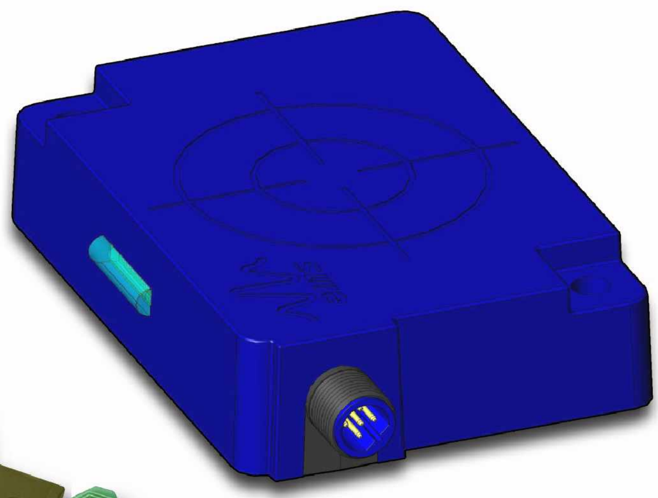
ESCORT MEMORY SYSTEMS
A Datalogic Group Company
ems

COBALT C1007-SERIES

High Frequency Passive RFID Controllers



OPERATOR'S MANUAL

Document P/N: 17-1327

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RFID AT WORK™

Cobalt C1007-Series RFID Controllers - Operator's Manual

For Models: C1007-232/485/USB-01

Publication P/N: 17-1327 REV 02 (08/07)

ESCORT MEMORY SYSTEMS

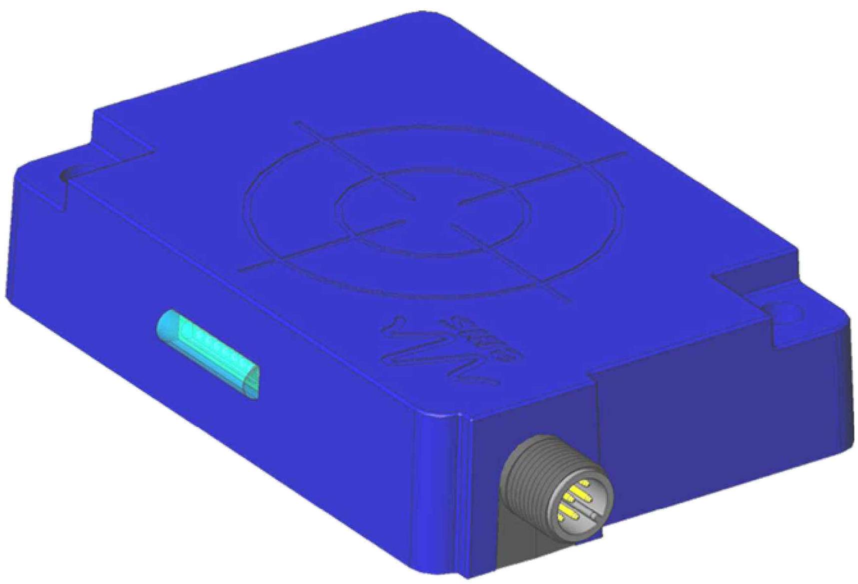
COBALT C1007-SERIES

RFID CONTROLLERS

High Frequency, Multi-Protocol, Passive RFID Controllers

For C1007 models:

- **C1007-232-01**
- **C1007-485-01**
- **C1007-USB-01**



OPERATOR'S MANUAL

How to Install, Configure and Operate
Cobalt C1007-Series RFID Controllers

ems

Regulatory Compliance - *Pending*

FCC Part 15.105

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 uses, generates, and can radiate radio frequency energy and, if not installed and used in accordance with these 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 encouraged 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.

FCC Part 15.21

Users are cautioned that changes or modifications to the unit not expressly approved by Escort Memory Systems may void the user’s authority to operate the equipment.

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 that may cause undesired operation.”

This product complies with CFR Title 21 Part 15.225.

CE

This product complies with the following regulatory specifications: EN-300-330, EN-300-683, EN 60950, IEC 68-2-1, IEC 68-2-6, IEC 68-2-27 and IEC 68-2-28.

