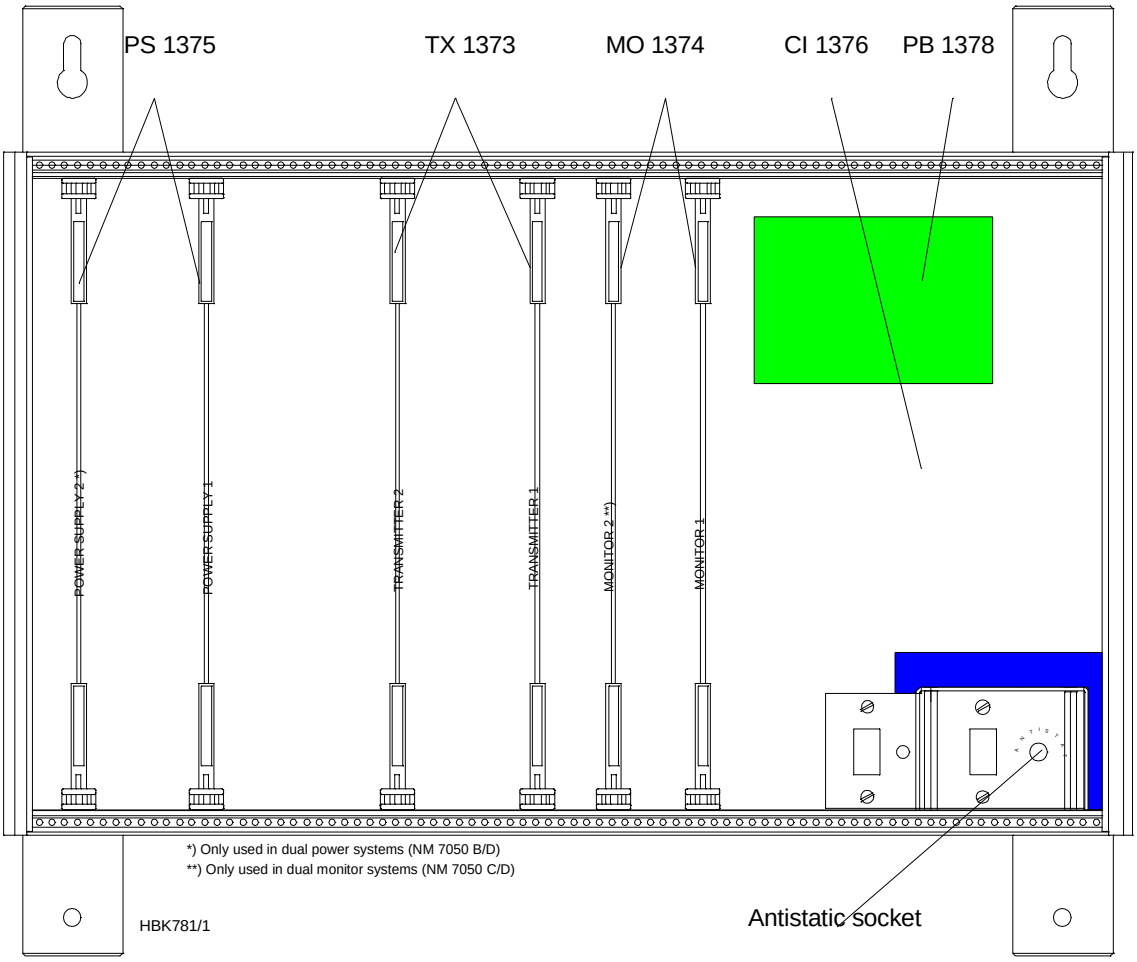

Figure 2-2 NM 7050 Module Location

Notice the location of the different plug in boards. It is essential for the MB to function, that the cards are placed in these locations. If your MB is configured with only one plugin board of each type, they must be placed in the number one locations. The backplane is however , marked with notifications of where each boards place is..

The electronic devices inside NM 7050 are sensitive to Electro Static Discharge (ESD). Please follow the instructions given in the preface of this manual to avoid damage during servicing and transportation.

3 System Description

3.1 Introduction / Overview

The system is housed in a compact cabinet. There are four models/configurations of the NM 7050.

Variant	Monitor	Power Supply
NM7050A	**1**	**1**
NM7050B	**1**	**2**
NM7050C	**2**	**1**
NM7050D	**2**	**2**

Table3-1 Models / Configurations

As shown in Table 3-1, the beacon can have one or two monitor units and one or two power supply units. Figure 3-1 shows a block diagram of the MB system.

The monitor and transmitter control function is based on software. The system is based on modern technology with extensive Remote Monitoring and Maintenance capabilities, and very high reliability and integrity.

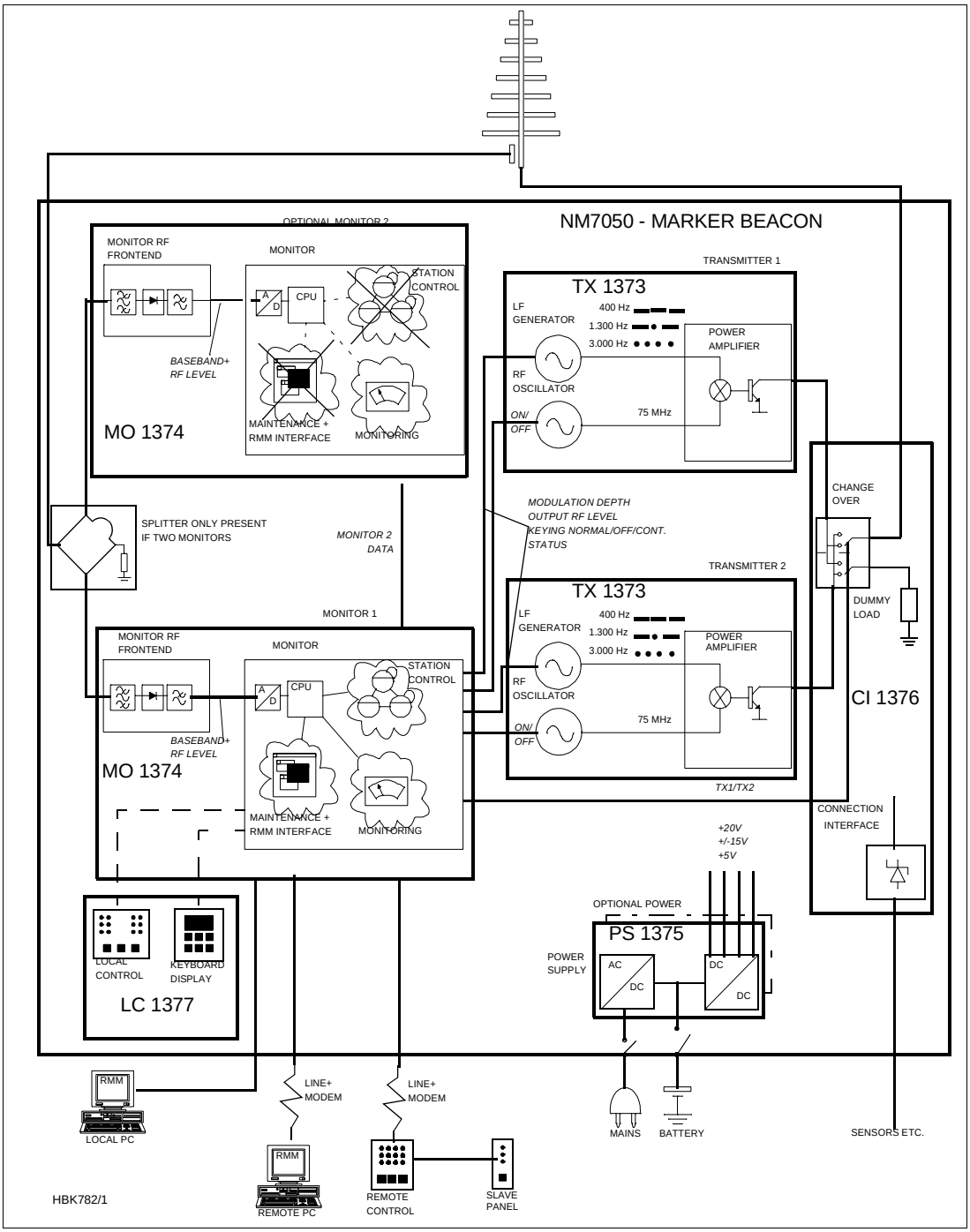

Figure 3-1 MB block diagram

3.2 Transmitters / Modulators

The NM7050 consists of two TX1373A transmitters. The main transmitter is connected to the antenna, while the standby transmitter is connected to dummy load. A failure in the main transmitter will cause an automatic change over to the standby transmitter.

The audio signals are generated in the LF circuitry mainly by a Field Programmable Gate Array (FPGA). A strap field selects Inner, Middle or Outer Marker settings.

An onboard oscillator generates a 75MHz carrier wave which is amplitude modulated with the

audio signal in the Power Amplifier (PA). The PA is capable of delivering up to 4W power at 97% depth of modulation.

Unwanted frequencies are removed by a lowpass filter after the PA.

3.3 Monitors / Transmitter Control

The marker beacon has one or two MO1374 monitor modules depending on model (Table 3-1).

The MO1374 is mainly a microprocessor based module. It contains the MB software and forms the basis of the monitor, station control, system maintenance handling and RMS user interface.

A detection of error in the transmitter signal causes change-over to the standby transmitter. Failure of the standby transmitter leads to an alarm and optional shutdown of the standby transmitter.

On a system with two monitor units, both must report error for alarm to be generated (2 of 2 voting). If the monitors disagree, the WARNING and DISAGR LEDs on the front panel is lit.

The MO1374 consists of two submodules:

The RF frontend receives a RF signal from the antenna (or recombining network for dual antenna system). It demodulates the signal into analogue values propotional to the RF power, the modulation depth and the morse code envelope. These parameters are digitized and monitored by the CPU section.

The CPU section includes an 80CI88 CPU, memory, communication ports and an AD converter system.

3.4 Power Systems

The marker beacon can have either one or two PS1375 power modules depending on model (Table 3-1). The PS1375 is 100W with 120V or 230V AC input voltage and +28V/3.5 A, +20/2.5A, ±12V/1.25A and 5V/6A DC output voltages. Outputs are short circuit protected. On the NM7050 B/D the two modules operate in parallel.

The 28V output is temperature compensated to ensure optimum battery charging. It gives 26.4V at 50°C and linearly increase to 29.6V at -30°C.

The backup battery is an external 24V battery. The battery gives a backup time of 6 hours, and have external charging possibilities for longer backup time. This battery is automatically brought into circuit on mains power failure. The charging time is approximately eight hours with one PS1375 and five hours with two PS1375.

3.5 Remote control system

The remote control unit is used in the tower or in the technical control room. It has indicators for operating status as well as detailed warnings and an aural alarm device with reset. It can control equipment on/off and change over, and has an Access Grant switch to allow/inhibit remote control from the RMM system.

The Remote Control Unit is connected to the MB by one pair telephone cable.

3.6 Remote Maintenance Monitoring (RMM)

The NM7000 series has a built-in Remote Maintenance Monitoring system. This system consists of the RMS system, remote PC terminals with the RMM program installed, and the local keyboard/display. Figure 3-2 illustrates the RMM/RMS systems.

