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APPENDIX I
OF
TEST REPORT T50915R_F

Installation Manual

FCC ID:	Q47-MCROEM
Manufacturer:	ERG Transit Systems
Test Sample:	Contact less Smart Card Readers
Model:	MCR_OEM
Serial No:	14.7456MHz Unit: Antenna - 0350435, Main Board - 04273566 and 22.1184MHz Unit: Antenna - 05129574, Main Board - 0504009
Date:	27th October 2005

Device Product Group

MCROEM User Manual

Document No: DPG-00604 **Category: 431** **Revision: 1.0**

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Document History

Revision	Revision Date	Description	Author
0.1	8 Aug 2005	Draft	Dan Zorde
0.2	2 Sep 2005	Updates to Section 4.4 and onwards	Dan Zorde
0.3	21 Sep 2005	Updates as per advice from EMC Tech	Dan Zorde
0.4	11 Oct 2005	Change FCC ID to Q47-MCROEM	Dan Zorde
1.0	11 Oct 2005	First release	Dan Zorde

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FCC Compliance Statement

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encourage to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The MCR was submitted and a grant of authorisation received from the FCC as a modular device under the intentional radiator requirements of part 15, Subpart C.

The party that incorporates the MCR into their product is responsible for verification of the emissions produced by the final product and must adhere to the limits specified in the code of Federal Regulations 47, Part 15, Subpart B.

Furthermore, a label must be applied on the exterior of the final product, referring to this enclosed module, which shall state, “Contains FCC ID: Q47-MCROEM” or “Contains Transmitter Module FCC ID: Q47-MCROEM”.

Notice: When an AC to DC power source is used to supply power to the integrated equipment, the final equipment will also have to comply with the AC line conducted emissions according to FCC Part 15, Subpart B.

Warning: Any changes or modifications not expressively approved by ERG Transit Systems could void the user's authority to operate this equipment

1 Introduction

1.1 Purpose

The purpose of this document is to provide summary technical details of the electrical interface and physical characteristic of the Multiprotocol Card Reader (MCR). It is intended for use by third party developers wanting to integrate the MCROEM Module into new or existing products.

1.2 Scope

This manual is intended for use by third party developers and integrators familiar with similar type of equipment. This manual contains technical information sufficient to give technical personnel an operational understanding of the MCR.

1.3 Terminology

The following table contains a list of Equipment Terminology and their meanings.

Table 1: Terminology

Term	Definition
A	Amp(s), Ampere(s)
ASK	Amplitude Shift Keying
bps	Bits per second
BPSK	Binary Phased Shift Keying
CMOS	Complementary Metal-Oxide Semiconductor
CPU	Central Processing Unit (microprocessor)
CSC	Contact-less Smart Card
Host	A processing unit communicating directly with and housing the MCR.
EIA	Electronic Industry Association
EMC	Electromagnetic Compatibility
GND	Ground – negative supply
Hz	Hertz, cycles per second
IEC	International Electrotechnical Commission
ISO	International Standards Organisation
LCD	Liquid Crystal Display
MCR	Multiprotocol Card Reader
mm	millimetre(s)
NRZ-L	Non-return to zero - level
OOK	On-Off keying
PCB	Printed Circuit Board
s	second(s)
TIA	Telecommunications Industry Association
TTL	Transistor Transistor Logic

2 Overview of the MCR

The MCROEM Module is an easy-to-use, economical means of introducing contact-less smart card capability into a host. Figure 1 contains a picture of the MCROEM Module. Section 3 provides an overview of the module architecture. Section 4 provides a description of the interface connector and pins. Section 5 provides dimensional details, section 6 describes how the MCR is to be mounted inside the host and Section 7 describes the final tuning procedure.

