MR810
RESPIRATORY HUMIDIFIER

TECHNICAL MANUAL

Revision C

Fisher & Paykel HEALTHCARE

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Fisher & Paykel Healthcare have a policy of continual product improvement and reserve the right to alter specifications without notice

CONTENTS

1 GENERAL INFORMATION

1.1 INTRODUCTION

This manual is intended for use by qualified service personnel who will service and maintain the Fisher & Paykel Healthcare MR810 Respiratory Humidifier. This manual covers the following:

- Specifications
- Operation of the MR810, and controls
- Maintenance procedures
- Troubleshooting
- Servicing (full diagrams and parts list are in the appendices)
- Electrical safety test procedures

1.2 GLOSSARY OF TERMS

Ambient sensor	A thermistor located in the heater-wire adaptor that allows the humidifier to monitor the ambient temperature.
Breathing Circuit	Tubing which carries respiratory gases from the chamber to the patient.
Chamber	Vessels containing water in which gas is heated and humidified by passing it over the heated water.
Heater-wire	Wire inside the breathing circuit that heats the respiratory gases to minimise condensation.
Heater-wire Adaptor	Electrical connection between the humidifier and the breathing circuit.
Humidifier	The device which is used to heat the chamber to humidify the respiratory gas.
Inspiratory Limb	The section of the breathing circuit that takes inspired gases to the patient.
PCB	Printed circuit board.
Respiratory gas	Gases breathed in by the patient.
Single Heated Breathing Circuit	A breathing circuit that has the inspiratory limb heated by a heater-wire.
Thermistor	A resistive device used to measure temperature.

1.3 DEFINITIONS

NOTE: A **NOTE** provides important information or explanation of procedures or conditions that may otherwise be misinterpreted or overlooked.

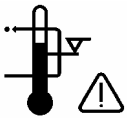
Caution

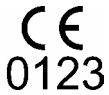
A **CAUTION** statement designates the possibility of damage to this or other equipment if a procedure is not followed exactly.

WARNING:

A WARNING statement refers to conditions with a possibility of personal injury if a procedure is not followed exactly.

1.4 SYMBOLS

Front Panel Symbols	
	Power On/Off (stand by)
	Temperature Control
	Increasing Setting
Internal Symbols	
	Caution: Electrostatic Sensitive Device
	Protective Earth
	Thermal Cut Out

Side Panel Symbols	
	Caution: Hot surfaces may exceed 75 °C
	Type BF
	Attention – consult accompanying documents
	Alternating Current
	Drip Proof Protection to IPX1
	Date of Manufacture
	C-tick for EMC
	UL Marking
	CE marking

1.5 TECHNICAL MANUAL REVISION HISTORY

Revision	Description of Change	Date Issued
A	First release.	May 2002
B	Spare parts list updated. Removed PCB component list.	October 2002
C	Updated for Rev B PCB. Removed PCB schematic and component layout. Reformatting.	April 2004

2 SPECIFICATIONS

2.1 MECHANICAL

Dimensions:	94 x 154 x 135 mm (without chamber fitted).
Weight:	1.7 kg without chamber.
	2.0 kg with MR290 filled with water.

2.2 ELECTRICAL

Supply Voltage:	230 V~ (MR810A--) 115 V~ (MR810J--) 100 V~ (MR810G--)
Supply Frequency:	50 or 60 Hz
Supply Current:	0.8 A maximum at 230 V~ (MR810A--) 1.6 A maximum at 115 V~ (MR810J--) 1.8 A maximum at 100 V~ (MR810G--)
Heater-wire:	22 V~ at 30 W
Heater Plate:	150 W
Heater Plate Thermal Cutout:	Operates at 93 ± 5 °C

2.3 PERFORMANCE

Note: Performance results obtained at 23 °C ambient temperature.

2.3.1 HEATER-WIRE MODE PERFORMANCE

Table 1: Heater-wire mode performance for each temperature setting

Temperature Setting	Constant flow range (L/min)	Delivered patient temperature (°C)
Low	5 to 60	26 to 29
Medium	5 to 60	30 to 33
High	5 to 30	33 to 36

Results obtained using an RT308 oxygen therapy breathing circuit.

2.3.2 NON HEATER-WIRE MODE PERFORMANCE

Table 2: Non heater-wire mode performance for each Temperature Setting

Temperature Setting	Constant flow range (L/min)	Delivered patient temperature (°C)
Low	5 to 60	23 to 25
Medium	5 to 40	25 to 27
High	5 to 30	28 to 32

Results obtained using an RT307 oxygen therapy breathing circuit.

2.4 TRANSPORT AND STORAGE

Transport Temperature:	-10 to 50 °C (14 to 122 °F) 30 to 95 % relative humidity
Storage Temperature:	-10 to 50 °C (14 to 122 °F) 30 to 95 % relative humidity

2.5 STANDARDS

IEC 60601-1:1988, Medical electrical equipment, Part 1: General requirements for safety (and EN 60601-1, UL 60601-1, CAN/CSA 22.2 No 601.1, AS/NZS 3200.1.0)

IEC/EN 60601-1-2:2001, Medical electrical equipment, 2: Electromagnetic Compatibility

ISO 8185:1997, Humidifiers for medical use - General requirements for humidification systems

3 OPERATION AND CONTROLS

3.1 APPLICATION

The MR810 Respiratory Humidifier is designed to heat and humidify respiratory gases delivered to the patient via a face, nasal, or oral mask. The inspired gas is passed through the chamber of water where it is heated and humidified. An optional heated breathing circuit (heated via a wire inside the circuit), can be used to minimise condensate in the breathing circuit and maximise humidity delivery to the patient; this is recommended.

The MR810 humidifier consists of two heaters: (a) a heater plate which the humidification chamber slides onto, and (b) an optional heater-wire in the breathing circuit.

3.2 WARNINGS AND CAUTIONS

WARNING:

Ensure probe port caps are inserted into probe ports of the breathing circuit.

Caution is required when delivering gases that are not body temperature saturated.

The use of breathing circuits, chambers or other accessories which are NOT approved by Fisher & Paykel Healthcare may impair performance or compromise safety.

Refer to operating instructions for each accessory.

Ensure maintenance of grounding integrity by connection to a hospital grade receptacle.

Ensure that the humidifier is always positioned lower than the patient's airway.

Ensure the humidifier is securely mounted.

The operation of high frequency surgical apparatus, short wave or microwave equipment in the vicinity of the humidifier may adversely affect its function. If this occurs the humidifier should be removed from the vicinity of such devices.

Visually inspect accessories for damage before use.

Hot surfaces may exceed 75 °C.

Do not use flammable anaesthetics.

Always disconnect supply before servicing.

Caution

The MR810 does not deliver body temperature saturated gases.