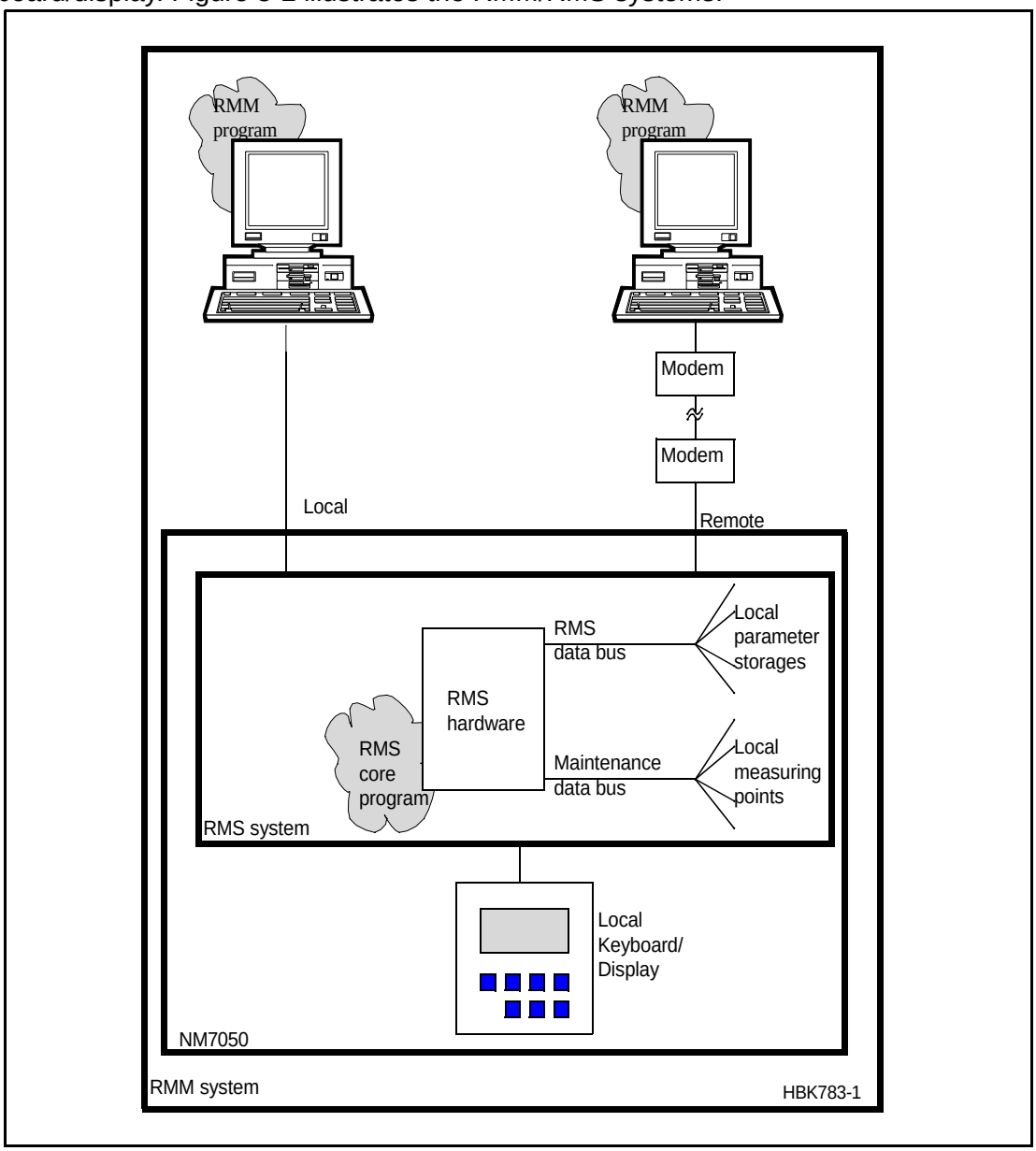

Figure 3-2 The NM 7050 RMM/RMS systems

The centre of the RMM system is a CPU with the RMS core program. The RMS collects measurements and diagnostic data, and makes them available to the user. The collected information allows easy and cost effective maintenance, fault finding and routine reporting. In addition, system settings are distributed and parameter readings are collected via the RMS/CPU.

External Personal Computers are used for a user friendly interface to the RMM system. The equipment has two serial output ports, typically used to connect a local PC and a connection to a central maintenance facility.

The local keyboard/display allows readings and controls through an LCD display and a seven-button keypad. This gives access to the RMM functionality without the need for a PC.

3.7 RMM Access

Access to the RMM system is controlled by multiple hardware and software access controls. One password is required for each access level, i.e. one password for level 1, two for level 2 and three for level 3. Optional hardware controls may inhibit writing in the upper access levels.

Access level 1
- Readout of all the monitor values, warning and alarm limits.
- Readout of all the maintenance values and warning limits.
- Readout of all the delays.

Access level 2
- TX1 and TX2 : morse normal, continuous or off.
- TX1 and TX2 : test signals 50% depth of mod. and 50% RF level.
- Diagnostics.

Access level 3
- Settings of all the monitor warning and alarm limits.
- Settings of all the maintenance warning limits.
- Settings of all the delays.

3.8 Local Keyboard/Display Functions

Through a menu based interface all main commands, adjustments and monitor limits are accessible from the front panel keypad and LCD display. In addition a quick read function gives readout of all main monitor parameters at a glance.

3.9 Document structure

In Figure 3-3 the document structure is shown. The upper tree is the contents of the cabinet,

while the lower tree is additional tower equipment.

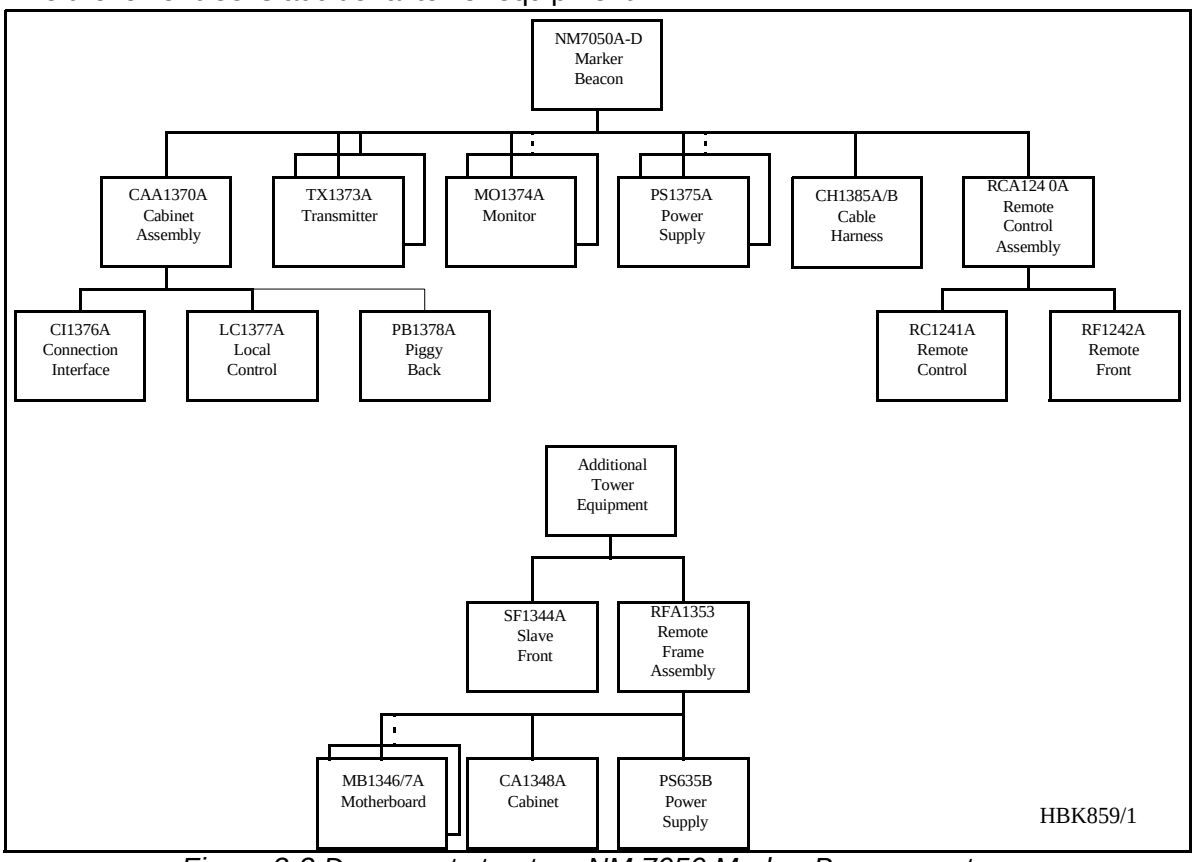

Figure 3-3 Document structure NM 7050 Marker Beacon system

4 Technical Specifications

NM 7050 Marker Beacon Cabinet.

4.1 Signal Requirements

4.1.1 Transmitter

Frequency range	75 MHz
Frequency tolerance	±0,005 %
Output power range	0,005 – 4 W adjustable. Fixed attenuator optional in lower range
Harmonic radiation	2,5 uW maximum
spurious radiation	25 uW maximum
OUTPUT POWER STABILITY	±0.5dB
Test function	Preset adjustable RF level

4.1.2 *Modulator*

MODULATION TYPE	AM	
Modulation alternatives		
	KEYED	
	CONTINUOUS	
	OFF	
MODULATION FREQUENCY AND IDENTIFICATION		
INNER MARKER	3000 Hz	• • • • • • •
MIDDLE MARKER	1300 Hz	— • — •
Outer marker	400 Hz	— — —
Modulation depth	95%	
adjustable range	45-97 %	
MAX. STEP SIZE	0,5 % Depth of Modulation	
stability	±4 % Depth of Modulation	
Frequency tolerance	±2,5 %	
Total harmonic dist.	8 %maximum	
Keying		
Speed	125 MS/DOT APPROX.	
PAUSE TO DOT RATIO	1:1	
PAUSE TO DASH RATIO	1:3 dots/SEC	
	2 dashes/sec	
Test function	Preset adjustable Depth of Modulation, normal, continous or no keying	

4.1.3 Monitoring

4.1.3.1 Alarm Functions

RF power reduction	1,5-3 dB adjustable
Change of modulation depth	50-70 % Depth of Modulation
Keying absence	
Alarm identification to automatic transmitter change over SENDERUMSCHALTUNG	2-5 sec.
LINE BREAK	MB - Remote Control (DISABLE OPTIONAL) Standby alarm identification to transmitter shutdown shall be configurable.