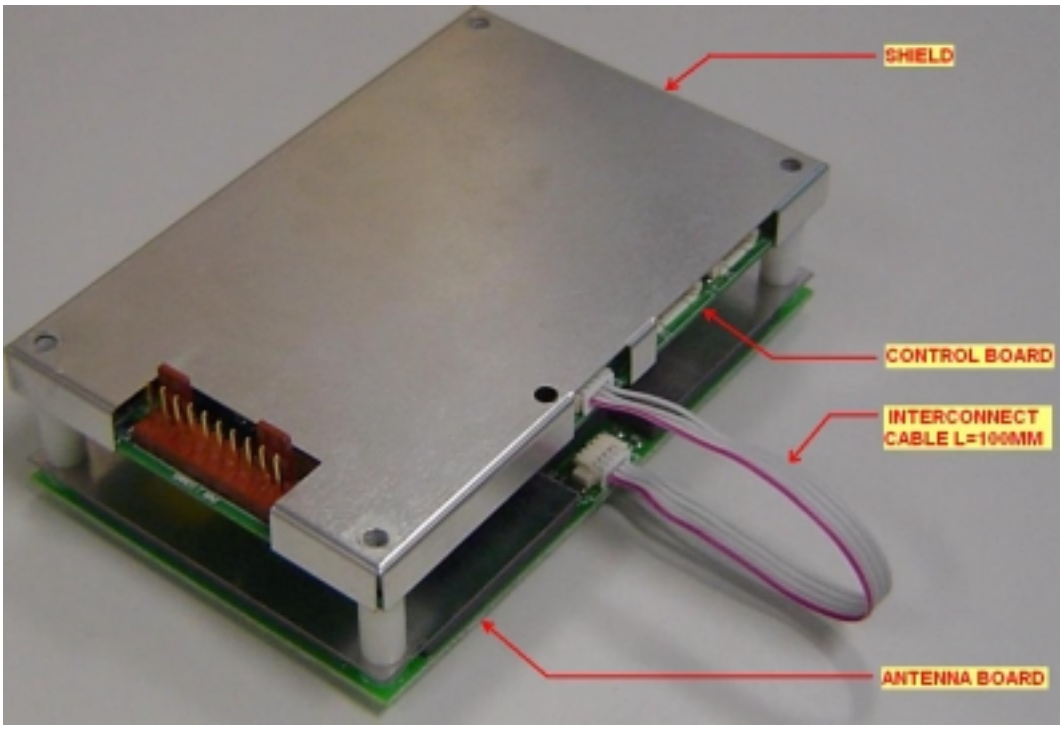

Figure 1: MCROEM Module

The MCROEM module is a compact contact-less reader, which enables developers to rapidly add contact-less functionality to new or existing products.

Each MCR consists of a Control Board and Antenna Board; this set is tuned and tested at the factory prior to shipment. Each set is shipped with a 100 mm interconnecting cable as shown in Figure 1.

The MCR serves as the data communications link between customer smart cards and the host in which the MCR is installed.

For MCR-to-Card communications, the Control Board receives data signals from the host. It then transmits the data signals via RF to a smart card held within reading distance of the MCR's Antenna Board. For Card-to-MCR communications, RF data signals from the smart card are received by the Control Board via the Antenna Board where they are sent to the host via connector 1 located on the Control Board. Figure 2 contains a block diagram that illustrates the MCR mode of operation.

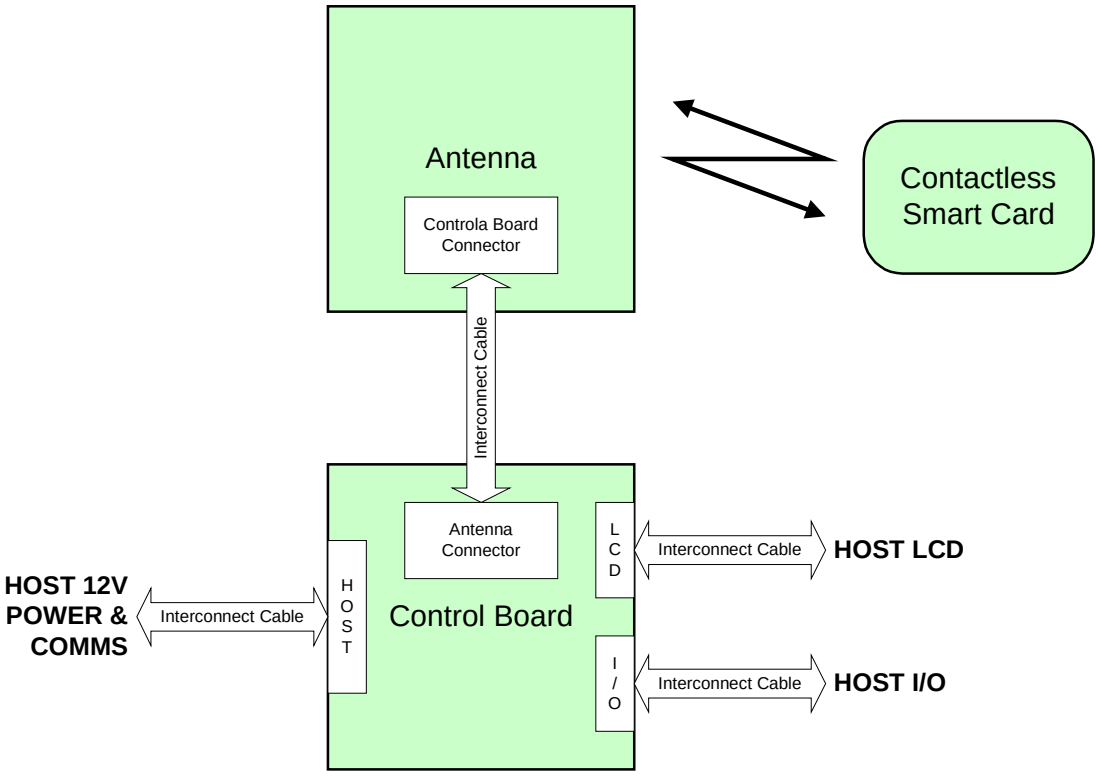

Figure 2: MCROEM Module – Operation

For implementation into simple products, the MCR can be utilised as the controller of the product, allowing for driving an onboard LCD and TTL I/O devices. Hence, all interfacing to the device is via the MCR host connector. With the implementation of LCD and I/O, the MCR CPU will, via commands from the host, display text/graphics and operate any I/O implemented via the CPU port pins.