3.3 SETUP

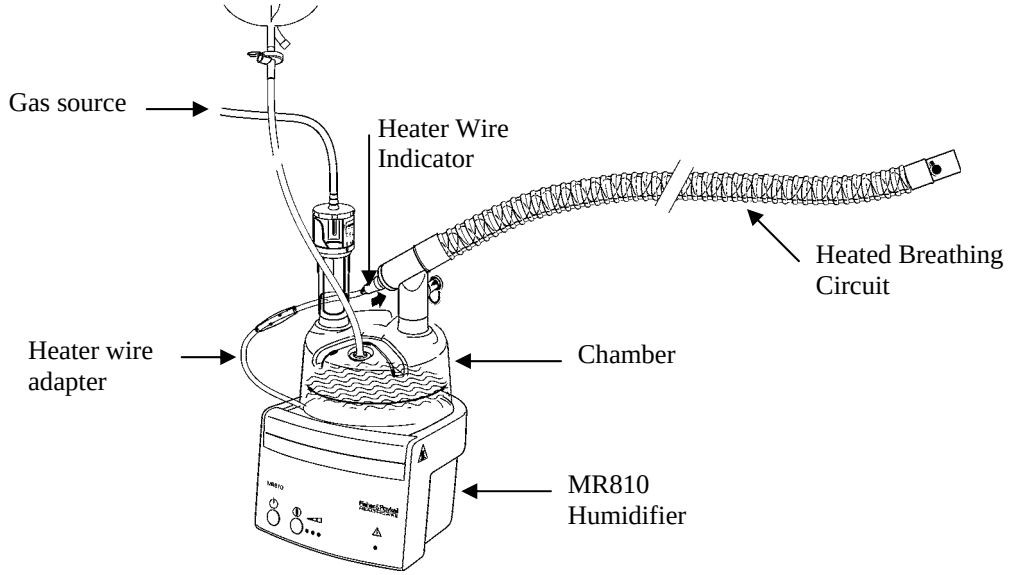


Figure 3.1: Typical setup for oxygen therapy using a heated breathing circuit

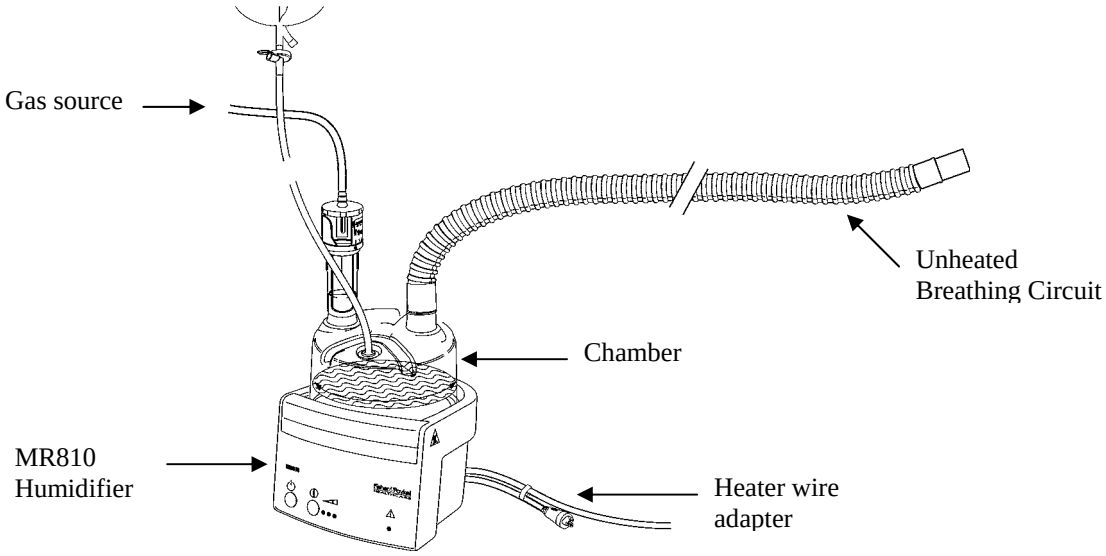


Figure 3.2: Typical setup for oxygen therapy using an unheated breathing circuit

3.4 CONTROLS AND INDICATORS

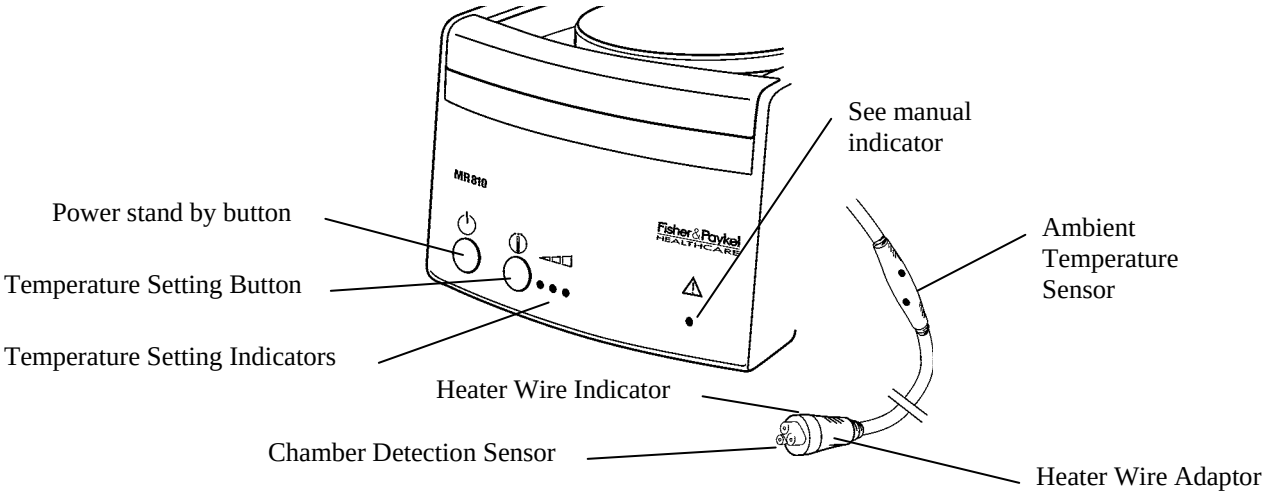


Figure 3.3: MR810 controls and indicators

3.4.1 POWER BUTTON

When this button is pressed briefly, the humidifier will toggle "on" or "off". The humidifier defaults to the High setting when turned on. The humidifier also stores the previous setting in non-volatile memory.

The operator can toggle between Default-to-High and restoring the previous setting by depressing both mode and power buttons when mains power is first applied.

NOTE: There is no immediate feedback to the operator that the Default-to-High setting has been changed.

When the device is turned on, the humidifier performs internal diagnostic checks before initiating normal control.

WARNING: Even if the MR810 is switched off with the power button, the unit is still energised. Disconnect the MR810 from the power supply before servicing.

3.4.2 TEMPERATURE SETTING BUTTON AND LEVEL INDICATORS

The temperature setting button, when pressed briefly, decrements the temperature setting, cycling from high to low. Three green LED indicators indicate the temperature setting as follows:

● ● ●	High setting:	All three LEDs illuminated
● ● ○	Medium setting:	Left and middle LED illuminated
● ○ ○	Low setting:	Left LED illuminated only

For more information on the temperature settings refer to § 3.5.

3.4.3 "SEE MANUAL" INDICATOR

The "See Manual" indicator displays two fault types:

Hardware Fault. The "See Manual" indicator flashes off and on. Briefly pressing the Temperature Setting button briefly produces a pattern on the three Temperature Setting Indicators, representing a fault code. Refer to § 5.2 for fault code definitions.

Microprocessor Fault. The "See Manual" indicator is on continuously.

3.4.4 HEATER-WIRE INDICATOR

The Heater-wire Indicator is located in the connector at the end of the heater-wire adaptor. If the heater-wire adaptor is connected to a compatible heated wire circuit then the green indicator will illuminate, and the heater-wire mode of operation is initiated.

If a heated circuit is connected and the Heater-wire Indicator does not turn on then a fault is present in either the heated circuit or the heater-wire adaptor, and non heater-wire mode of operation will be initiated.

Refer to § 5 for trouble shooting.

3.4.5 AMBIENT TEMPERATURE SENSOR

Measures ambient air temperature for controlling the heating of the heated wire breathing circuits. Refer to § 3.5.1 for more information.

3.4.6 CHAMBER DETECTION SENSOR

A thermistor is embedded in the third pin in the heater-wire connector. This thermistor senses the chamber type (reusable or single-use) by measuring the temperature of the gas exiting the chamber as it passes through the circuit elbow.

3.5 OPERATION

The MR810 humidifier has two modes of operation: (a) heater-wire mode and (b) non heater-wire mode.

3.5.1 HEATER-WIRE MODE

Connecting a heated wire breathing circuit (between 10 and 28 Ω) to the MR810 will automatically initiate the heater-wire mode of control. The flow detection algorithm starts, and the Heater-wire Indicator in the heater-wire connector illuminates.

Flow Detection State

At power-on the MR810 controls the heater plate to a fixed temperature dependent on the setting (40 °C at Low, 50 °C at Medium and High). The humidifier monitors the power required by the heater plate to maintain this temperature. Once the system is stable (about half an hour), the humidifier estimates the gas flow rate based on the power required. The humidifier then initiates the normal control state. With the temperature measured by the chamber sensor thermistor, the humidifier can identify the type of chamber (reusable or single use) being used and control accordingly.

The humidifier applies power to the heater-wire circuit dependant on the ambient temperature and the mode selected.

Normal Control State

Once the flow has been estimated, the humidifier controls the heater plate to a fixed temperature based on the estimated flow. The humidifier then continues to monitor the heater plate temperature and power consumption for changes. Any significant power change (due to a change in flow, chamber run out of water etc.), will cause the humidifier to switch back to the flow detection state. Small power changes will cause the humidifier to step the heater plate temperature up or down to compensate for the change.

Mains Voltage Compensation

The humidifier automatically compensates for fluctuations in mains voltage to accurately control the power being delivered to the heater-wire and heater plate. Compensation is limited to ± 10 % of rated operating voltage.

Ambient Temperature Compensation

In the heater-wire mode of operation, cold ambient temperatures will cause the humidifier to automatically increase the heater-wire power, minimising the condensate in the breathing circuit. Conversely for high ambient temperatures the heater-wire power is automatically reduced.

Ambient temperature compensation is limited to between 18 and 30 °C, as shown in Figure 3.4, effectively limiting the maximum effect due to ambient temperature compensation.

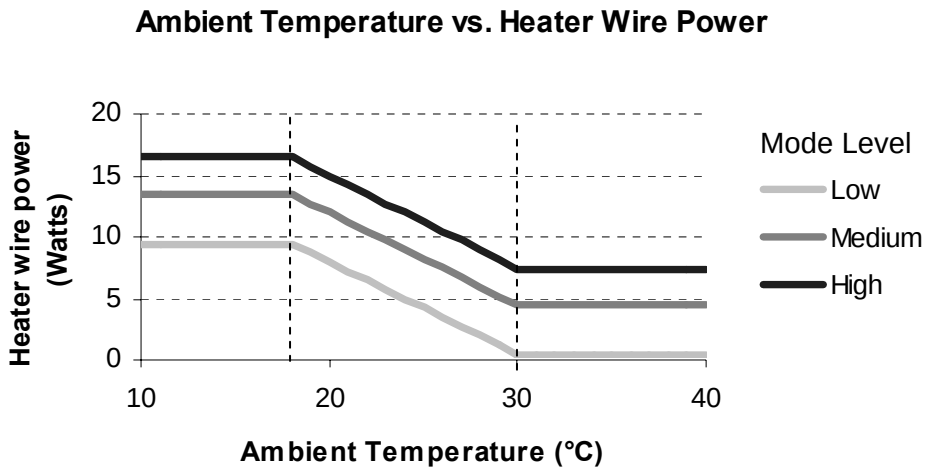


Figure 3.4: Heater-wire power over the ambient temperature 10 to 40 °C

3.5.2 NON HEATER-WIRE MODE

If no heater-wire is detected, the MR810 initiates non heater-wire mode. In this mode the heater plate temperature is controlled to a fixed value. Heater plate temperatures for each temperature setting are as follows:

Low Setting: 45 °C

Medium Setting: 60 °C

High Setting: 70 °C

As this mode controls to a fixed heater plate temperature, any variation in ambient temperature has no effect on the control algorithm.

3.6 DIAGNOSTIC PORT

The diagnostic port is used for downloading information when servicing of the unit is required. It must be used with the communication cable found in the service kit REF 043042263 to connect to a PC.

Figure 3.5 Diagnostic port

4 MAINTENANCE & CLEANING PROCEDURES

4.1 CLEANING

The following is the recommended cleaning procedure for the MR810 Respiratory Humidifier. Solutions listed below have been tested to ensure that no damage will occur with the metal and plastic components of the humidifier. Cleaning should be performed as required.

1. Disconnect the humidifier from the electrical outlet.
2. Clean the humidifier with one of the following using a damp cloth:
   - Normal dishwashing detergent
   - Isopropyl alcohol
3. Wipe the humidifier clear of any cleaning residues before use.

Caution

DO NOT immerse the humidifier in any liquid. Using other solutions may damage the humidifier.

4.2 ANNUAL MAINTENANCE

To ensure that the humidifier is safe and effective in operation the following maintenance shall be carried out **ANNUALLY**.

4.2.1 VISUAL CHECK

Check the humidifier for physical damage as follows:

1. Check the power cable for damage, replace if necessary (§ 6.6).
2. Check the heater-wire adaptor for kinks, abrasions or damage to the connector. Replace if necessary (§ 6.6).
3. Check the heater plate for deep scratches, replace if necessary (§ 6.5.3).
4. Check the humidifier case for cracks and ensure case screws are fitted and correctly tightened (the three screws under the humidifier). Check the finger guard is fitted and prevents contact with the heater plate during normal operation.

4.2.2 ELECTRICAL SAFETY CHECK

Check that the humidifier is electrically safe to use. Refer to § 7.

4.2.3 PERFORMANCE TEST PROCEDURE

Carry out the performance test procedure described in § 8.

5.2 SEE MANUAL CODES

When the See Manual Indicator is illuminated the humidifier will switch off the heater plate and heater-wire. Pressing the Temperature Setting button displays the error code on the Temperature Setting Indicators, as explained in Table 3.

Table 3: Indicator codes and their meaning

Temperature Setting Indicators	See manual Indicator	Fault Description	Section
○ ○ ○	●	Microprocessor failure, replace PCB.	6.4
● ○ ○	◌	Button fault. Check buttons are correctly seated.	6.7.1
○ ● ○	◌	Heater plate primary thermistor fault (short or open circuit). Check the thermistor is working correctly, replace if necessary.	6.5.4
◍ ● ○	◌	Heater plate secondary thermistor fault (short or open circuit). Check the thermistor is working correctly, replace if necessary.	6.5.4
○ ○ ◍	◌	Ambient thermistor fault (short or open circuit), check heater-wire adaptor, replace if necessary.	6.6
● ○ ●	◌	Chamber Sense thermistor fault (short or open circuit), check heater-wire adaptor, replace if necessary.	6.6
○ ● ◍	◌	Heater-wire relay fault (short or open circuit). PCB faulty, service or replace PCB as necessary.	6.4
○ ◌ ○	◌	Heater control triac error (Heater-wire triac short circuit or heater plate triac open/short circuit). Service triac circuitry, replace PCB if necessary.	6.4
○ ◌ ◌	◌	Heater-wire Clip Circuit error. Service the hardware clip circuit, replace PCB if necessary.	6.4
◌ ◌ ◌	◌	Failed factory production testing. Device should be returned to your Fisher & Paykel Healthcare representative.	