4.1.3.2 Monitor input levels

Adjustment range, nominal level	+1 TO -25 dBm (strap settings for IM, MM and OM sensitivity)

4.1.3.3 Monitor stability at nominal levels

RF POWER VALUES	±0,5 dB
MODULATION DEPTH VALUES	±1,0 % *Depth of Modulation* @ 10 – 30 ºC ±3,0 % *Depth of Modulation* @ full temp. range ±2,0 % *Depth of Modulation* *variation for 3dB RF reduction @ 10-30°C.*

4.1.3.4 Warning funktion

RF POWER REDUCTION	40-75 % *of alarm limit*
Change of modulation depth	40-75 % *of alarm limit*
Maintenance parameter outside limits	
Mains failure	

4.1.3.5 Protocols

Monitor 1 to monitor 2 communication	SERIAL DATA PROTOCOL (not RS 232)
RMM DATA PROTOCOL	RS232

4.1.4 Remote Control

Either

Data Transmission Medium	2-wire line, 600 ohm
Data modulation	SERIAL, FSK
Transmitter level	-10 DBM ± 2 DB
Receiver dynamic range	-10 DBM... -34 DBM OR RS232

or

RS-232 interface in both Marker Beacon and remote control

4.2 Environmental characteristics

Operating temperature	-40 TO +55 ºC	(main cabinet except display)
	-10 TO +55 ºC	(display, remote control and slave panel)
Storage temperature	-40 TO +60 ºC	
HUMIDITY	*95% TO +35 °C*	*DECREASING LINEARLY TO 60% AT +55 °C*
VIBRATION	*0.15MM OR 19.6M/S2 (2G)*	*VERTICAL,*10Hz to 500Hz

4.3 EMV-charakteristics

GENERAL SPECIFICATIONS FOR EMC	ETS 300 339
	EN50081-1 (emmission)
	EN50082-2 (immunity)
	EN61000-3-2 (harmonic current emmission)
	EN61000-3-3 (voltage fluctuations and flicker)
SPURIOUS AND HARMONICS	CISPR 22
SAFETY	EN 60950

4.4 Mechanical characteristics

Dimensions (hxwxd):	
MB CABINET	267 X 450 X 343 MM
REMOTE CONTROL	71 X 132 X 200 MM
SLAVE PANELS	51 X 132 X 200 MM

The MB rack is wall mounted. The remote control and slave panel fit a 19" shelf.

4.5 Power supply

OPERATING VOLTAGE:		
MAIN SUPPLY		230 V +15 %/-20 %, 45-65 HZ,
	OR	120 V +15 %/-20 %, 45-65 HZ
STAND-BY BATTERY		24 V DC *NOMINAL,* float charged by the main Supply. The battery is able to use an external charger. The equipment is able to operate without battery.
POWER CONSUMPTION:		
MB CABINET:		< 50 W
REMOTE CONTROL		< 5 W
BATTERY CHARGER		*ADAPTED TO 5 HOURS (NM 7050 B/D)* or 8 hours (NM 7050 A/C) charging time to 90% battery capacity for a battery giving 6 hours operation. External battery charges may be connected for longer operation, and shorter charging time.

5 Electrical installation

5.1 Marker beacon cabinet

5.1.1 Connection Overview

All electrical connections except the local PC connection, the mains connection and the RF IN and OUT connections are on the CI1376 connection interface board inside the cabinet.

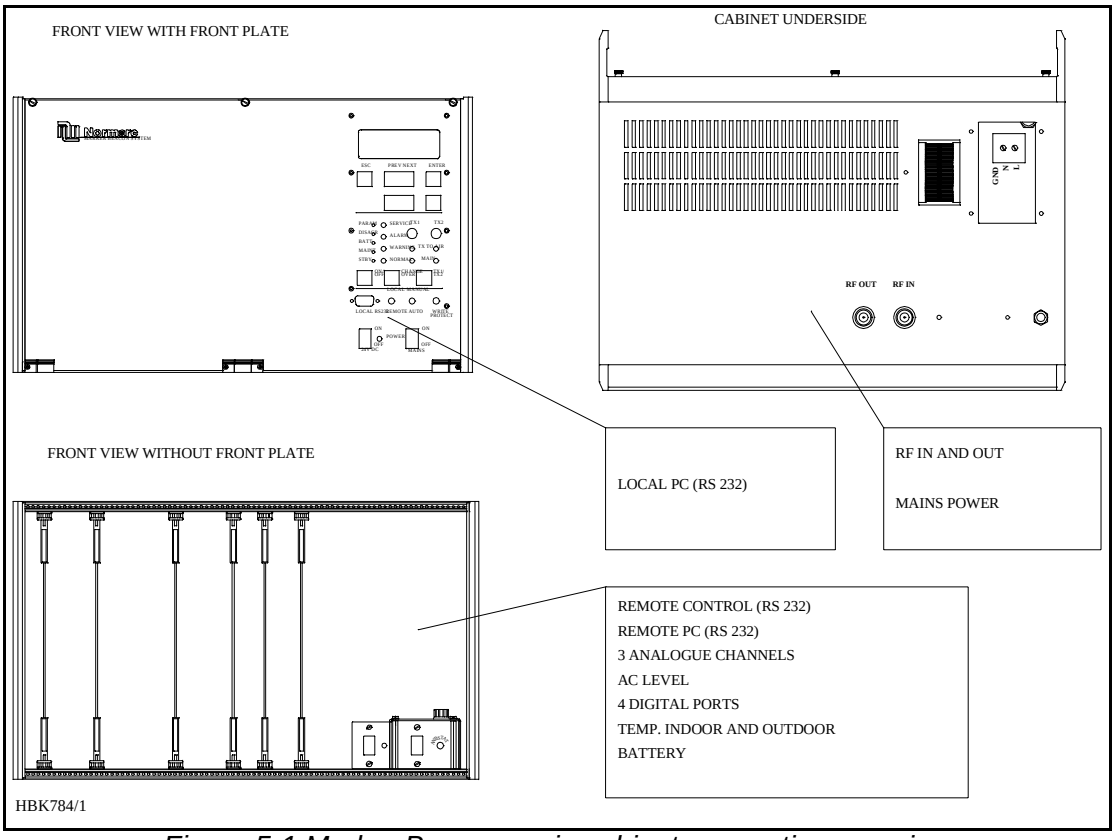

Figure 5-1 Marker Beacon main cabinet connection overview

5.1.2 RF In and Out

- The output signal RF OUT is connected to the antenna with N-connectors and 50 Ω coaxial cable.

The input signal RF IN is connected to the antenna probe with N-connectors and 50 Ω coaxial cable.

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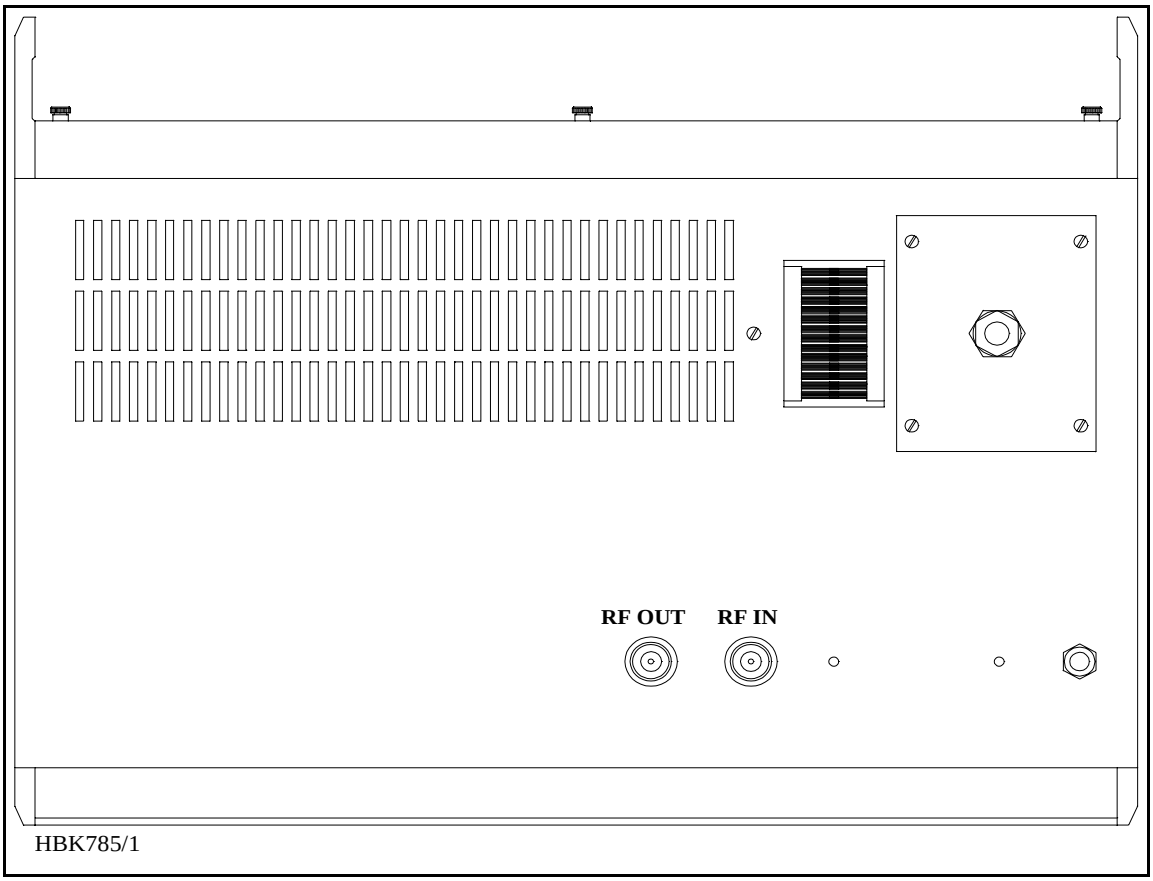

Figure 5-2 RF cable connection

5.1.3 Battery

The external backup battery is connected between BATT GND (-) and BATT +24V (+) on the connector marked BATTERY on **CI 1376**.

A 16Ah battery gives approximately six hours backup time with 5-8 hours charging time dependent on model. For longer backup time an external charger is required to be able to charge the battery within a reasonable time. An external battery protection circuit (like Normarcs **BP 543**) has to be connected between the EXT. CHARGER (+) and BATT GND (-) input. In addition MAINS directly on **NM 7050** has to be disconnected. Figure 5-4 shows the connections schematically.