In more complex devices with their own LCD and I/O, or devices with no need for these features, these circuit options can be depopulated during manufacturing to reduce costs.

3 Module architecture

The Control Board contains a microprocessor, non-volatile memory, and radio frequency transmitting and receiving circuitry. This board communicates with smart cards via a RF link provided by the Antenna Board, and to the host terminal or integrated product via a RS-422 or RS-232 serial protocol.

The Antenna Board consists of a printed circuit board with copper traces forming the transmit and receive antenna. The board is attached to a ferrite plate and a metal back plate that serves as a ground plane.

Control of a device LCD and device I/O is achieved via direct access to port pins and the data bus on the CPU. By sending appropriate command instructions via the serial link, the LCD and device I/O can be operated.

The module architecture is illustrated in Figure 3.

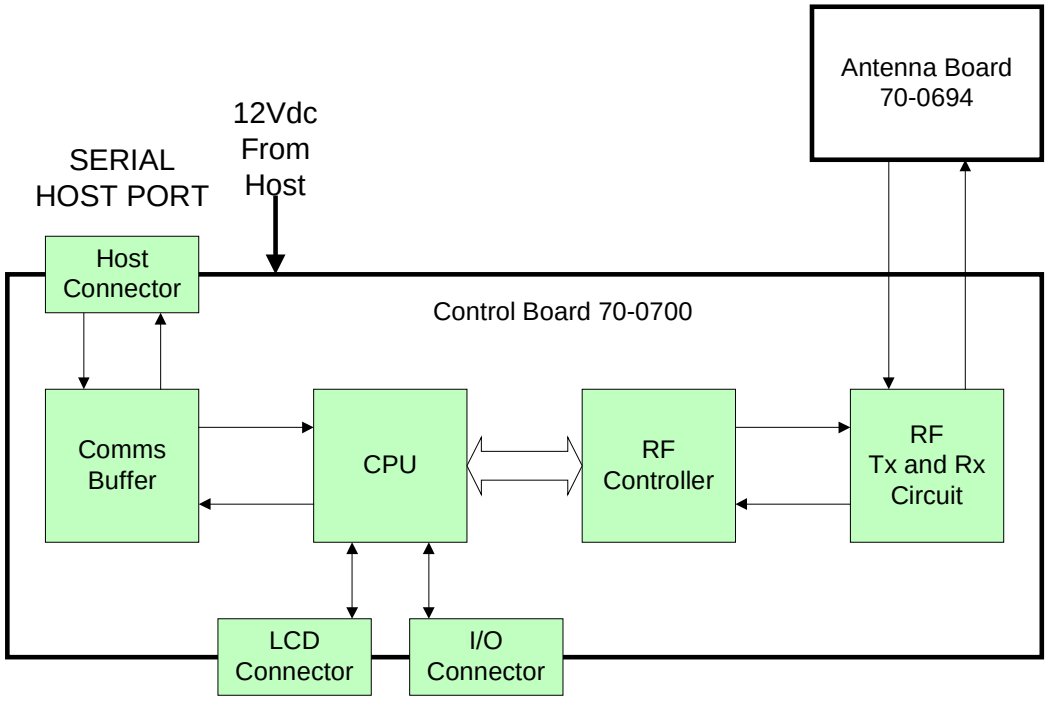

Figure 3: Module Architecture

3.1 Electrical specification

3.2 Host serial communication interface

Item	Description
MCR to Host communication interface	Serial RS-232 and RS-422 full duplex.
MCR to host baud rate	Serial 9600bps to 460Kbps.

3.3 Power Supply

The MCROEM module derives power directly from the host. After supply power is applied to the MCR it will be operational in less than 1.2 seconds.

Item	Description
Supply voltage	12Vdc +10%/-5%, with ripple of less than 50mV peak-peak.
Supply current	Maximum 300 mA, typical 150 mA
Input power requirements	Maximum 3.60 Watts

3.4 RF controller

The standards supported by the RF controller are ISO/IEC 14443 Type A, ISO/IEC 14443 Type B and Mifare Standard.

3.4.1 Transmitter

The MCR transmitter complies with the following specifications:

Item	Description
Carrier Frequency	13.56 MHz $\pm$ 7 kHz (ISO/IEC 14443-2:2001, 6.1)
Modulation Rise and Fall Time	< 2.0 μsec (ISO/IEC 14443-2:2001, 8.1.2 and 9.1.2)
ASK Modulation	100% Modified Miller (ISO/IEC 14443-2:2001, 7 and 8) 8%-14% NRZ (ISO/IEC 14443-2:2001, 7 and 9)

3.4.2 Receiver

The MCR receiver complies with the following specifications:

Item	Description
Carrier Frequency	13.56 MHz
Subcarrier Frequency	847.5 kHz (ISO/IEC 14443-2:2001, 7, 8 and 9)
Subcarrier Data	OOK Manchester (ISO/IEC 14443-3:2001 7 and 8) BPSK NRZ-L (ISO/IEC 14443-2:2001, 7 and 9)

3.4.3 Card Interface

The MCR module supports contact-less smart cards conforming to the following signal interface protocols:

- ISO/IEC 14443 Type A.
- ISO/IEC 14443 Type B.