Temperature Setting Indicator description

- ○ Indicator off
- ◌ Indicator flashing
- ◍ Indicator on

6 SERVICING PROCEDURES

NOTE: A complete list of spare parts in contained in Appendix C.

6.1 PRECAUTIONS

WARNING:

Even if the MR810 is switched off with the power button, the unit is still energised. Disconnect the MR810 from the power supply before servicing.

After servicing the humidifier should be electrically safety tested (§ 7), and performance tested (§ 8), to ensure correct operation.

Ensure case screws are correctly fitted to the product after assembly. Replace the top case if any screw thread strips.

Caution

The MR810 contains electrostatically sensitive components. Ensure antistatic procedures are followed when servicing.

Do not use excessive force when re-fastening screws. (Refer to Table 6 for correct torque settings).

6.2 OPENING THE CASE AND REMOVING THE PCB

6.2.1 OPENING THE CASE

WARNING:

Even if the MR810 is switched off with the power button, the unit is still energised. Disconnect the MR810 from the power supply before servicing.

1. Ensure mains plug has been disconnected from the wall socket.
2. Place the unit upside down and remove the three screws in the bottom cover (refer to Figure 6.1).
3. Pull the case front forward to disengage the two clips, then lift the front of the bottom cover up and then away (see Figure 6.1). Refer to the exploded diagram (Figure 8.1) for further dis/assembly detail.

Figure 6.1: Removing the case bottom

6.2.2 REMOVING THE PCB

1. Unscrew the two screws holding the PCB in place.
2. Carefully lift the rear of the PCB up, the cable clamp will need to be guided out of its locator on the top case. Lift the PCB away from the case front (see Figure 6.2 below), and carefully flip the PCB upside down onto the bench.

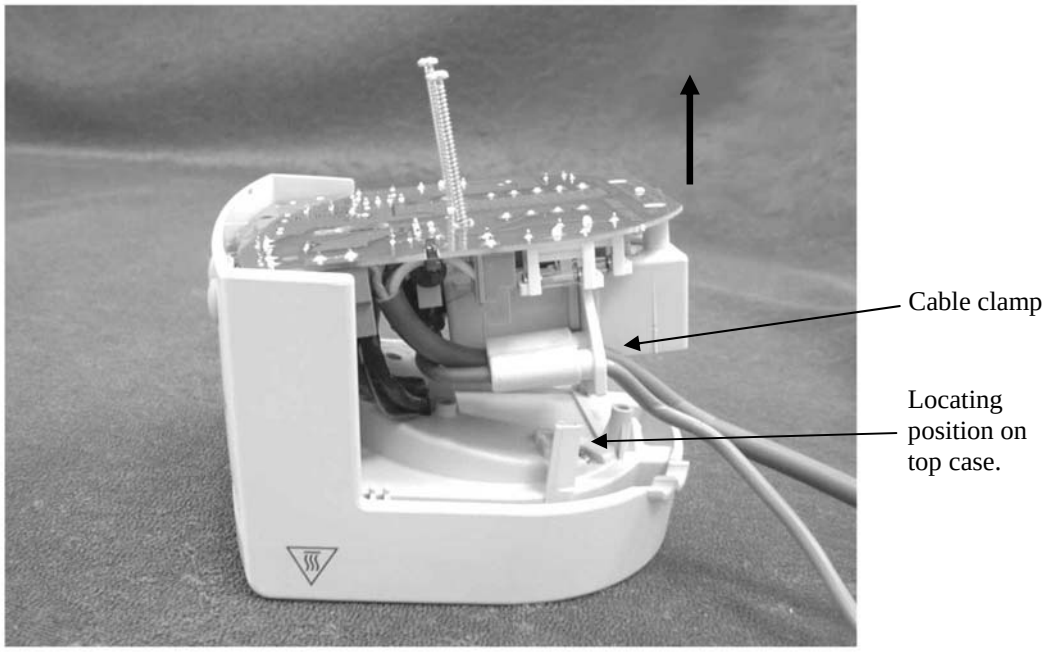


Figure 6.2: Removing the PCB

6.3 REPLACING FUSES

WARNING:

Be sure to replace fuses with the correct type and rating, specified in Table 4.

Always replace fuse F3 with a 2 A fast blow type as serious injury could result from the wrong fuse. Open the case and remove the PCB (refer to § 6.2)

Note: A limited number of MR810AEA units were manufactured with fuse F3 rated at 1.5 A. These units can be identified by the fuse rating information laser-scribed on the inside of the lower case. For these units only, F3 must be replaced with a 1.5 A fast blow fuse.

1. Slide the cable clamp up out of the transformer mount and lift it away from the fuses.
2. The fuses can now be accessed. Refer to Figure 6.3 for the location of the fuses and Table 4 for replacement fuses.
3. Install the PCB and assemble the case (refer to § 6.8).

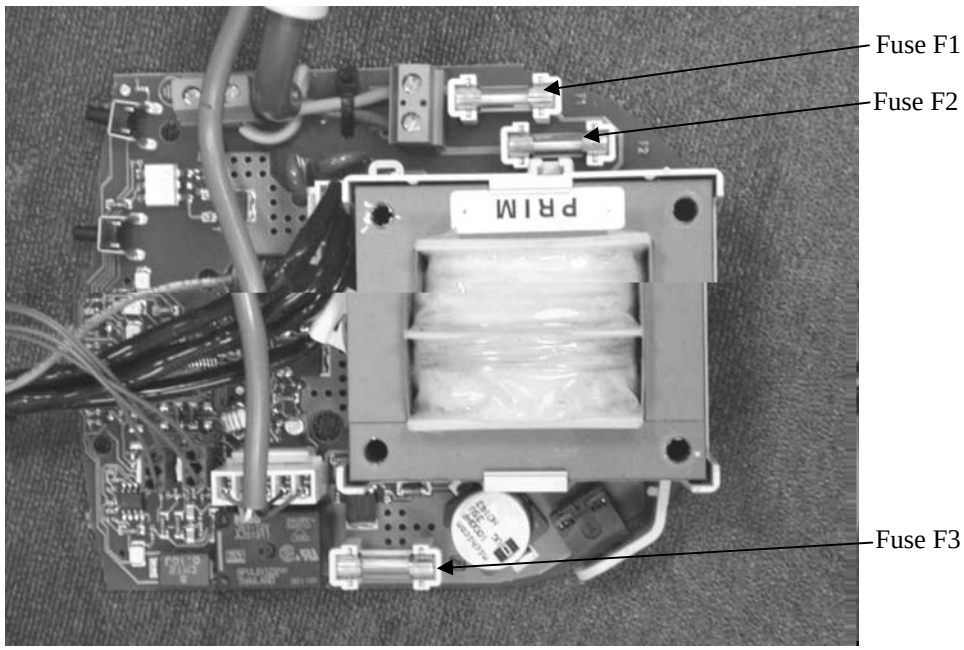


Figure 6.3: Fuse Location

Table 4: Replacement fuse ratings and part numbers (for single fuses)

Model	Supply Voltage	Fuse Type	Part Number
MR810A--	230 V~	F1: 1.5 A 250 V~, Fast Blow F2: 1.5 A 250 V~, Fast Blow F3: 2.0 A 250 V~, Fast Blow	999 830 008 999 830 008 999 830 009
MR810J--	115 V~	F1: 2.0 A 250 V~, Fast Blow F2: 2.0 A 250 V~, Fast Blow F3: 2.0 A 250 V~, Fast Blow	999 830 009 999 830 009 999 830 009
MR810G--	100 V~	F1: 2.0 A 250 V~, Fast Blow F2: 2.0 A 250 V~, Fast Blow F3: 2.0 A 250 V~, Fast Blow	999 830 009 999 830 009 999 830 009

6.4 REPLACING THE PCB

Table 5 : Spare PCB part numbers

Model	Supply Voltage	PCB Part Number
MR810A--	230 V~	043 042 232
MR810J--	115 V~	043 042 233
MR810G--	100 V~	043 042 234

1. Open the case and remove the PCB (refer to § 6.2).
2. Cut the cable tie holding the phase and neutral conductors to the PCB (refer to Figure 6.4).
3. Slide the power cable and heater-wire adaptor clamp off the transformer support and lift away.
4. Unscrew the power cable (phase, neutral, and earth), and the heater plate earth connection.
5. Detach the heater-wire adaptor connector, the heater plate connector and the two heater plate thermistor connectors (refer to Figure 6.4).
6. Unpack the replacement PCB and check that it is the correct voltage model from Table 5 above.
7. Reconnect the power cable, secure the phase and neutral wires to the PCB using a small (2.5 mm wide) cable tie.
8. Screw the heater plate protective earth into the protective earth terminal block.
9. Reconnect the heater-wire adaptor, heater plate harness and two thermistors to their respective locations.
   Note: the primary and secondary thermistors can be connected to either location on the PCB.
10. Slide the power cable and heater-wire adaptor clamp onto the transformer of the new PCB.
11. Reinstall the PCB, and close the case (refer to § 6.8).