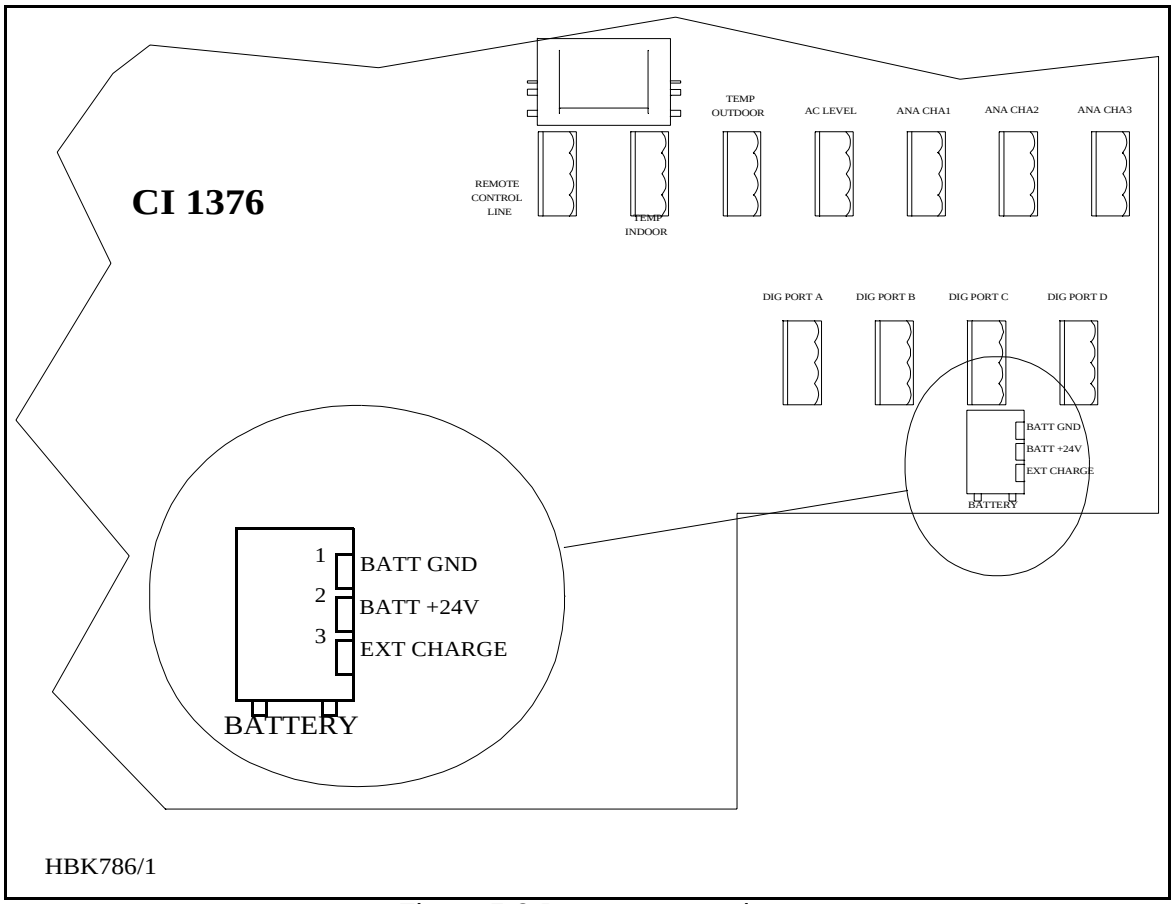

Figure 5-3 Battery connection

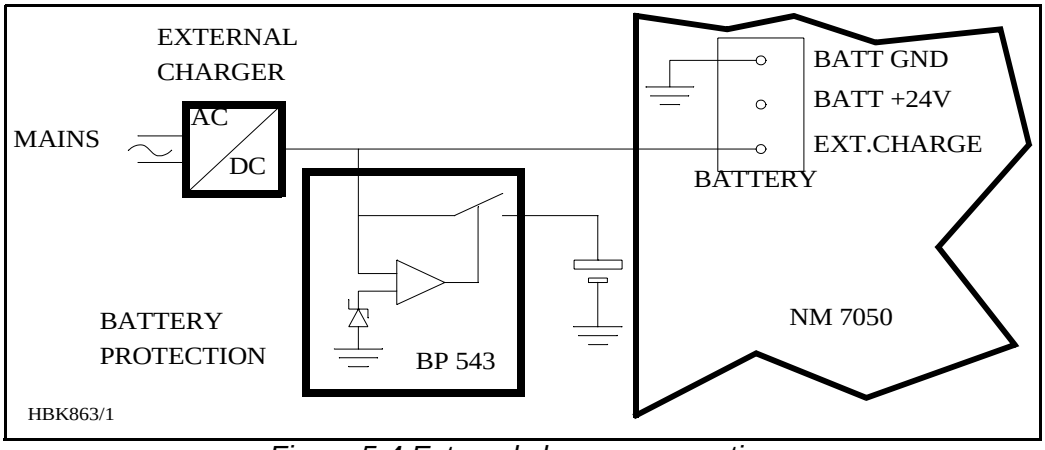

Figure 5-4 External charger connection

5.1.4 Mains

The mains power cable connections are underneath the cabinet. They are covered by a aluminium plate fastened with four screws. The cable itself is threaded through the cable gland and the three wires are connected to the terminals N, L and GND shown below in figure 6-4.

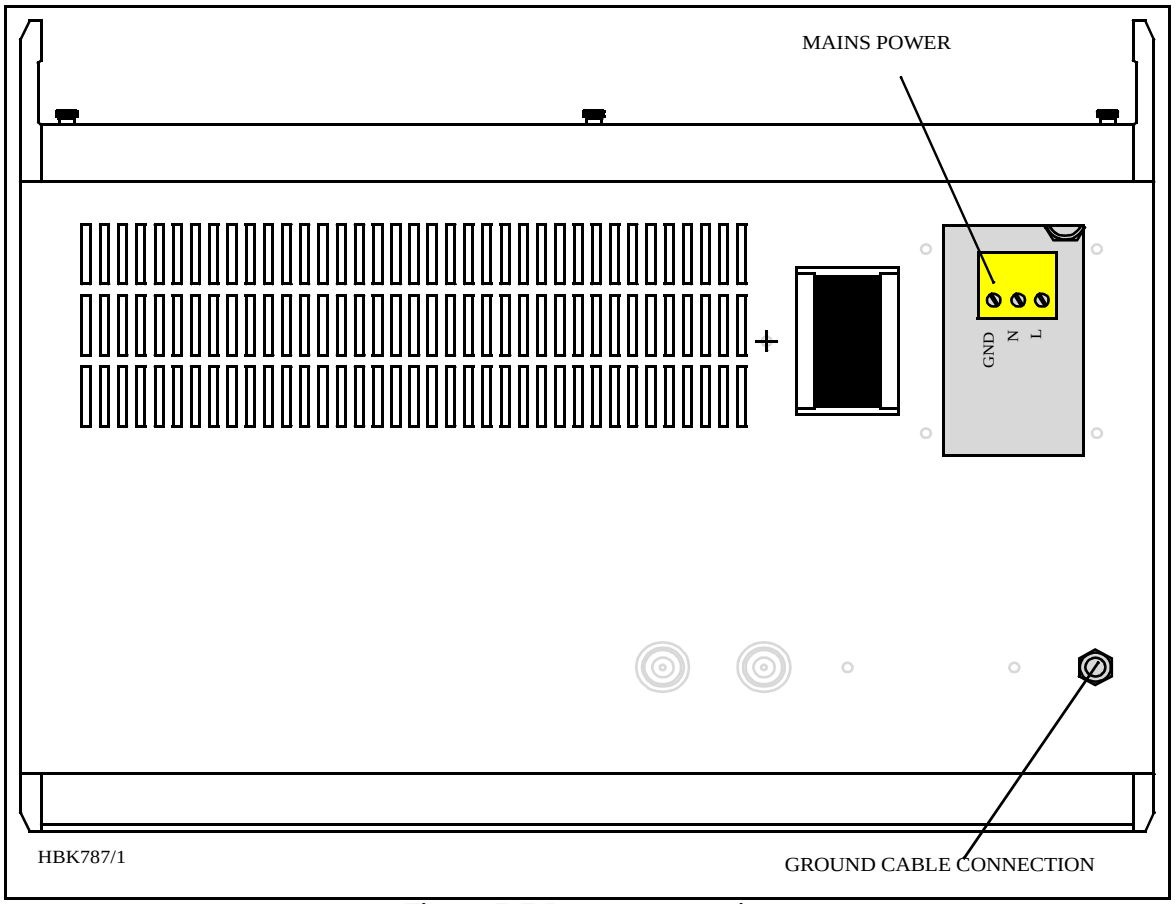

Figure 5-5 Power connection

5.1.5 Modem Power

A DC powered modem or other external equipment designed for 22V-27V DC can be connected to the terminal block marked MODEM POWER. Maximum current consumption should be 800 mA.

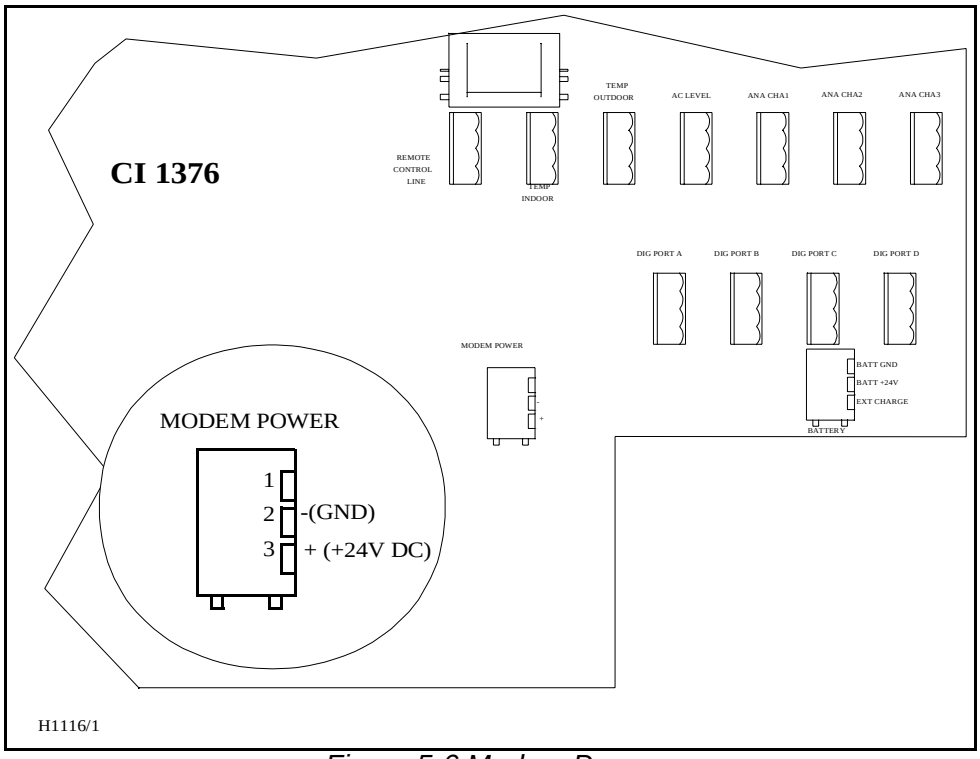

Figure 5-6 Modem Power

5.1.6 Remote Control

The remote line and remote control is connected to the CI 1376 connection interface board as illustrated in Figure 5-7.

- FSK_[A,B] is the modem line pair.
- GND is main cabinet ground

A suitable female connector for the remote line is Weidemüller *BLZ-5.08/4* or equivalent.

Alternatively the remote control connection is done with a RS 232 interface. The mode is configured on MO 1374, refer to 7.2.3.

Note: The position of RXD and TXD is interchanged from the normal RS-232 layout in the Remote Control connector. Therefore a special cable must be used for connection to external equipment.