4 Interface Connections

4.1 Supported Communications Interfaces

The serial interface between the Host and MCR supports both:

- RS-422, full duplex
- RS-232

The MCR is connected to the host via a 10-pin connector located on the Control Board. The interconnection between the host and the MCR may be achieved using an interconnecting cable as shown in Figure 4.

The default terminal to CAD communication speed is 460kbps for RS-422 and 115.2kbps for RS-232. Slower communication speeds are available via software selection on start-up.

4.1.1 Communications Interface Connector

The MCR interface connector mates with a straight connector.

Straight connector: *Molex #22-01-2105 or equivalent*

4.1.2 Communications Interface Connection

Pin	Designation	Signal Level	Function
1	Reset	CMOS logic	Can be used to reset the MCR.
2	GND	Ground	Power Supply negative
3	+12V	+12Vdc	Power Supply positive
4	Rx-	RS-422 -ve	Serial data from Host to MCR
5	Rx+	RS-422 +ve	Serial data from Host to MCR
6	Tx-	RS-422 -ve	Serial data from MCR to Host
7	Tx+	RS-422 +ve	Serial data from MCR to Host
8	TxD	RS-232	Serial data from MCR to Host
9	GND	Ground	Power supply negative
10	RxD	RS-232	Serial data from Host to MCR

Table 2: Serial Interface Connections

If the Host provides a hardware reset, it will be a logic-level, active-low signal with a minimum pulse width of 10 microseconds.

4.2 Supported LCD Interface

The interface between the device LCD and the MCR is buffered 5V TTL signalling. The MCR connection to an LCD is achieved via a simple 30 way flexible PCB connection to the CPU data bus and control lines.

4.2.1 LCD Interface Connector

The MCR interface connector mates with a flexible PCB.

MCR Connector: *JST_FLZ_SM30*

4.2.2 LCD Interface Connection

Pin	Designation	Signal Level	Function
1			Not used
2			Not used
3			Not used
4			Not used
5			Not used
6	Backlight	Ground	Switch for backlight ground
7	+5V	+5V	Power supply positive for backlight
8			Not used
9	B_/Reset	5V TTL	LCD Reset
10	B_CSLCD2	5V TTL	LCD chip select upper half
11	B_CSLCD1	5V TTL	LCD chip select lower half
12	B_D7	5V TTL	LCD data bus
13	B_D6	5V TTL	LCD data bus
14	B_D5	5V TTL	LCD data bus
15	B_D4	5V TTL	LCD data bus
16	B_D3	5V TTL	LCD data bus
17	B_D2	5V TTL	LCD data bus
18	B_D1	5V TTL	LCD data bus
19	B_D0	5V TTL	LCD data bus
20	B_LCD_CLK	5V TTL	LCD data clock
21	/B_LCDRW	5V TTL	LCD read write signal
22	B_A0	5V TTL	LCD address bus
23	CTRST	-20V	Negative supply for LCD contrast
24	LCD_Volt	+5V	Power supply positive for LCD
25	GND	Ground	Power supply negative for LCD
26			Not used
27			Not used
28			Not used
29			Not used
30			Not used

Table 3: LCD Interface Connections

4.3 Supported I/O Interfaces

The I/O interface between the device and MCR is 3.3V TTL signalling. I/O interfacing is via a 15-pin connector located on the Control Board.

4.3.1 I/O Interface Connector

The MCR interface connector mates with a straight connector.

Straight connector: *Molex #51021-1500 or equivalent*

4.3.2 I/O Interface Connection

Pin	Designation	Signal Level	Function
1	+12V	+12Vdc	Power Supply positive
2	+3.3V	+3.3Vdc	Power Supply positive
3	Temp1	Analogue	0-3.3V input
4	GND	Ground	Power Supply negative
5	Audio	3.3V TTL	PWM output
6	Audio_Vol	3.3V TTL	Volume control
7	Keyrow1	3.3V TTL	TTL input
8	Keyrow2	3.3V TTL	TTL input
9	Keyrow3	3.3V TTL	TTL input
10	Green_Led	3.3V TTL	TTL output
11	Yellow_Led	3.3V TTL	TTL output
12	Red_Led	3.3V TTL	TTL output
13	Key_Led1	3.3V TTL	TTL output
14	Key_Led2	3.3V TTL	TTL output
15	Key_Led3	3.3V TTL	TTL output

Table 4: I/O Interface Connections

4.4 Interconnecting cable

Figure 4, show a suggested interconnecting cable when the MCR is connected to a remote host. When the MCR is fitted as part of a product, connectors on the MCR can be plugged straight onto matching sockets, eliminating the need for cables.