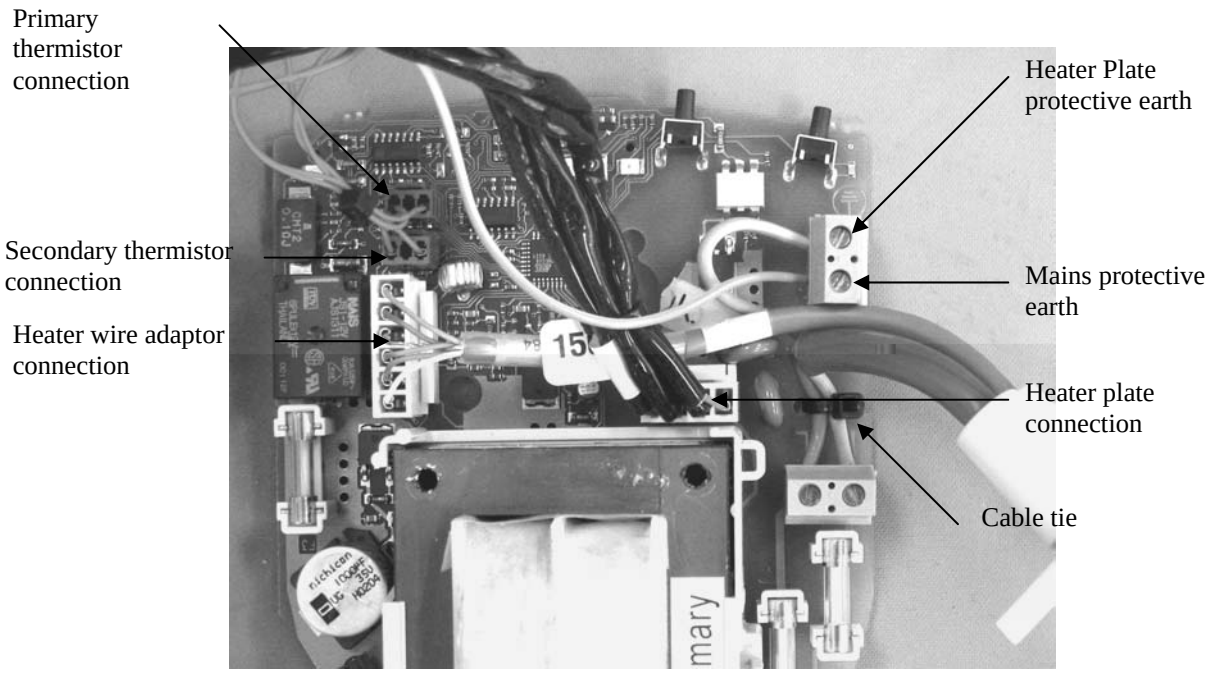


Figure 6.4: Harness and power cable connections

6.5 SERVICING THE HEATER PLATE

Table 6: MR810 Screw Torque Settings

Exploded Diagram Reference	Screw	Application	Driver	Torque (in/oz)	Torque (Nm)
Figure 8.2: 9,11	Screw M4 x 8 Pan Phil Taptite	Heater Plate Earth, Heater Plate Element	Philips #2	205–234	1.45-1.65
Figure 8.2: 3,6	Screw M3 x 5 Pan Phil Taptite	Thermostat, Thermistor	Philips #1	163-177	1.15-1.25
Figure 8.1: 5	Screw M3 x 5 Pan Phil Taptite	Heater Plate Stand-off	Philips #2	85– 113	0.6 – 0.8
Figure 8.1: 1,2	Screw 6 x 53 Pan Phil TY25 ZP	MR810 PCB, Case screw	Philips #2	99 –127	0.7 – 0.9

6.5.1 RESETTING THE THERMAL CUT-OUT

NOTE: If the heater plate is still hot, allow it to cool sufficiently before attempting to reset the thermal cut-out.

1. Disconnect the power supply and open the case (refer to § 6.2).
2. With the humidifier upside down, the thermal cut-out can be reset by depressing the red thermal cut-out reset button through the hole in the PCB (Figure 6.5), using a pin of at least 60 mm long and diameter of approximately 4-5 mm. If the thermal cut-out "clicks" when pressed then the cut-out had been tripped.
3. Close the case (refer to § 6.8.2).

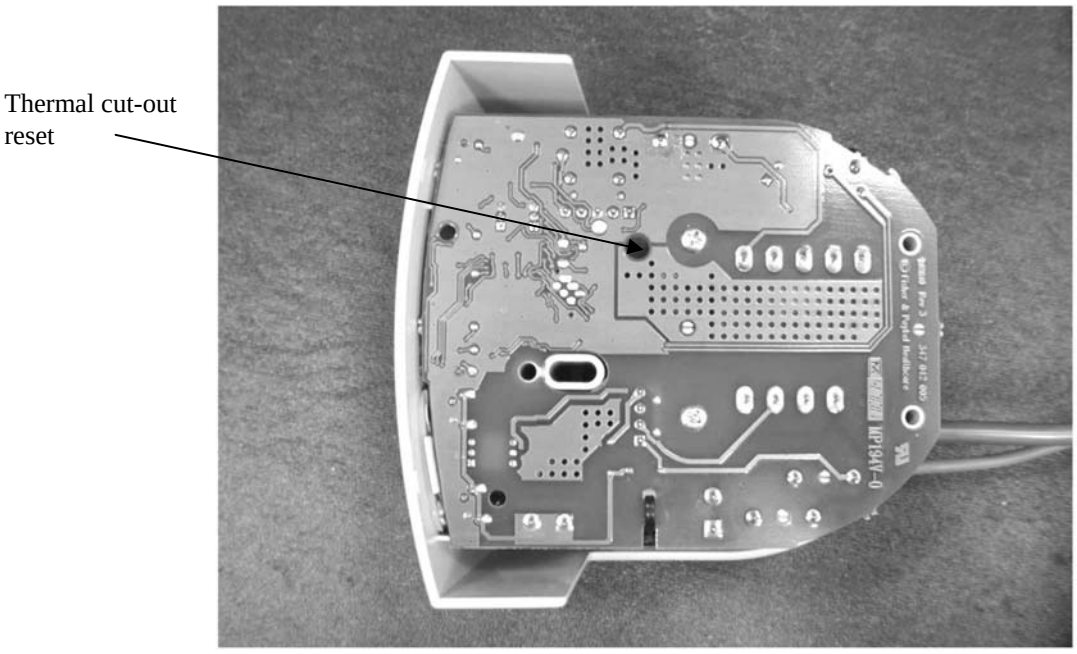


Figure 6.5: Location of the thermal cut out reset button

6.5.2 REMOVING THE HEATER PLATE

1. Disconnect the power supply, remove the case bottom, unscrew and lift out the PCB (refer to § 6.2).
2. Unscrew the heater plate protective earth wire from the PCB, disconnect the heater plate and the heater plate thermistor harnesses, separate the case top from the PCB. (Refer to Figure 6.4 for connector locations).
3. Unscrew the three heater plate mounting screws (refer to Figure 6.6).
4. Remove the case top from the heater plate being careful not to lose the three heater plate springs underneath.

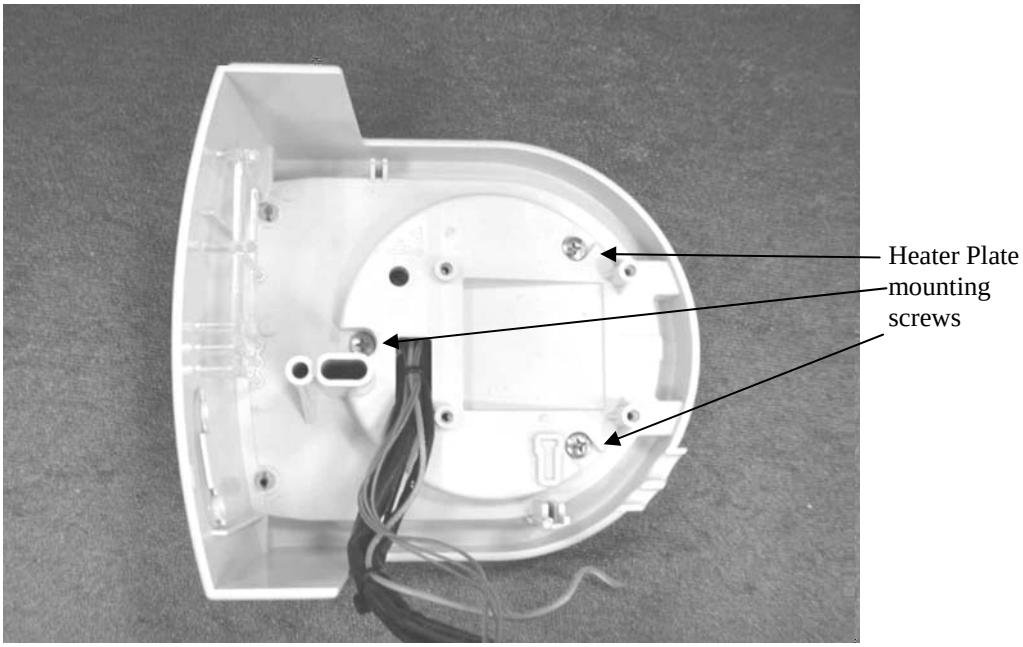


Figure 6.6: Location of heater plate mounting screws

6.5.3 REPLACING THE HEATER PLATE

Table 7: Spare heater plate part numbers

Model	Supply Voltage	Heater Plate Part Number
MR810A--	230 V~	043 042 236
MR810J--	115 V~	043 042 237
MR810G--	100 V~	043 042 238

1. Open the case and remove the PCB (refer to § 6.2).
2. Remove the heater plate (refer to § 6.5.2).
3. Unpack the replacement heater plate and check that it is the correct voltage from Table 7 above.
4. Reinstall the heater plate (refer to § 6.5.7).
5. Reassemble the PCB and the case (refer to § 6.8).

6.5.4 REPLACING THE HEATER PLATE THERMISTOR

If the device has shown a thermistor fault, the resistance of the thermistor(s) can be checked at known temperatures against the resistance-temperature table (Table 8 below).

Table 8: Thermistor resistance temperature table

Temperature		Resistance	Temperature		Resistance
°C	°F	Ω	°C	°F	Ω
5	41.0	22916	32	89.6	7676
10	50.0	18422	33	91.4	7398
15	59.0	14922	34	93.2	7133
20	68.0	12174	35	95.0	6878
21	69.8	11698	40	104	5756
22	71.6	11244	45	113	4843
23	73.4	10810	50	122	4098
24	75.2	10396	55	131	3484
25	77.0	10000	60	140	2977
26	78.8	9622	65	149	2556
27	80.6	9263	70	158	2204
28	82.4	8915	75	167	1908
29	84.2	8584	80	176	1660
30	86.0	8268	85	185	1449
31	87.8	7965	90	194	1269

NOTE: Heater plate thermistor(s) will be required (part number 095 428 870).

1. Open the case and remove the PCB (refer to § 6.2).
2. Remove the heater plate (§ 6.5.2). Refer to Figure 8.2 for the exploded diagram.
3. Cut the two cable ties securing the thermistors (refer to Figure 6.7).
4. Remove the screw holding the heater plate thermistors (refer to Figure 6.8).
5. Place the new heater plate thermistor and screw it down.

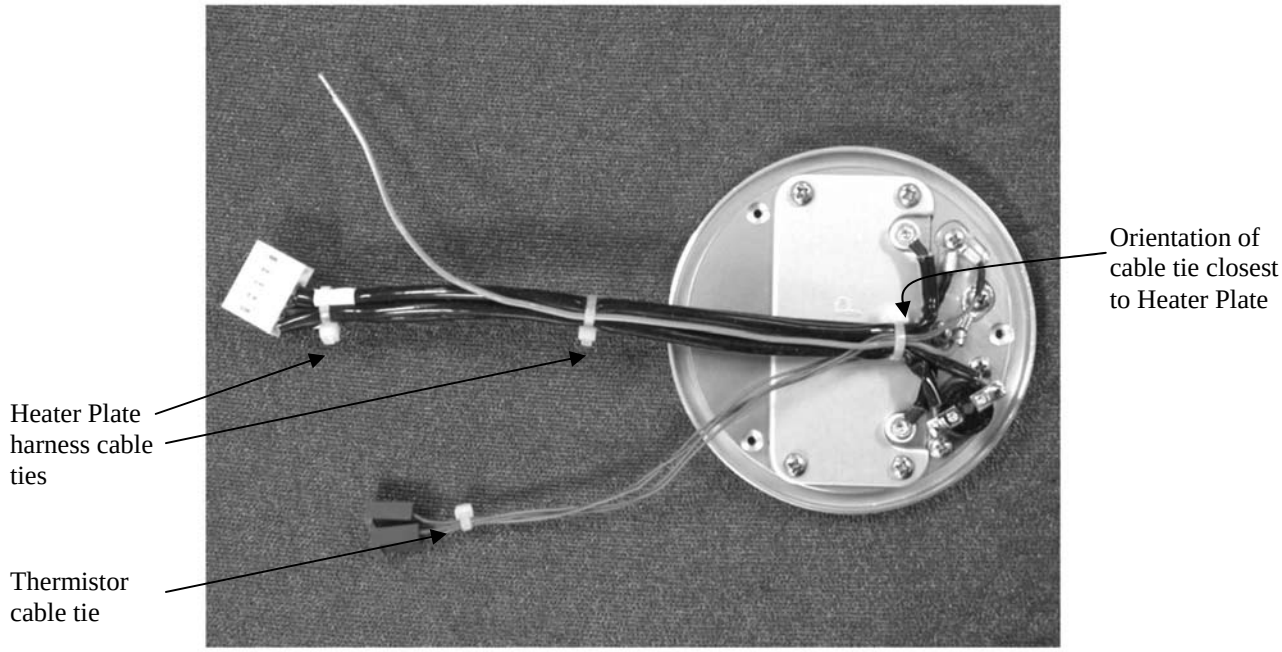


Figure 6.7: Location of cable ties securing heater plate harness

6. Clip one small cable tie (2.5 mm wide) around the heater plate harnesses near the heater plate, securing all wires as they protrude through the top case. Place a second cable tie near the thermistor connectors to secure the thermistor wires as they enter the connector (refer to Figure 6.7 for cable tie location).
7. Install the heater plate back into the case top (§ 6.5.7).
8. Reassemble the PCB and the case (§ 6.8).