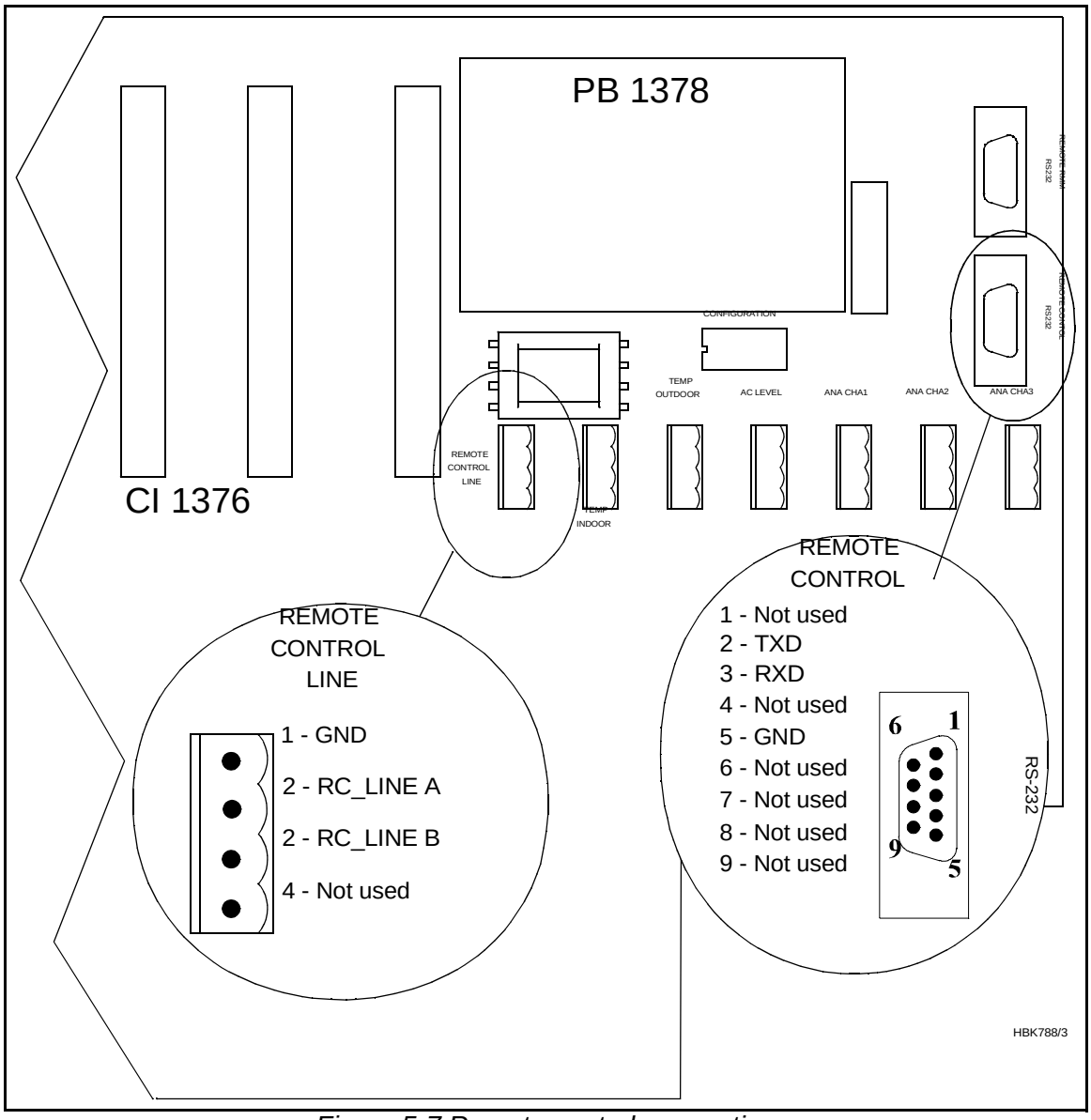

Figure 5-7 Remote control connection

5.1.7 PC and Modem

Modem connections for remote PC are the standard pin out RS232, 9 pins DSUB connector on the CI1376 connection interface board marked remote-rmm as illustrated in Figure 5-8.

For local PC connection use the RS232 on front panel Figure 5-9.

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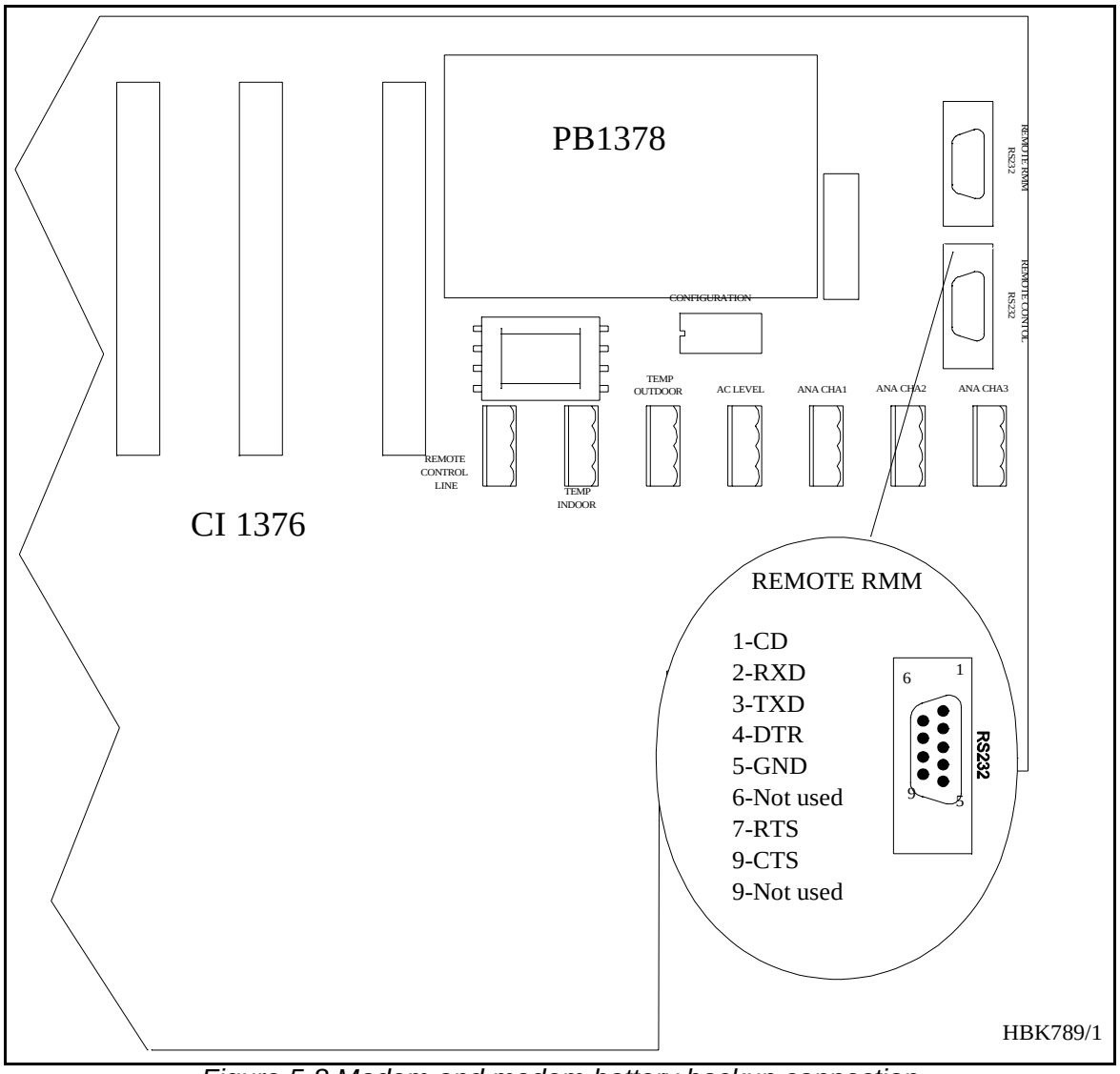

Figure 5-8 Modem and modem battery backup connection

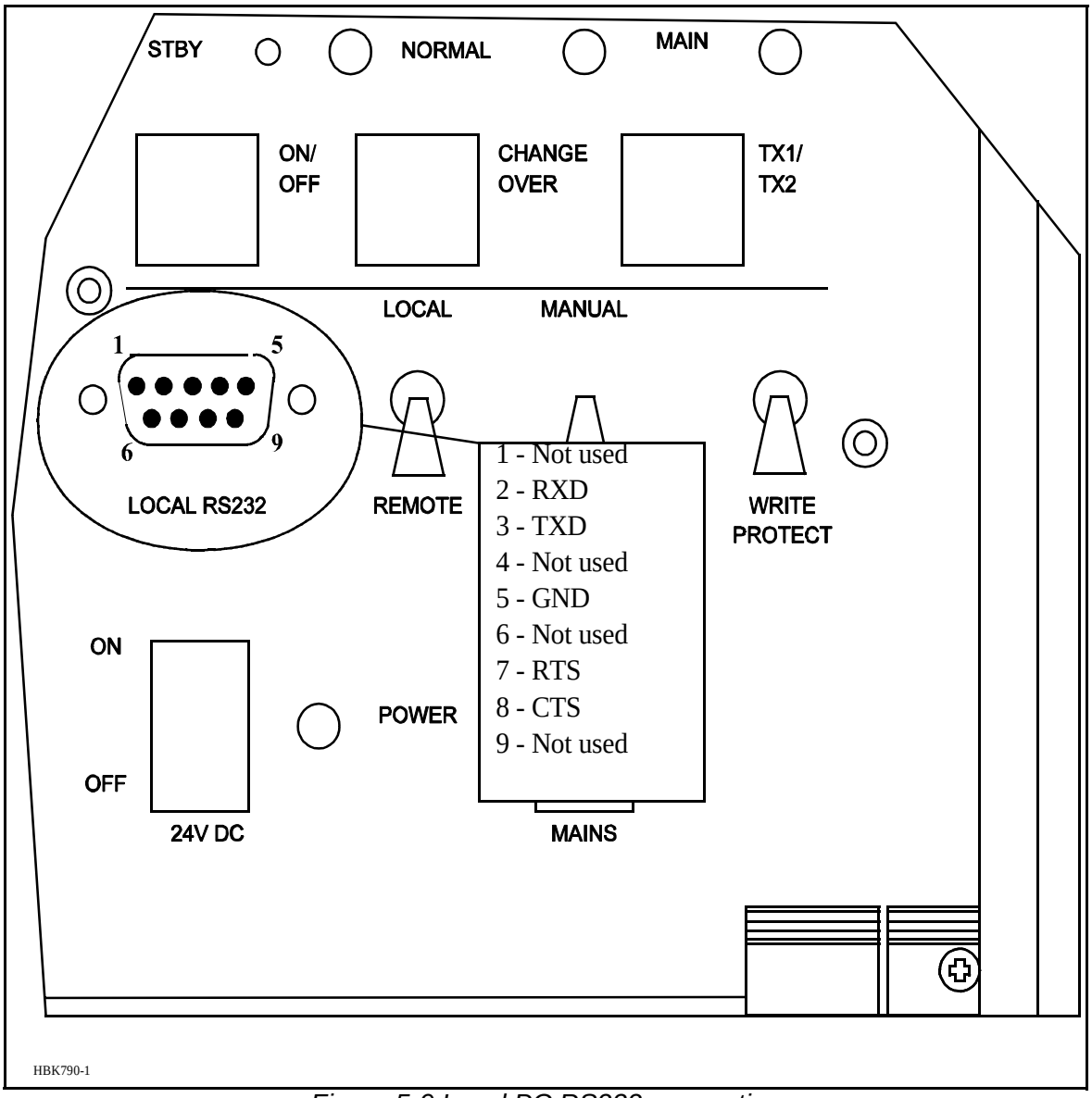

Figure 5-9 Local PC RS232 connection

5.1.8 Analogue Inputs

The analogue inputs are connected to the CI1376 connection interface board as illustrated in Figure 5-10.