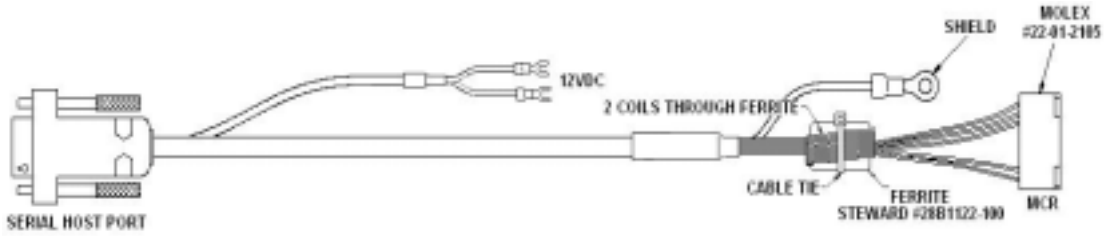

Figure 4: Interconnecting Host Cable

Ferrite bead, Steward #28B1122-100, must be fitted as shown in Figure 4, on the power/communications cable connecting to the MCR

5 Mechanical specification

5.1 Physical Dimensions

The two components that form the MCR (Control and Antenna boards) are organised so that they can be physically separated by a distance of up to 100 mm, and connected via a connecting cable. It is possible to stack the two components into a thickness of 24.5 mm.

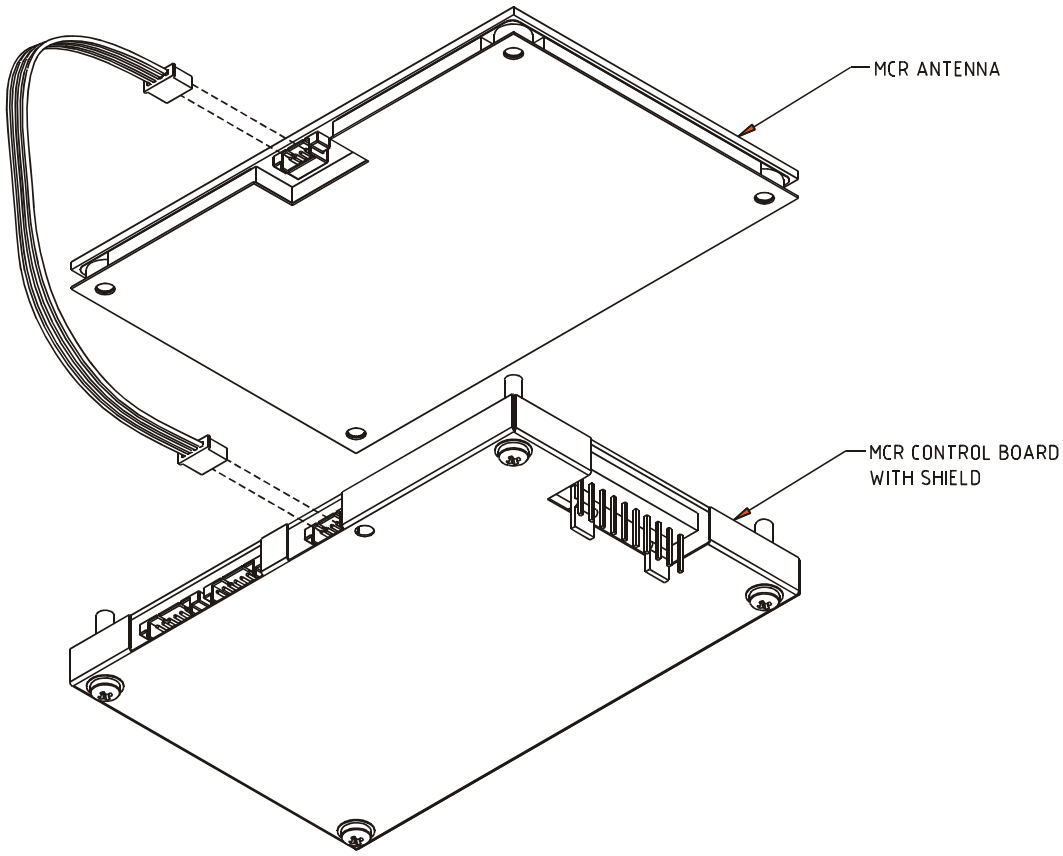

Figure 5: Typical stacking arrangement

5.1.1 Size

The guaranteed Reader volumetric envelope is shown in Figure 6. It is acceptable to mount the MCR in a larger volumetric envelope if space is available.

The Control Board and Antenna have the following dimensions:

	Length (mm)	Width (mm)	Height (mm)	Tolerance (mm)
Control Board	104	67	15.5	± 0.5
Antenna Board	104	67	5.5	± 0.5