6.5.5 REPLACING THE THERMAL CUT-OUT

NOTE: a replacement thermal cut out will be required (part no 349 040 051).

1. Open the case and remove the PCB (refer to § 6.2).
2. Remove the heater plate (refer to § 6.5.2). Refer to Figure 8.2 for the exploded diagram.
3. Cut the cable ties attached to the heater plate harness.
4. Unsolder the two wires attached to the thermal cut-out (Figure 6.8).
5. Remove the two screws holding the heater plate thermal cut-out.
6. Place the new thermal cut-out and screw it down.
7. Solder the wires back onto the thermal cut-out.
8. Ensure the thermal cut out has not been tripped by pressing the red reset button.
9. Clip three small cable ties (2.5 mm wide) around the heater plate harnesses. Place one close to the heater plate, securing all wires as they protrude through the top case. Place another halfway up the wires securing the heater plate harness and protective earth wire (leave the thermistor wires free for flexibility in connecting to the PCB). The last tie secures the heater plate harness wires near the Molex plug (this tie may not need to be cut to replace the cut out). Refer to Figure 6.7 for cable tie locations.
10. Install the heater plate back into the case top (refer to § 6.5.7).
11. Reassemble the PCB and the case (refer to § 6.8).

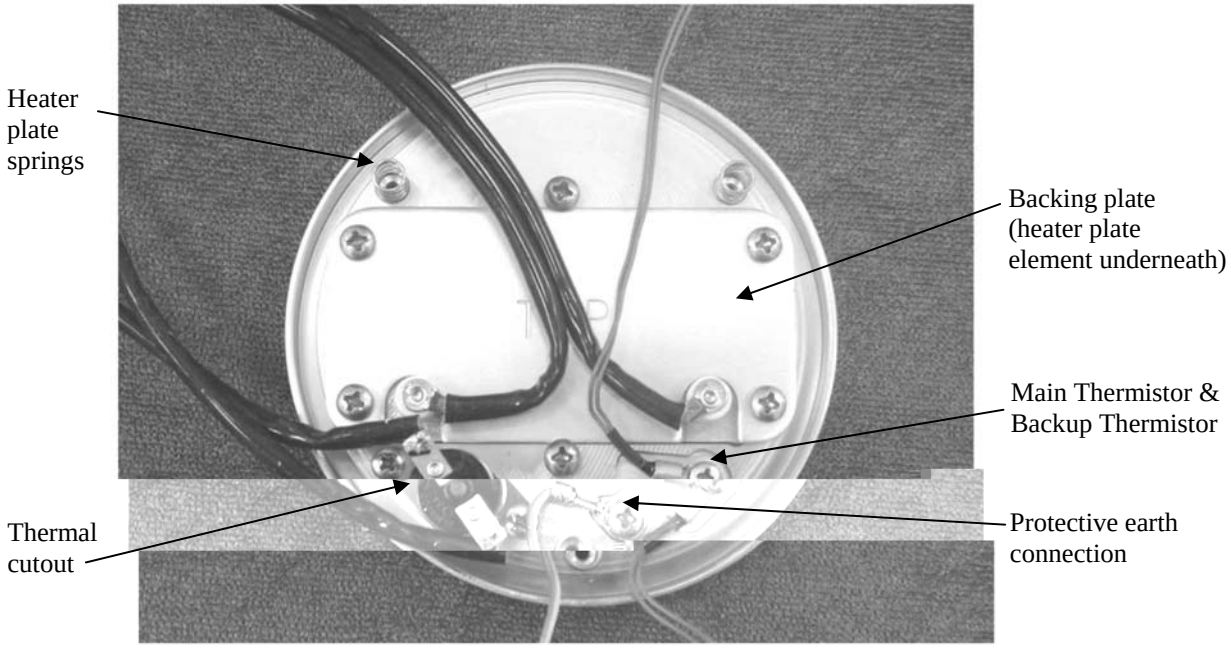


Figure 6.8: Heater plate components

6.5.6 REPLACING THE HEATER PLATE ELEMENT

NOTE: The correct heater plate element is required (refer to Table 9 below).

1. Open the case and remove the PCB (§ 6.2).
2. Remove the heater plate (§ 6.5.2).
3. Cut the cable ties attached to the heater plate harness.
4. Unscrew the six screws holding the backing plate and remove it (Figure 6.8). Refer to Figure 8.2 for the exploded diagram.
5. Check the heater plate resistance against Table 9. Discard the heater plate element if the resistance is incorrect (do not discard the mica insulator situated under the heating element).
6. Inspect the mica insulator for any holes by holding it up to the light, and replace it if any are visible (part number 331 040 114).
7. Ensure the mica insulator is correctly located on the heater plate and place the new element and backing plate over the top.
8. Screw the heating element backing plate back on with the six screws.
9. Clip three small cable ties (2.5 mm wide) around the heater plate harnesses. Place one close to the heater plate, securing all wires as they protrude through the top case. Place the second tie halfway up the wires securing the heater plate harness and protective earth wire (leave the thermistor wires free for flexibility in connecting to the PCB). The last tie secures the heater plate harness wires near the Molex plug. (Refer to Figure 6.7 for cable tie locations).
10. Install the heater plate back into the case top (§ 6.5.7).
11. Reassemble the PCB and the case (§ 6.8).

Table 9: Replacement heater plate elements

Model	Supply Voltage	Heater Plate Element Part Number	Heater Plate Resistance (Cold)
MR810A--	230 V~	043 041 342	353 ± 12 Ω
MR810J--	115 V~	043 041 340	88 ± 3 Ω
MR810G--	100 V~	043 040 341	67 ± 2 Ω

6.5.7 INSTALLING THE HEATER PLATE

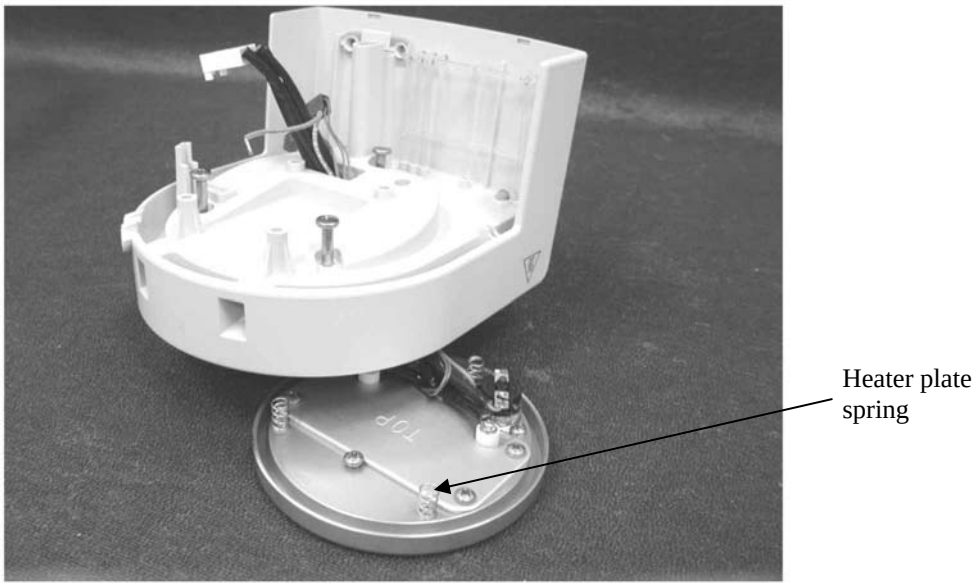


Figure 6.9: Heater plate assembly

1. Ensure the heater plate springs are located in their respective location holes on the heater plate.
2. Pull the heater plate harness through the hole in the case top (Figure 13).
3. Carefully orient the case upper over the heater plate springs, then screw the three mounting screws back into place.

6.6 REPLACING THE POWER CABLE OR HEATER-WIRE ADAPTOR

Note: The spare heater-wire adaptor, part number 043 042 322, includes the cable clamp and collet for the mains cable and heater-wire adaptor.

Table 10: Part numbers and colour codes of Fisher & Paykel Healthcare power cables

Model	Supply Voltage	Power Cable Part Number	Phase Colour	Neutral Colour	Earth Colour	Plug
MR810ALU MR810AGU MR810AFU MR810ARU MR810ANU	230 V~	095 428 323	Brown	Blue	Green / Yellow	Schuko
MR810AEA	230 V~	095 428 317	Brown	Blue	Green / Yellow	Australasian
MR810AEK	230 V~	095 428 569	Brown	Blue	Green / Yellow	UK
MR810AEU	230 V~	095 428 856	Brown	Blue	Green / Yellow	No Plug
MR810ADU	230 V~	095 428 854	Brown	Blue	Green / Yellow	Danish
MR810JHU MR810JSU	115 V~	095 428 322	Brown or Black	Blue or White	Green / Yellow	USA Right angle
MR810GJU	100 V~	095 428 869	Brown or Black	Blue or White	Green/Yellow	Japanese

Caution

When connecting the power cable ensure the polarity of the wires is correct (the table given above applies to power cords supplied by Fisher & Paykel Healthcare). If other cables are used ensure that they are fitted with ferrules to prevent loose wire strands.