The inputs are:

- Analogue Channel 1-3 - three differential DC analogue inputs, P (pin-1) is the positive and N (pin-3) is the negative terminal, and pin 2 is GND.
  Maximum voltage: ±15V
  Input impedance: 10kΩ
- Temp Indoor and Outdoor - temperature measurement inputs with interface to an LM35 temperature sensor.
  Maximum voltage: ±15V
  Input impedance: 10kΩ
- AC Level - AC level measurement input. Intended for use with a battery eliminator to monitor the mains voltage.
  Maximum voltage: 24Vpp

Input impedance: 10 kΩ

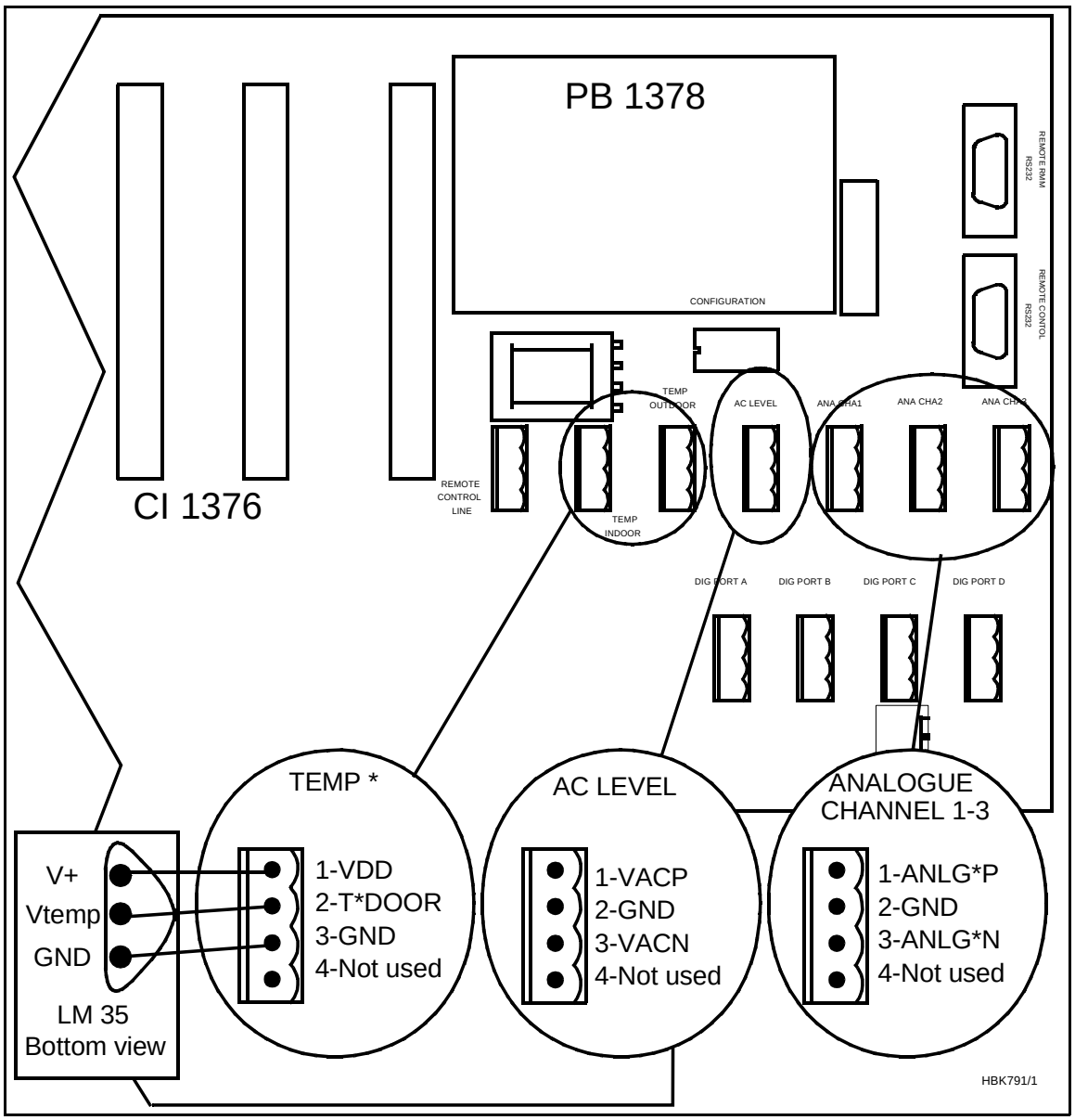

Figure 5-10 Analogue input connections

5.1.9 Digital Inputs and Outputs

Eight bi-directional digital channels (numbered 0-7) are sited on the CI1376 connection interface board as illustrated in Figure 5-11.

Logical levels: TTL
Input impedance: 560Ω.

A suitable female connector is Weidemüller *BLZ-5.08/4* or equivalent.

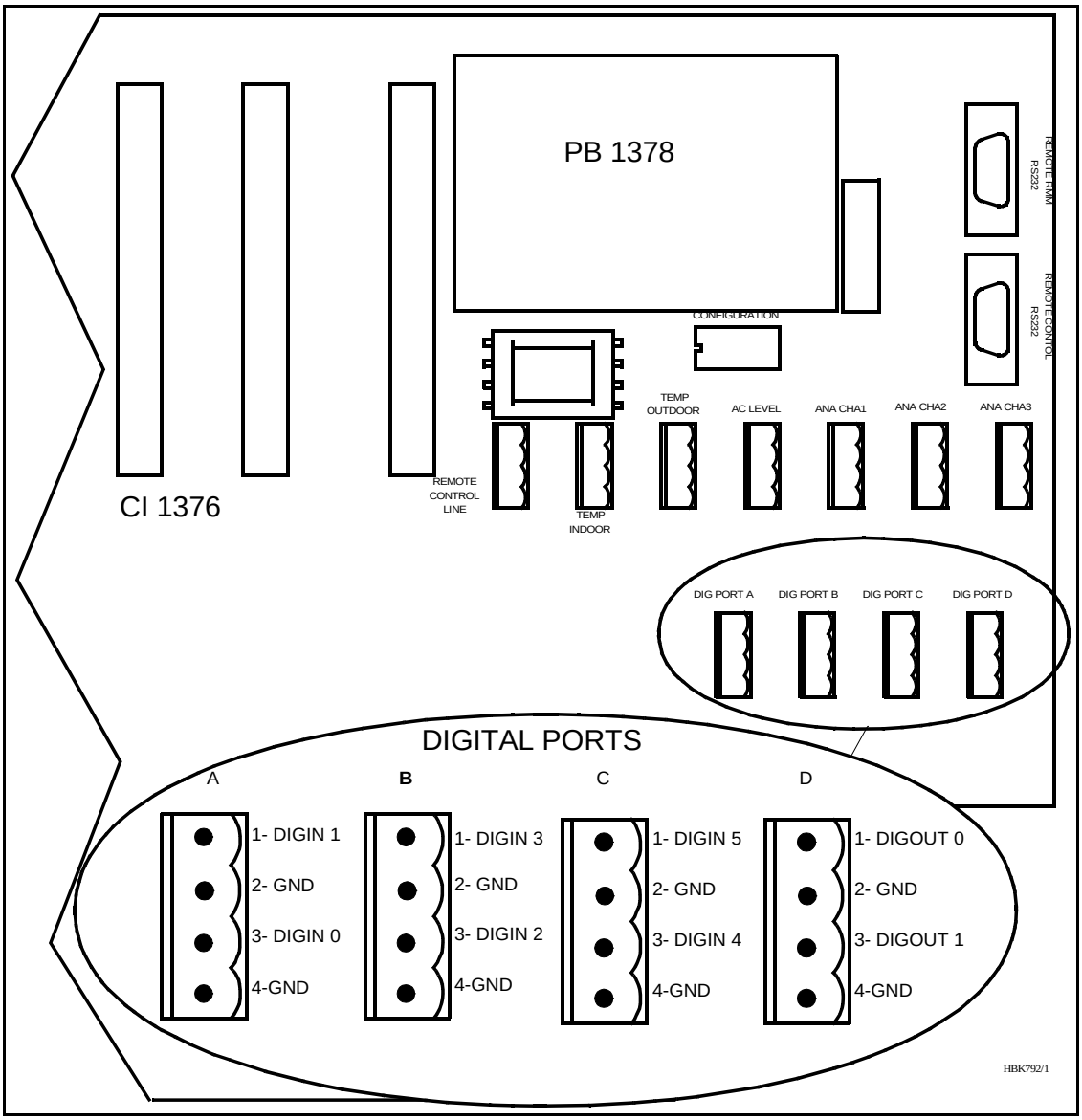

Figure 5-11 Digital input/output connections

5.1.10 Power for Modem or other external devices

A DC powered modem or other external equipment designed for 22V - 27V DC can be connected to the screw terminal J30. Maximum current consumption should be 0.8A.

The terminal marked OUT+ is 22V - 27V DC, OUT- is ground

5.1.11 Remote Control Interface (MB rack)

The transmission medium (telephone line (FSK modem) or RS 232) to the Remote Control can be selected by plugs and link straps S700 and S701 on the MO1374 module:

S700 pins connected	S701 pins connected	Function	Connector on CI 1376:
1-2	1-2	Telephone line	P3 Remote Control Line
3-4	3-4	RS 232	P4 Remote Control RS232
5-6	5-6	Not used	Not used

5.2 Tower equipment

5.2.1 Remote Control Connection

The remote control is connected to the corresponding MB by connecting the REMOTE CONTROL connector on CI1376 to P9 on MB1346, as shown in Figure 5-12.

Suitable female connectors are Weidemüller *BLZ-5.08/4* or equivalent. 600 Ω cable should be used.