Table 5: Physical Dimensions

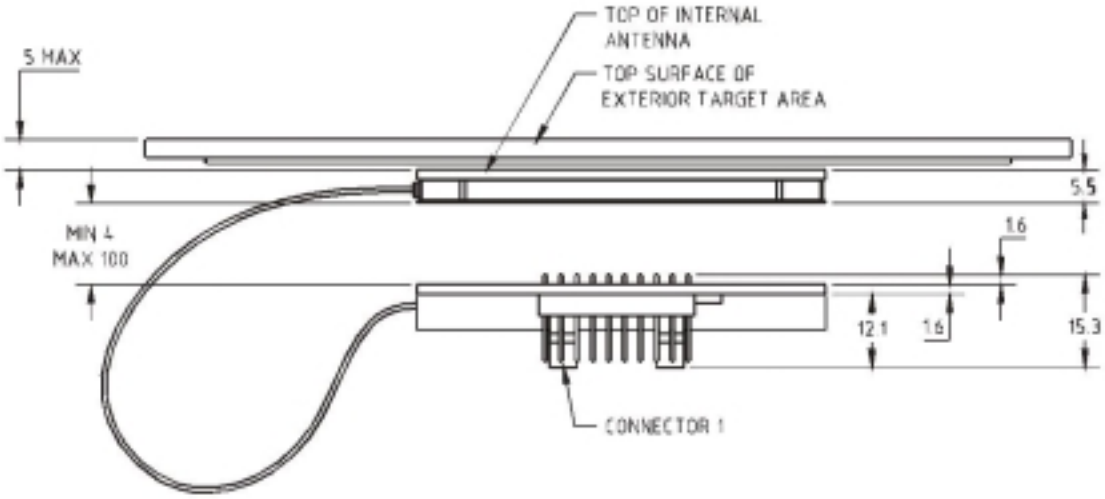

Figure 6: Typical physical envelope

5.1.2 Mounting Holes

All mounting holes are M3.2. The mounting holes are aligned and may be used with screws and plastic spacers to secure the MCR inside the product. The 100 mm cable allows the Control Board and Antenna Board to be separated to accommodate different mounting scenarios. For instance, the boards could be stacked, mounted side by side or mounted on an angle.

Spacers between the shield and control pcb, ensure the shield remains fixed to the control pcb, and eliminates shield deformation during assembly into the final device.

5.2 Individual Component Dimensions

5.2.1 Control Board Dimensions

The Control Board dimensions, and the placement of the connectors, conform to those shown in Figure 7.

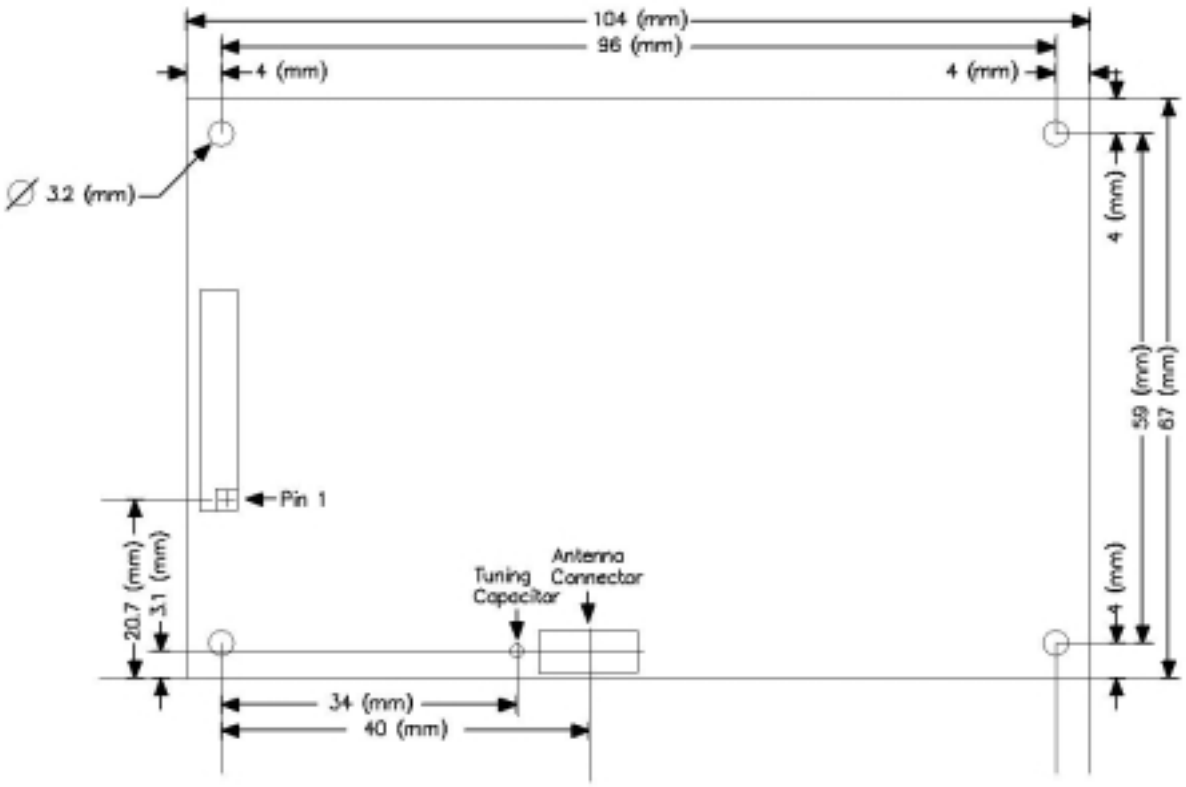

Figure 7: Control Board Dimensions

5.2.2 Antenna Dimensions

The Antenna conforms to the dimensions shown in Figure 8. The Antenna thickness is 5.5 mm.