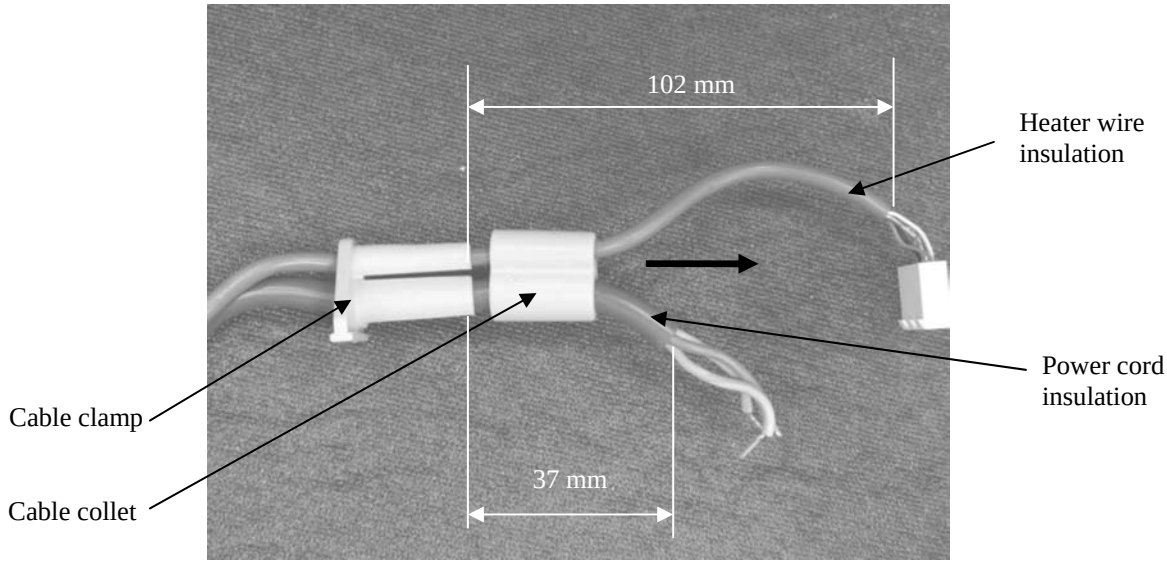


Figure 6.10: Showing the disassembly, assembly of the cable clamp

6

1. Open the case and remove the PCB (§ 6.2).
2. Cut the cable tie retaining the phase and neutral conductors to the PCB (see Figure 6.4 for PCB connection locations).
3. Unscrew the power cable conductors from their terminal blocks.
4. Unplug the heater-wire adaptor harness from the PCB.
5. Slide the cable assembly off the transformer support.
6. With a large flat-blade screwdriver, carefully lever off the cable collet from the cable clamp. (Figure 14 shows separated cable clamp parts).
7. Replace the power cable (refer to Table 10) or heater-wire adaptor (part number 043 042 322) as required.
8. Leave approximately 102 mm of the heater-wire insulation protruding from the closed cable clamp, and 37 mm of the power cord insulation (Figure 6.10).
9. Carefully slide the cable collet back over the power cable and forcefully press the cable collet back onto the clamp.
10. Terminate the power cable to the correct locations on the PCB. (Refer to Table 10 for colour codes, and Figure 6.4 for PCB connection locations).
11. Anchor the phase and neutral conductors to the PCB with a small cable tie (2.5 mm wide).
12. Slide the cable assembly back onto the transformer support; ensure cables are not under excessive tension.
13. Install the PCB and close the case (refer to § 6.8).
14. Check the power cable is held securely by pulling on it firmly.

6.7 REPLACING THE PUSH BUTTONS AND THE LED LIGHT PIPE

6.7.1 REPLACING THE PUSH BUTTONS

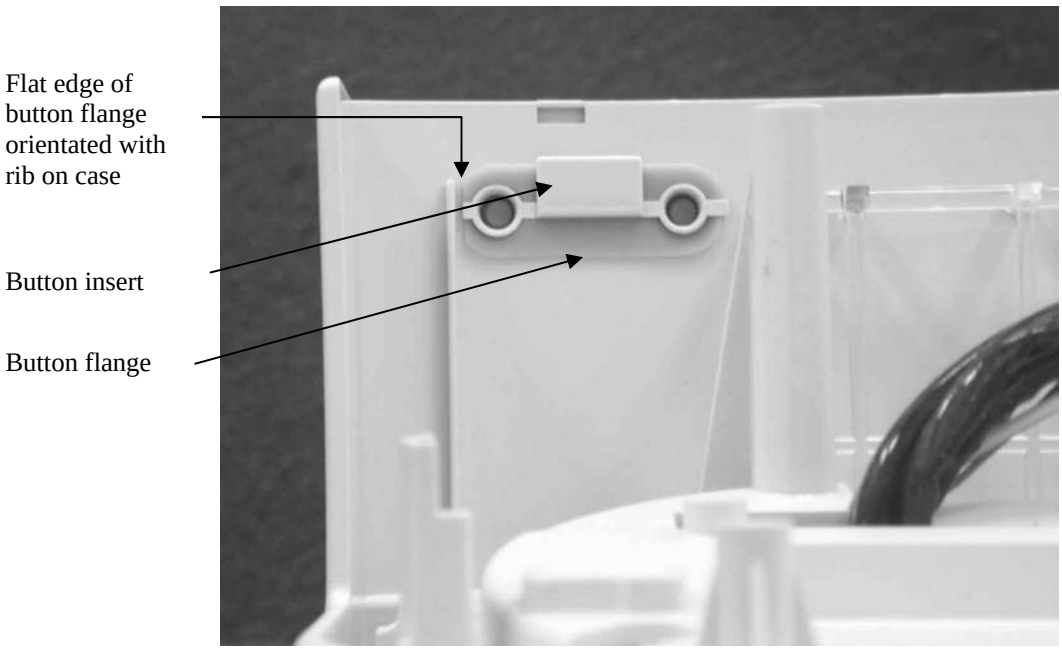


Figure 6.11: Orientation of button flange and button insert

1. Open the case and remove the PCB as outlined in § 6.2.
2. To replace the push buttons, remove the button retainer from inside the case. Now push the silicone button from the front through the hole. Discard the button.
3. To install the new push button: orient the flat edge of the button flange with the rib on the case (the buttons are designed to go in one way only). Now press the push button through the holes from inside the case (Figure 6.11).
4. Orient the short side of the button retainer to the rib side of the case with the tab protruding towards the base of the upper case. Insert the button retainer into the rear of the silicone buttons (Figure 6.11).
5. Now install the PCB, check the push button operation, and close the case as outlined in § 6.8

6.7.2 REPLACING THE LED LIGHT PIPE

1. Open the case and remove the PCB as outlined in § 6.2.
2. Pull the LED light pipe out of the holes in the front of the top case and lift away (Figure 6.12).
3. Insert the new LED light pipe into the four locations in the top of the case, and then slide the four LED light pipes into their holes in the front of the case. Check that the LED light pipe ends are flush with the case front.
4. Now install the PCB and close the case as outlined in § 6.8

6.8 ASSEMBLING THE PCB AND CASE

6.8.1 INSTALLING THE PCB

1. Ensure the LED light pipe is located correctly in the holes in the top and front of the case top.
2. Carefully angle the front of the PCB over the LED light pipe, inserting the push button stems into the silicone push buttons, ensure the light pipe stems protrude into the holes on the PCB (Figure 6.12).
3. Carefully guide the cable clamp into the slot in the case top.
4. Check that no wires are trapped between the transformer mount and upper case.
5. Install the two screws through the PCB assembly into the case top and screw down (torque settings as per Table 6); check the push button operation.

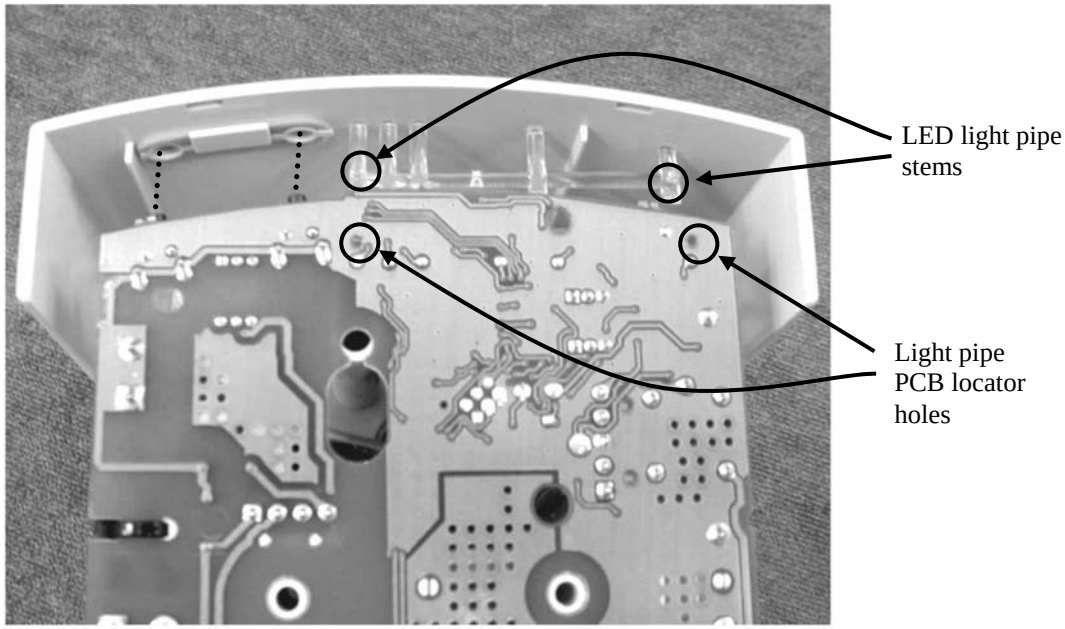


Figure 6.12: Installing the PCB

6.8.2 REASSEMBLING THE CASE

1. Angle the back of the case bottom into the case top (Figure 6.1).
2. Drop the front into position, ensuring the screw hole and drain are correctly located. Then press the front down and the case top should snap into place.
3. Screw the three screws into place to secure the case lower (torque settings as per Table 6, § 6.5).

WARNING: Ensure case screws are correctly fitted to the product. Replace the top case if any screw threads strip.

6.9 COMPLETING THE SERVICE

1. Power up the device and check that the push buttons and indicators work correctly.
2. Complete the appropriate electrical safety tests outlined in § 7.
3. Perform the performance tests outlined in § 8.

7 ELECTRICAL SAFETY TESTS

After the MR810 has been serviced, perform the following electrical safety tests as listed below or in accordance with relevant country regulations.

7.1 PROTECTIVE EARTH RESISTANCE

Use an ohmmeter and measure the resistance from the earth pin on the mains plug to the heater plate. To ensure good contact with the anodised heater plate an alligator clip is recommended. Connect at the front of the heater plate where the anodising has been removed (see Figure 7.1). The resistance should be ≤ 0.2 Ω.

7.2 EARTH LEAKAGE CURRENT

Measure earth leakage with the earth probe of the tester on the heater plate (see Figure 7.1). Earth leakage current is measured at normal mains operating voltage and frequency; it should not exceed 0.5mA maximum.

7.3 INSULATION RESISTANCE

Use a 500 VDC insulation resistance tester to measure the resistance from the phase pin on the mains plug to the heater plate (see Figure 7.1). Insulation resistance should be ≥ 10 MΩ.

Figure 7.1: Location of test point on heater plate

8 PERFORMANCE TEST PROCEDURE

8.1 INTRODUCTION

This section outlines the performance testing required for the MR810 as part of the annual maintenance or after servicing of the humidifier.