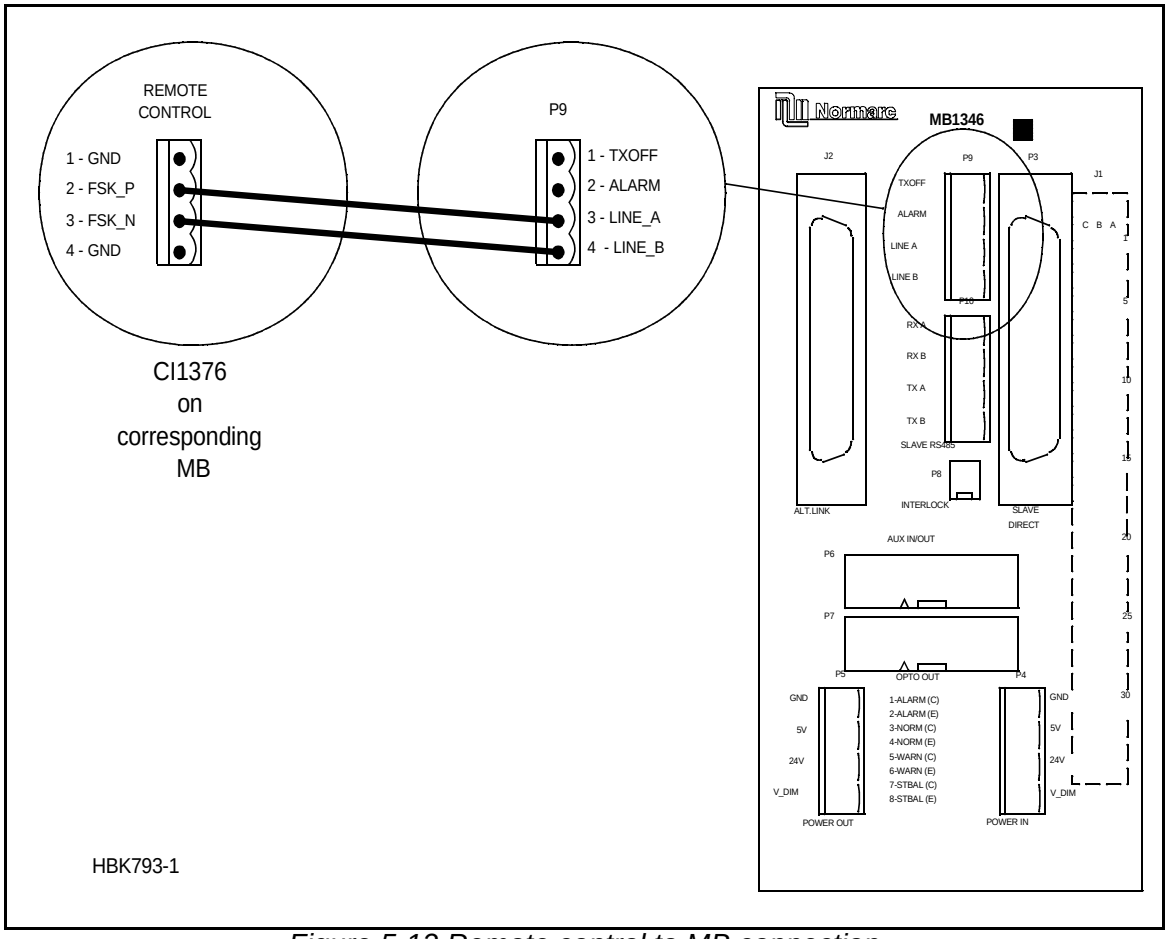

Figure 5-12 Remote control to MB connection

The power supply to the remote control is connected according to Figure 5-13. The battery charger is connected to P2 on the MB1347 - power supply motherboard. Output connector P3 on MB1347 is connected to input connector P4 on MB1346 - remote control motherboard. Several MB1346's are serial linked by connecting P5 on one board to P4 on the next.

Suitable female connectors are Weidemüller *BLZ-5.08/4* or equivalent.

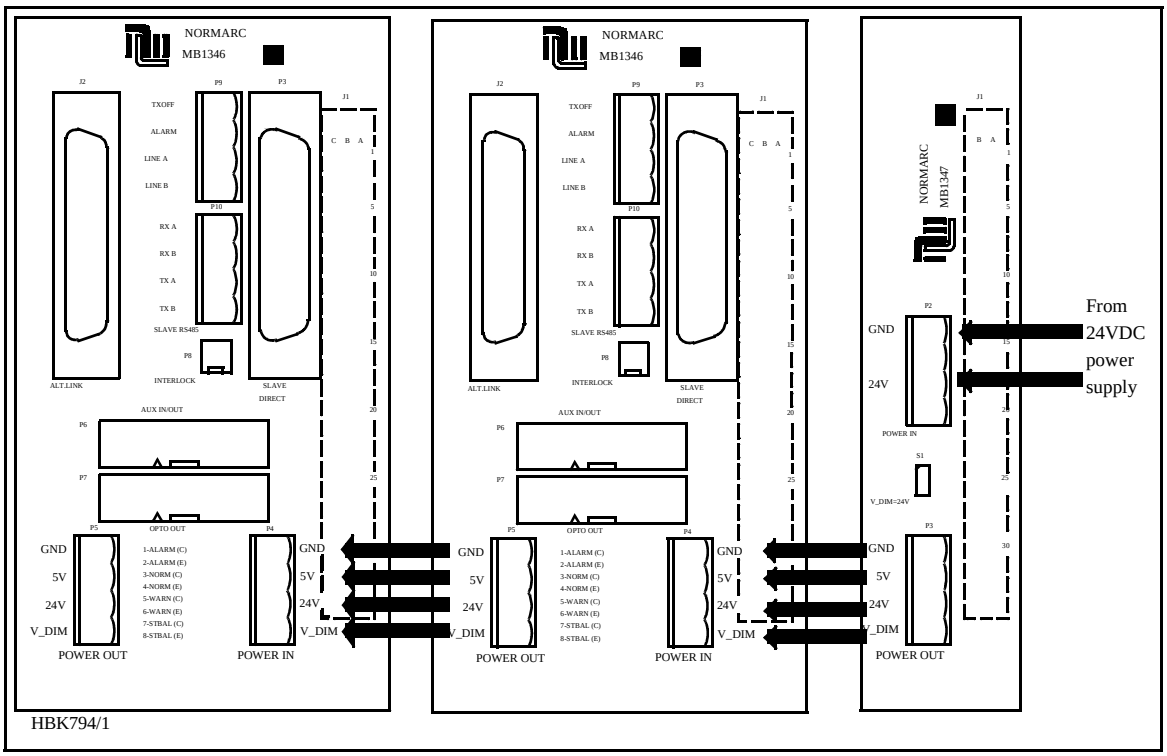

Figure 5-13 Remote control power supply connections

5.2.2 Remote Slave Connection

The remote slave panel SF1344 is connected to the corresponding remote control's mother-board by connecting P3 on MB1346 to P1 on SF1344. P10 on MB1346 is not used. See Figure 5-14.

Suitable connectors are standard 25 pins female DSUB (Harting 0967 025 0442 and 0967 225 4704 or equivalent), connected by a 10 wire 1:1 cable.

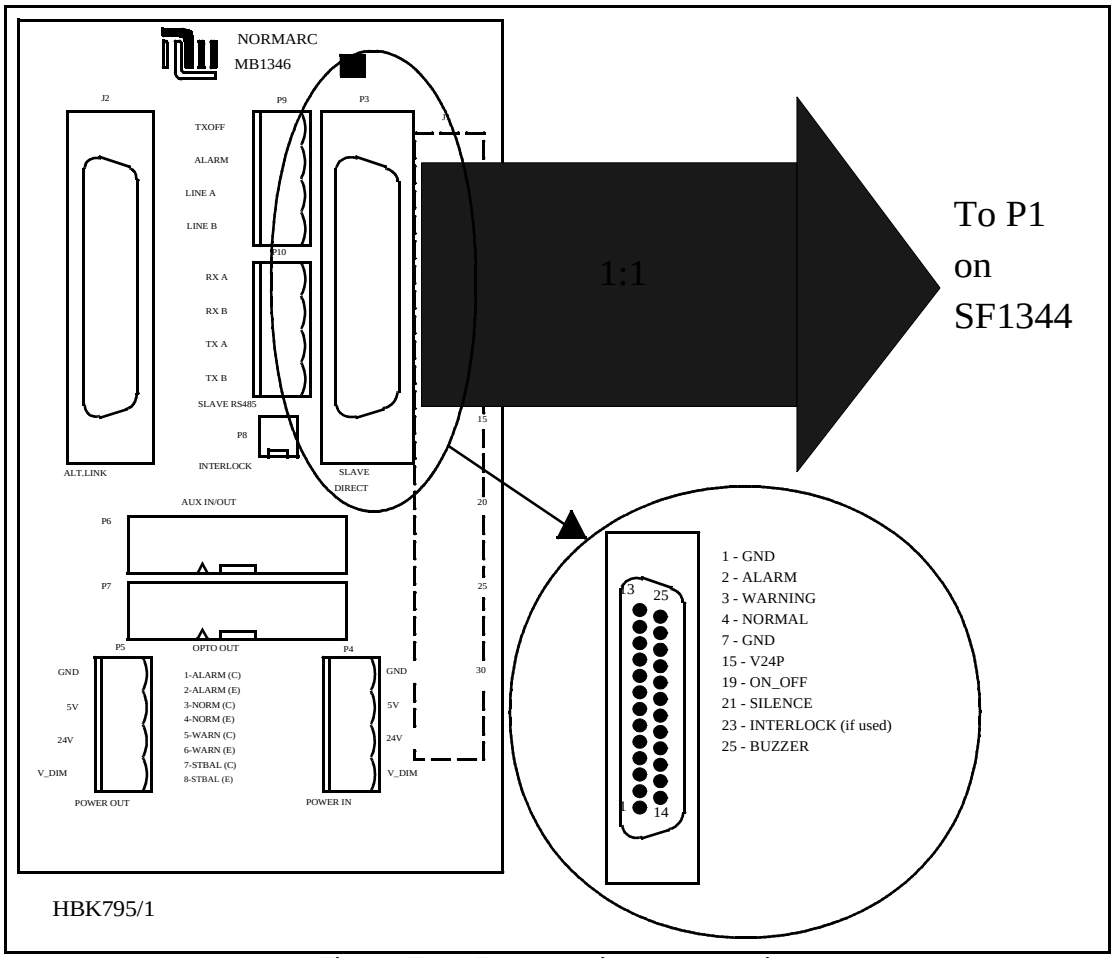

Figure 5-14 Remote slave connection

6 Antenna

Normarc supplies single and dual antennas, NM 3561 and NM 3562 respectively. The single antenna may be used for inner, middle and outer marker, while the dual antenna is specially designed for outer markers. The advantage of the dual antenna is a lower spread in FLYING THROUGH TIME inside the localizer coverage area. In addition to two antenna elements, the monitor and distribution network DI 726 is included in NM 3562.

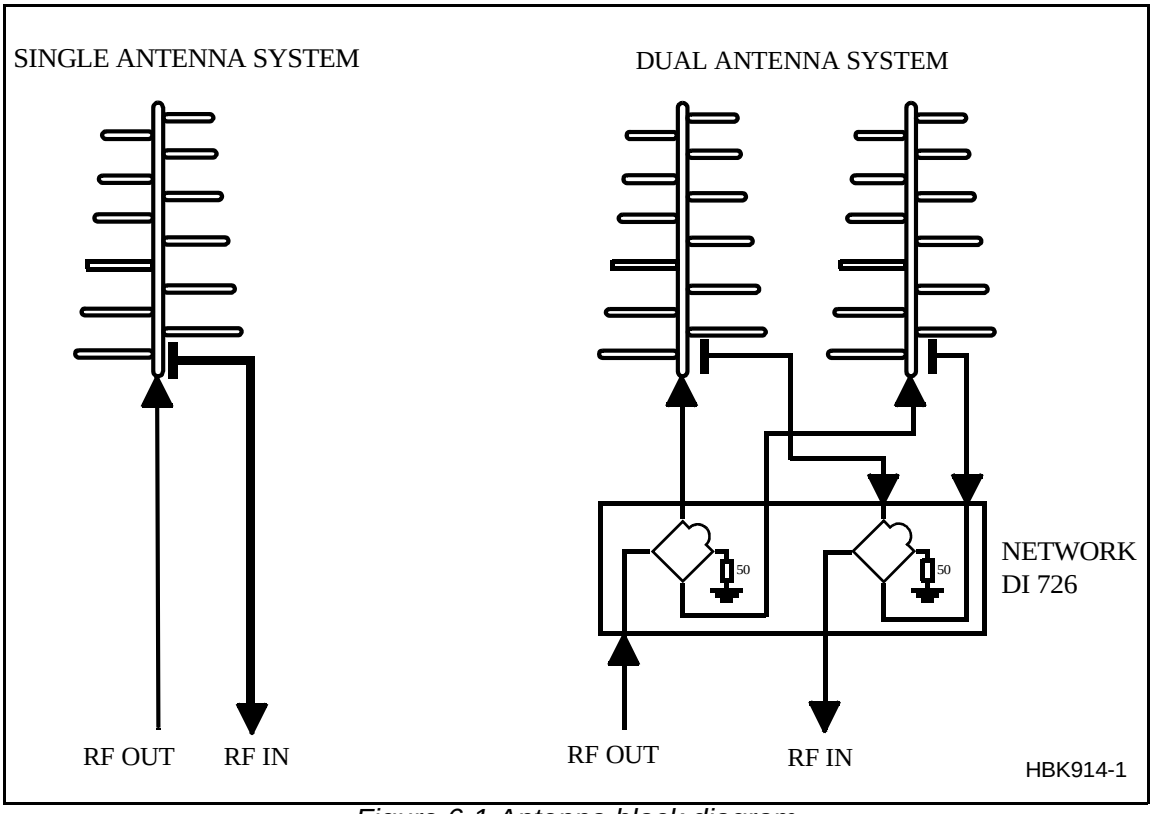

Figure 6-1 Antenna block diagram

Figure6-2 shows the field strength of the radiated signal directly above the middle marker antenna. Figure6-3 and Figure6-4 illustrate the field strength above the outer marker antenna, using single and dual antenna, respectively. The localizer course sector is scetched. Along an elliptical curve, the field strength is constant. If you look at the diagrams as ordinary geographical maps, you will see that the dual antenna "field-strength-mountain" is steaper and more stretched sideways than the single antenna "mountain". This corresponds to a sharper on/off response on the aircraft's marker beacon instruments.