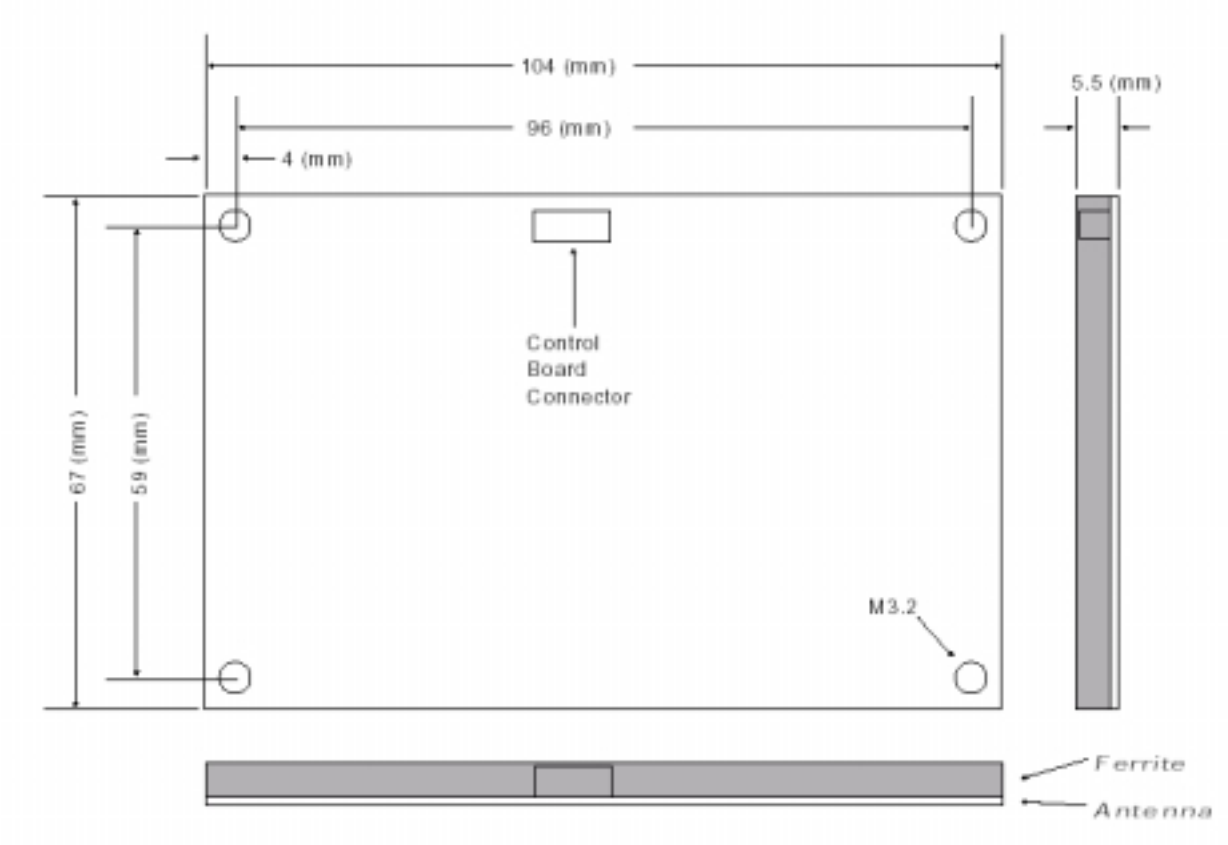

Figure 8: Antenna Dimensions

6 Mounting guidelines

These guidelines are intended to assist product designers maximise the operation of the MCR in products:

- Ensure that any metalwork and/or EMC coatings are at least *15 mm* away from the sides of the antenna board in a horizontal plane and more than *5 mm* below the vertical plane. Designers should use the maximum possible clearance.
- The top of the antenna PCB (non-metallic side) must face towards the card reading surface of the terminal and be *less than 5 mm* from the top surface. Any increase in this distance will impact the Reader performance, and may result in the product being unable to meet the project's specifications, particularly the operating distance.
- The surface of the target area, which is directly above the Antenna Board, must be a non-metallic surface such as plastic and be free of any metallic particles.
- It should be possible to tune the reader using the tuning capacitor shown in Figure 10 while leaving the antenna PCB fixed to the product. The product should ideally be designed to permit re-tuning once the MCR is fitted.
- Removal of the shield to mount the MCR in ways not otherwise possible will breach the FCC regulations and void all warranty.
- Ensure that the cable interconnecting the Antenna Board to the Control Board is located away from metal surfaces and that the cable is fixed to avoid movement. Any movement may degrade the reader performance, as the cable is an active part of the antenna system.
- Ideally, both the control and antenna PCBs should be kept together as a unit.