If the MR810 is intended to be used with a heated wire circuit, perform the functional check (§ 8.2) and the Heater-wire Mode Performance check (§ 8.3).

If the MR810 is intended to be used with a non heated circuit, perform the functional check (§ 8.2) and the non Heater-wire Mode Performance check (§ 8.4).

8.2 FUNCTIONAL CHECK

Check the function of the humidifier buttons and indicators as follows, allow two minutes to complete the test:

1. Apply power to the unit under test; as power is applied check that the "See Manual" indicator flashes briefly.
2. Check the operation of the power button. Replace if necessary (refer to § 6.7).
3. Turn the device on. Press the Temperature Setting button and cycle through all three settings of the humidifier. If pressing the Temperature Setting button has no effect, check the button seating, and replace if necessary. (Refer to § 6.7).
4. Using a Fisher & Paykel Healthcare compatible heated breathing circuit (such as an RT202), check that the LED in the heater-wire adaptor illuminates when plugged into the circuit. If the heater-wire indicator remains off, consult § 5 (Troubleshooting).

8.3 HEATER-WIRE MODE PERFORMANCE CHECK

Conduct this check if the MR810 is used with heated breathing circuits.

- The following test should be performed with either the RT202 kit (using the included MR290 chamber), or the MR370 chamber and CR140 reusable circuit kit. Other chambers or circuits will give different results.
- The test should be conducted in an ambient temperature of 23 ± 2 °C with no drafts. Do not conduct the test with a hot heater plate as this can affect the accuracy of the test. Allow the MR810 to cool before starting.
- Turning the device on/off, changing temperature settings, changing the gas flow, or disconnecting the heater-wire will require the test to be restarted.
- Allow 1 to 2 hours to complete the test.

8.3.1 EQUIPMENT REQUIRED

1. MR810 humidifier to be tested.
2. Single-use: RT202 single use breathing circuit or similar.
   Reusable: CR900 reusable heater-wire elbow with 1.5m reusable tubing (CR140 kit).
3. Single-use: MR290 chamber filled with water (included in RT202 kit).
   Reusable: MR370 reusable chamber filled to maximum water line.
4. Constant dry gas source of 10 ± 2 l/min.
5. Fisher & Paykel Healthcare Thermometer, part no 900MR033.

8.3.2 TEST PROCEDURE

1. Connect the MR810 as for normal operation (refer to § 3). Make sure the airway probe port is capped.
2. Check the thermometer for air bubbles in the red alcohol, and discard if any are present. Fully insert the supplied thermometer into the chamber temperature probe port.
3. Adjust the gas source to 10 ± 2 L/min.
4. Turn on the MR810 and set to the Medium setting, and check that the heater-wire indicator is on.
5. Allow the humidifier to stabilise for at least one (1) hour.
6. Check the thermometer temperature reading is within the range 29 to 35 °C. If not, leave the MR810 for another half-hour then recheck. After rechecking, the unit fails the test if still outside the temperature range. Consult § 5 (Troubleshooting).
7. Now remove the thermometer and cap the temperature probe port. Insert the thermometer fully into the airway probe port.
8. After five (5) minutes note the thermometer temperature. If the temperature is within the range 29 to 35 °C, the unit passes the test. If not, leave the unit for half an hour then repeat the test. The unit fails if it is still outside the specified temperature range. Consult § 5 (Troubleshooting).

8.4 NON HEATER-WIRE MODE PERFORMANCE CHECK

- Perform this check if the MR810 is used with non heater-wire circuits.
- The test should be conducted in an ambient temperature of 23 ± 2 °C with no drafts.
- Allow approximately 30 minutes to complete the test.

8.4.1 EQUIPMENT REQUIRED

1. MR810 humidifier to be tested.
2. MR250 chamber filled with water. (Note: the MR290 chamber is difficult to use for this test because of the floats).
3. Accurate glass thermometer (do not use the 900MR033 thermometer).

8.4.2 TEST PROCEDURE

1. Set up the humidifier with the MR250 chamber, filled with water to the maximum water level. This test does not require the use of a breathing circuit, nor is a gas flow required.
2. Ensure that the heater-wire adaptor is not connected, and that the heater-wire indicator remains off.
3. Select the medium setting and wait for 30 minutes to allow the water temperature to stabilise.
4. After 30 minutes stir the water in the chamber to mix it thoroughly. Record the water temperature using an accurate thermometer. Make sure the thermometer is not resting on the chamber base when taking the reading, as this will give an inaccurate measurement.
5. The thermometer must read between 55 and 60 °C. If it does not, recheck the temperature ten (10) minutes later (stir the water before checking). The unit fails the test if the temperature is still outside the limits. Consult § 5 (Troubleshooting).

Appendix A: MAINTENANCE CHECKLIST

This sheet is intended to be used as a history of maintenance performed on the MR810 humidifier. Please copy the form and complete as required.

Hospital _____ Ward / Department _____

MR810 Maintenance Record					
Serial Number					
Equipment Number					
Test Date					
Performed By					
	Pass/Fail	**Pass/Fail**	**Pass/Fail**	**Pass/Fail**	**Pass/Fail**
Visual Check (refer § 4.1)					
Mains Cable Undamaged					
Heater-wire Adapter Check					
Heater Plate Check					
Electrical Safety Check (refer § 7)					
Protective Earth Test (§ 7.1)					
Earth Leakage (§ 7.2)					
Insulation Resistance (§ 7.3)					
Performance Check (refer § 8)					
Functional Check (§ 8.2).					
Non Heater-wire Mode (§ 8.3).					
Heater-wire Mode Check (§ 8.3)					

Appendix B: PRODUCT HISTORY

This section details the changes made to the product which may have significance for servicing.

Table 11: Product Change History

Date	Change Number	First Serial # affected	Description of Change
April 2002	-	020411000001	Initial Release
February 2004	6998	040202000001	Updated to Rev B PCB

B.1 SERIAL NUMBER SN

Example: **020315012345** an MR810 manufactured on 15 of March 2002 with serial number 012345.

Table 12: Serial Number Format

02	03	15	012345
Year of manufacture	Month of manufacture	Day of manufacture	Serial Number

B.2 MODEL NUMBER

Example: **MR810AEU** is a 230 V~ model with English, French, and Spanish languages, and includes an additional Chinese instruction sheet

Table 13: Model Description

MR810 Model Type	Voltage	Languages	Plug	Additional details
ALU AGU AFU ARU ANU	230 V~	Italian, Spanish, Portuguese German, French, Italian French, German, Dutch Russian, Polish, English Norwegian, Swedish, Finnish	Schuko	
AEA	230 V~	English Only	Australasian	
AEK	230 V~	English Only	UK	
AEU	230 V~	English, French, Spanish	No Plug	Includes additional Chinese instruction sheet
ADU	230 V~	Danish Only	Danish	
JHU JSU	115 V~	English, Spanish, French English, Spanish, Portuguese	USA Right angle	
GJU	100 V~	Japanese Only	Japanese	

Appendix C: DRAWINGS AND PARTS LIST

C.1 MR810 SPARE PARTS LIST

Table 14: MR810 Parts List

Reference (Figure 8.1)	Part Number	Description
1	614 042 002	Printed Circuit Board Screws
2	614 042 002	Case Screws
3	043 042 324	MR810 AEA Lower Case including 5 Case Screws
	043 042 325	MR810 ADU Lower Case including 5 Case Screws
	043 042 326	MR810 AEK Lower Case including 5 Case Screws
	043 042 327	MR810 AEU Lower Case including 5 Case Screws
	043 042 328	MR810 AFU Lower Case including 5 Case Screws
	043 042 329	MR810 AGU Lower Case including 5 Case Screws
	043 042 330	MR810 ALU Lower Case including 5 Case Screws
	043 042 331	MR810 ANU Lower Case including 5 Case Screws
	043 042 332	MR810 ARU Lower Case including 5 Case Screws
	043 042 333	MR810 GJU Lower Case including 5 Case Screws
	043 042 334	MR810 JHU Lower Case including 5 Case Screws
	043 042 335	MR810 JSU Lower Case including 5 Case Screws
4	693 042 040	Cable Clip
5	336 060 143	Heater Plate Attachment Screw
6	693 042 043	Light Pipe
7	693 042 042	Button Retainer
8	043 042 323	Upper Case for all models
9	662 040 058	Heater Plate Spring
10	043 042 238	100 V~ Assembled Heater Plate
	043 042 237	115 V~ Assembled Heater Plate
	043 042 236	230 V~ Assembled Heater Plate
11	043 042 234	100 V~ Printed Circuit Board
	043 042 233	115 V~ Printed Circuit Board
	043 042 232	230 V~ Printed Circuit Board
12	095 428 869	100 V~ / 115 V~ Japanese Power Cord
	095 428 322	115 V~ USA Right Angle Power Cord
	095 428 323	230 V~ Schuko Power Cord
	095 428 317	230 V~ Australasian Power Cord
	095 428 569	230 V~ UK Power Cord
	095 428 854	230 V~ Danish Power Cord
	095 428 856	230 V~ No Plug
13	043 042 322	Heater-wire Adapter including Cable Clamp and Collet **For MR810 AEA models with serial numbers beginning with 03 and below only**
13	043 042 572	Heater-wire Adapter including Cable Clamp and Collet **For all MR810 models with serial numbers beginning with 04 and above only**
14	693 042 041	Silicone Button
15	662 040 050	Finger Guard Spring
16	693 042 036	Finger Guard
	999 830 008	1.5 A 250 V~ Fastblow Fuse (one off)
	999 830 009	2 A 250 V~ Fastblow Fuse (one off)