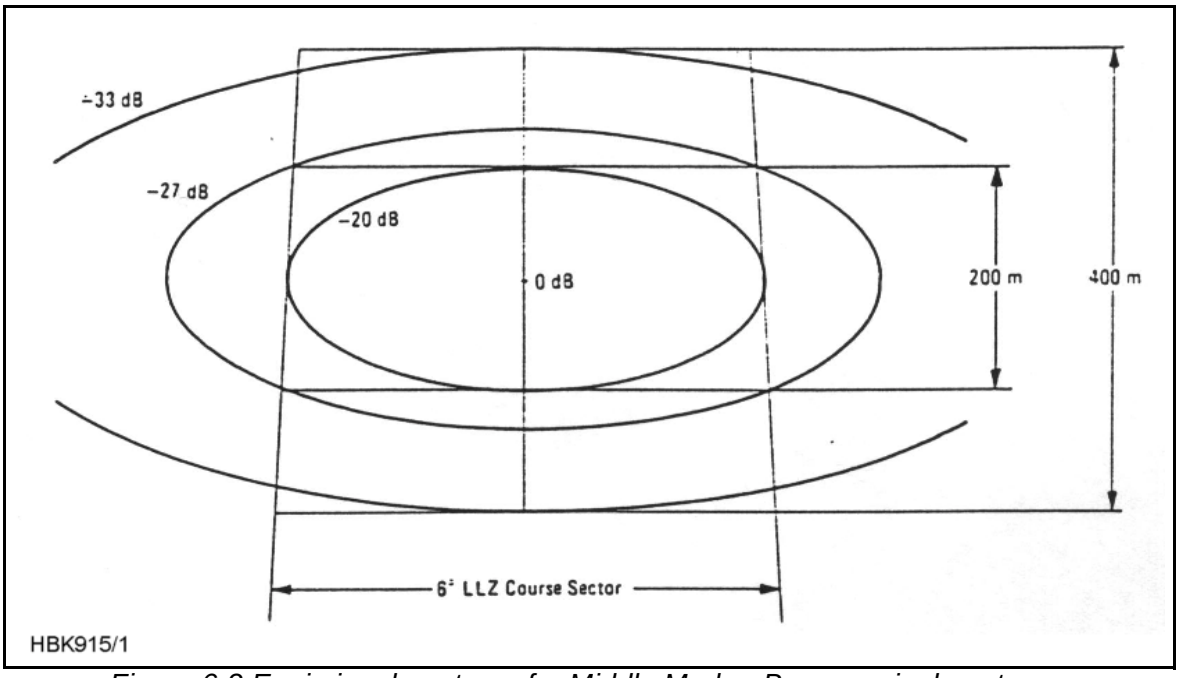

Figure 6-2 Equi-signal-contours for Middle Marker Beacon, single antenna

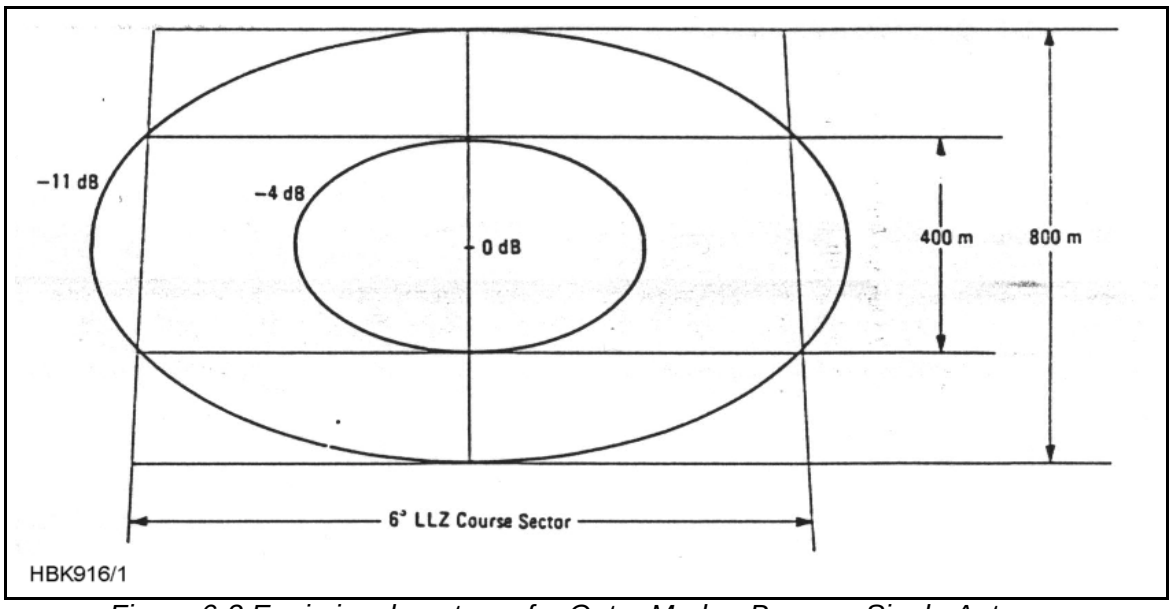

Figure 6-3 Equi-signal-contours for Outer Marker Beacon, Single Antenna

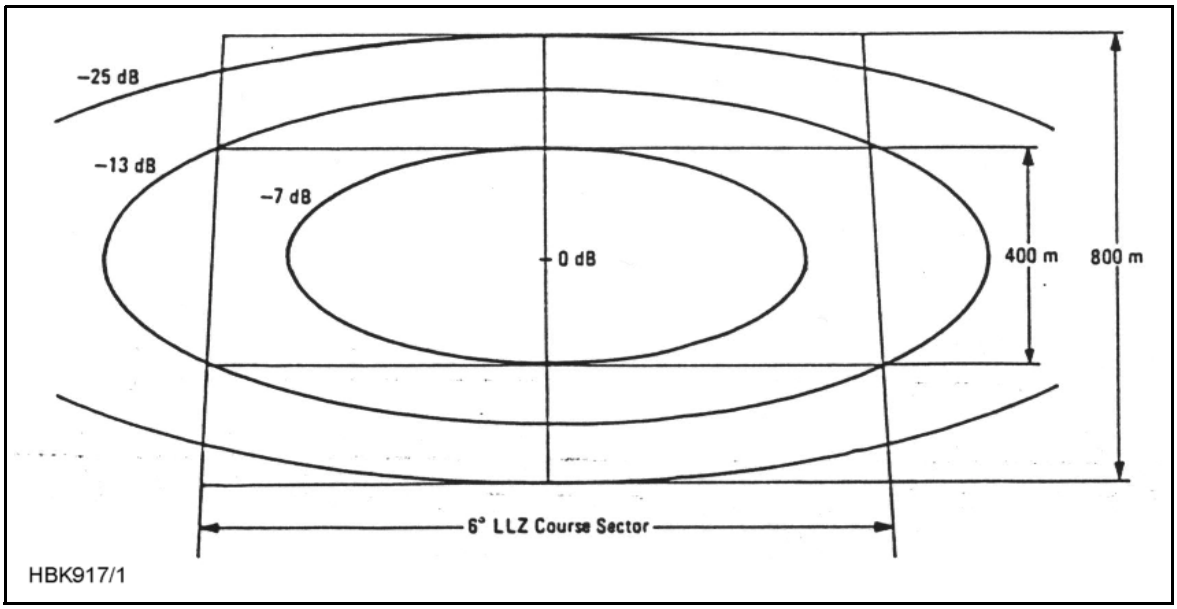

Figure 6-4 Equi-signal-contours for Outer Marker Beacon, Dual Antenna

6.1 Antenna NM 3561 / NM 3562 For Ils Marker Beacon

The NM 3561/NM 3562 Marker Beacon Antennas are log-periodic dipoles possessing properties of high gain and directivity, and low side lobes. The performances og the antennas conform to ICAO Annex 10 item 3.1.6, and are such that they are largely independent of environment factors such as rain, snow and ice, and they can therefore be located at «difficult» sites. The directivity of the antennas can, if required, be even further increased by adding additional elements to the array.

The radiation patterns for the antennas are almost unaffected by the surrondings, and the antennas are therefore suitable for offset location where tilting of the antennas is necessary in order to obtain the required signal coverage. (Refer to figure A-1)

Figure12-3, 12-4 and 12-5 shows constant field strenght lines through points in the glide path (GP angle 3º). The marker beacons are located vertically beneath the localizer course line at distance of 1050 m (middle marker) and 3.9 nautical miles (outer marker) from the threshold. The field strengths specified are relative to the maximum level directly above the antenna. The figures show that for an aircraft travelling at a speed of 50 m/s (96 knots) within the maximum allowable course sector of 6º the duration of the visual indication will be within the prescribes limits. The instrument panel lamp should be adjusted so as to switch on or off at the levels indicated in the figures i.e. -27 dB to -33 dB for Figure12-3, -11 dB to Figure12-4, and -13 dB to -25 dB for Figure12-5.

The marker beacon antennas are mounted on poles, with the dipoles parallel to the course line. The rear end of an antenna should be at least 2 metres above the ground.

The NM 3562 antenna comprises two elements, and is fed via a distribution network (DIA 726) which splits the transmitter power into two equal parts. The network is a coaxial cable hybrid housed in silumine box together with the monitor network which is used to combine the signal from the two monitor probes.

Specifications:	**NM 3561:**	**NM 3562:**
Antenna construction	1 LPDA	2 LPDAs
Frequency	75 MHz	75 MHz
Gain	8,2 dB	11 dB
VSWR 50 Ohm	1,2 dB	1,2 dB
Required RF power	0,5W	0,4W
Dimensions	3,3 x 2,2 m	3,3 x 4,7 m
Weight	50 kg	110 kg
Mounting	Both types: 2.2 metres above ground	
Temperature	Both types: -40ºC to +70ºC	
Wind velocity	Both types: up to 180 km/h	