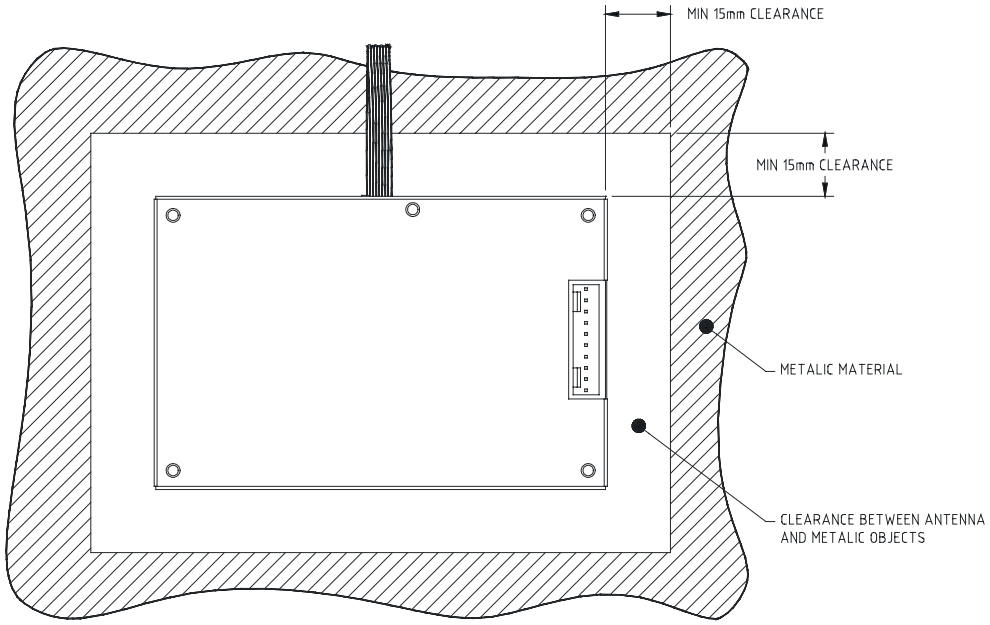

Figure 9: Clearance between antenna and metallic objects.

7 Antenna Tuning

The MCR is tuned at the factory for maximum operating range. It may be necessary to retune the MCR when it is mounted into a host device to compensate for the effects of the mounting environment (such as metallic parts or metallic paint near the antenna) and to ensure optimum performance. For this function, use an active smart card that is initialised for use with the particular host application.

1) With the MCR mounted in its operational environment place the test smart card onto the card reading surface of the terminal. Use a non-metallic spacer with the depth of the desired operating range. For example, if the desired operating range is 50 mm, then place a 50 mm spacer. Ensure that the host and MCR are powered.

2) Verify operational range by running the host internal diagnostic routines. Via the tuning hole in the shield, adjust the tuning by rotating CV1 using a plastic tuning tool to maximise the operating distance.

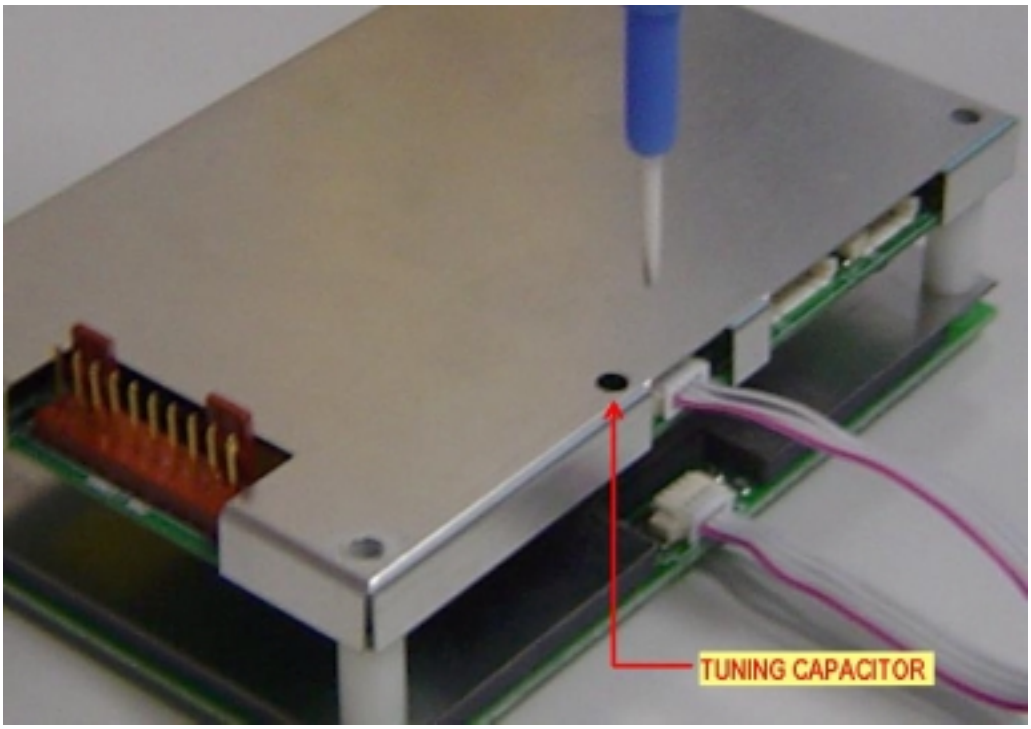

Figure 10: Location of tuning capacitor CV1