C

C.2 MR810 EXPLODED DIAGRAM

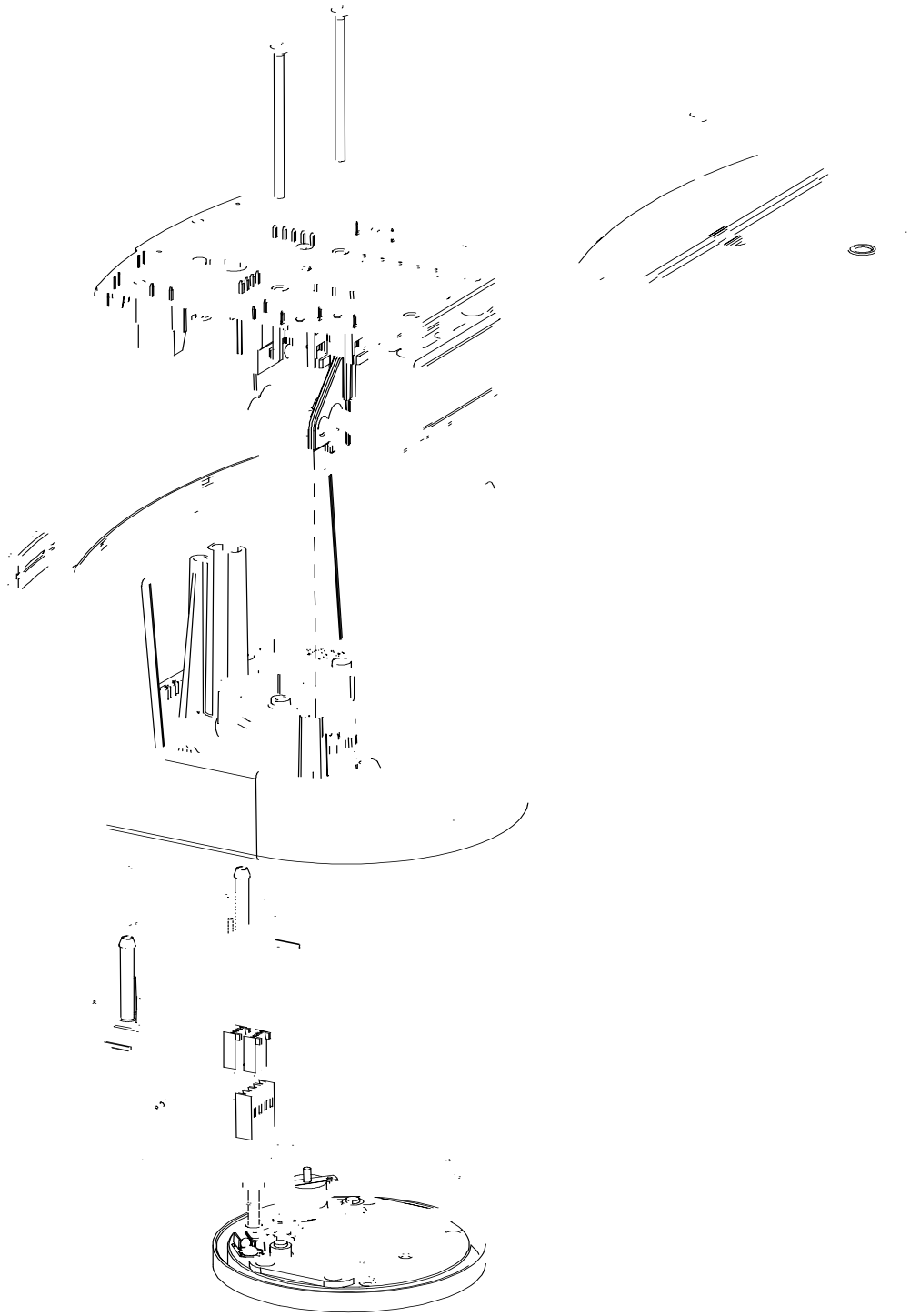


Figure 8.1: MR810 Exploded Diagram

C.3 HEATER PLATE PARTS LIST

Table 15: Heater Plate Parts List

Reference (Figure 8.2)	Part Number	Description
1	095 428 873	Heater Plate and Thermal Cut Out Harness
2	043 040 643	100 V~ Element
	043 041 340	115 V~ Element
	043 041 342	230 V~ Element
3	614 040 327	Thermal Cut Out Screw
4	349 040 051	Thermal Cut Out
5	095 428 870	Thermistor
6	614 040 327	Thermistor Screw
7	095 428 320	Protective Earth
8	331 040 114	Mica Insulator
9	614 040 117	Protective Earth Screw
10	622 040 130	Protective Earth Washer
11	614 040 117	Element Cover Screw
12	641 040 707	Element Cover
13	336 060 143	Heater Plate Attachment Screw
14	662 040 058	Heater Plate Spring
15	655 040 111	Heater Plate

C.4 HEATER PLATE EXPLODED DIAGRAM

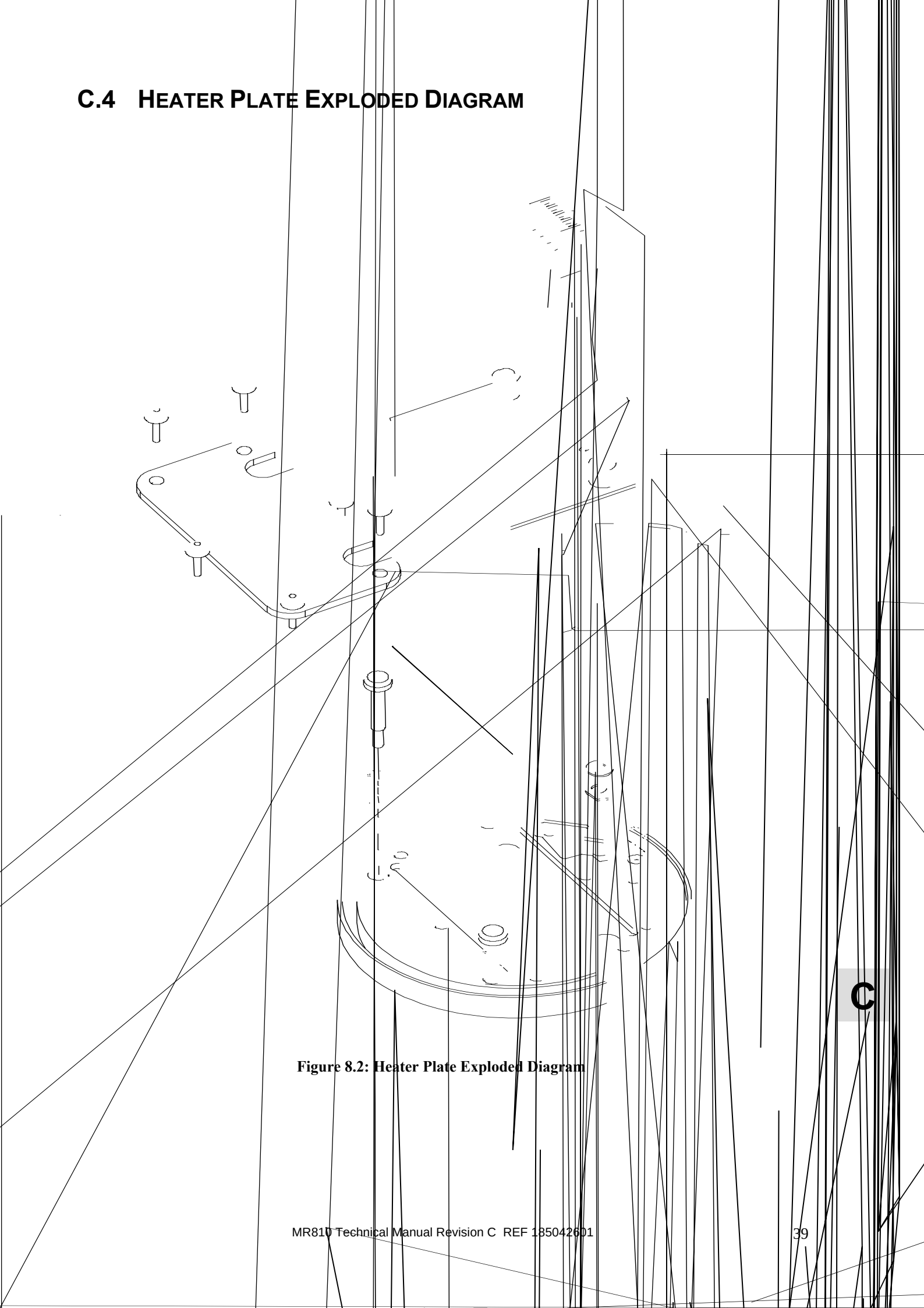


Figure 8.2: Heater Plate Exploded Diagram

Appendix D: ELECTROMAGNETIC COMPATIBILITY

D.1 COMPLIANCE AND WARNINGS

The MR810 with RT308 breathing circuit has been tested to and found compliant with the requirements of IEC 60601-1-2: 2001.

WARNING:

The use of other accessories other than those specified may result in increased emissions or decreased immunity of the equipment.

Verify correct operation if the MR810 is to be used adjacent to other equipment.

D.2 ELECTROMAGNETIC EMISSIONS

Guidance and manufacturer's declaration – electromagnetic emissions		
The MR810 is intended for use in the electromagnetic environment specified below. The customer or the user of the MR810 should assure that it is used in such an environment.		
Emissions Test	**Compliance**	**Electromagnetic environment - guidance**
RF emissions CISPR 11	Group 1	The MR810 uses RF energy only for its internal function. Therefore, its RF emissions are very low and not likely to cause any interference in nearby electronic equipment.
RF emissions	Class A	The MR810 is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

D

D.3 ELECTROMAGNETIC IMMUNITY

Guidance and manufacturer's declaration – electromagnetic immunity			
The MR810 is intended for use in the electromagnetic environment specified below. The customer or the user of the MR810 should assure that it is used in such an environment.			
Immunity Test	**IEC60601 test level**	**Compliance Level**	**Electromagnetic environment - guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30 %.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/output lines	± 2 kV for power supply lines ± 1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 1 kV differential mode ± 2 kV common mode	± 1 kV differential mode ± 2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	< 5 % U_T (> 95 % dip in U_T for 0,5 cycle) 40 % U_T (60 % dip in U_T for 5 cycles) 70 % U_T (30 % dip in U_T for 25 cycles) < 5 % U_T (> 95 % dip in U_T for 5 seconds)	< 5 % U_T (> 95 % dip in U_T for 0,5 cycle) 40 % U_T (60 % dip in U_T for 5 cycles) 70 % U_T (30 % dip in U_T for 25 cycles) < 5 % U_T (> 95 % dip in U_T for 5 seconds)	Mains power quality should be that of a typical commercial or hospital environment. If the user of the MR810 requires continued operation during power mains operation, it is recommended that the MR810 shall be powered from an uninterruptible power supply or battery.
Power Frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
Note: U_T is the a.c. mains voltage prior to application of the test level.			

Guidance and manufacturer's declaration – electromagnetic immunity

The MR810 is intended for use in the electromagnetic environment specified below. The customer or the user of the MR810 should assure that it is used in such an environment

Emissions Test	Compliance	Compliance Level	Electromagnetic environment - guidance
			Portable and mobile RF communications equipment should be used no closer to any part of the MR810, including cables, that the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. **Recommended separation distance**
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 V/m	$d = 1{,}2\sqrt{P}$ $d = 1{,}2\sqrt{P}$ 80 MHz to 800 MHz $d = 2{,}3\sqrt{P}$ 800 MHz to 2,5 GHz
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2,5 GHz	3 V/m	where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in metres (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[a], should be less than the compliance level in each frequency range[b]. Interference may occur in the vicinity of equipment marked with the following symbol. 

NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies.
NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and poles

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the MR810 is used exceeds the applicable RF compliance level above, the MR810 should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the MR810.

[b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.

Recommended separation distances between portable and mobile RF communications equipment and the MR810

The MR810 is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the MR810 can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the MR810 as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output	**Separation distance according to the frequency of transmitter (m)**		
power of transmitter (W)	**150 kHz to 80 MHz** $d = 1,2\sqrt{P}$	**80 to 800 MHz** $d = 1,2\sqrt{P}$	**800 MHz to 2,5 GHz** $d = 2,3\sqrt{P}$
0,01	0,12	0,12	0,23
0,1	0,38	0,38	0,73
1	1,2	1,2	2,3
10	3,8	3,8	7,3
100	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in metres (m) can be estimated using the equation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1: At 80 MHz and 800 MHz, the separation distance of the higher frequency range applies.

NOTE 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

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