TELEC

This product complies with TELEC Regulations for Enforcement of the Radio Law Article 6, section 1, No. 1.

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CHAPTER 1: GETTING STARTED

1.1 INTRODUCTION

Welcome to the ***C1007-Series RFID Controllers - Operator's Manual***. This manual will assist you in the installation, configuration and operation of Escort Memory Systems' C1007-Series RFID Controllers.

The C1007-Series product family is a complete line of passive high frequency read/write Radio-Frequency Identification solutions. These devices are designed to be compact, reliable and rugged, in order to meet and exceed the requirements of the industrial automation industry.

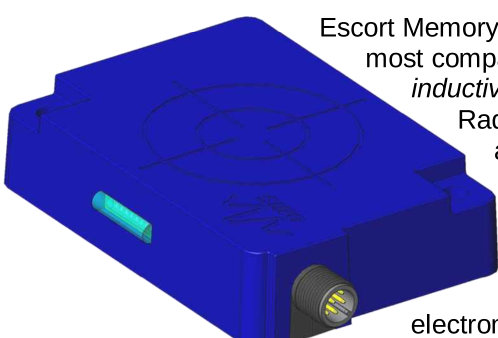
1.1.1 Company Background

Escort Memory Systems is an industry leader in providing Radio Frequency Identification (RFID) systems.

By consistently delivering an extended selection of high quality, highly durable RFID devices, Escort Memory Systems has built a solid reputation.

Escort Memory Systems' headquarters in Scotts Valley, CA.

1.1.2 The C1007-Series RFID Controller



Escort Memory Systems' C1007-Series RFID Controllers are among the most compact in our line of passive RFID controllers. Through *inductive coupling*, RFID enabled tags are able to utilize the Radio Frequency (RF) field from the controller's integrated antenna to acquire power. By being able to receive power from the RFID controller, the tag, itself, does not require an internal power supply or battery - and is therefore said to be "passive".

Passive tags, however, must enter the antenna's electromagnetic field to establish a link with the controller, and must remain within RF range during the entire data transfer process.

The C1007 Controller utilizes the internationally recognized ISM (*Industrial, Scientific and Medical*) frequency of 13.56 MHz to power the tag, while modulating side-band frequencies for communicating data.

The entire RFID system works by attaching a tag to a product or its carrier. The RFID tag acts as an electronic identifier, portable job sheet, or real-time tracking database. Tags are identified, read and written to by issuing specific commands from a host computer.

RFID tags can be read and written to through any nonconductive, non-metallic material, while moving or standing still, in or out of the direct line of sight.

The controller provides cost effective RFID data collection and control solutions to shop floor, item-level tracking and material handling applications. It is compatible with all LRP and HMS-Series tags from Escort Memory Systems.

1.1.3 Contents of the C1007 Package

Unpack the C1007 hardware and accessories. Retain the original shipping carton and packing material in case any items need to be returned. Inspect each item for evidence of damage. If an item appears to be damaged, notify your EMS product distributor.

The C1007 product package contains the following components:

EMS P/N	QTY	DESCRIPTION
C1007-XXX-01	1	C1007-Series RFID Controller
00-3000	1	HF-Series Configuration Tag (I-CODE SLi)
17-3140~3	1	C1007-Series RFID Controller – Installation Guide

Note: XXX = 232, 485 or USB

User Supplied Components

To configure a complete RFID system, you will need to provide the following items:

- Passive, read/write RFID tags (EMS' HMS, LRP and/or T-Series)
- Controller-to-Host communication interface cable: (*RS232, RS485 or USB*)
- Host device: (*PC, PLC, MUX32, TCP/IP, Ethernet/IP, Subnet16 Gateway or Hub*)
- Power supply: 10~30VDC, 3.6W (*150mA @ 24VDC*)
- Mating connectors: (*when applicable*)
- Mounting hardware (*screws, washers and nuts*)

1.1.4 C1007 Features

- High performance, low-cost, 13.56MHz RFID controller with integrated RF antenna that may be mounted directly to metallic surfaces
- Supports multiple RF, ABx, air and serial communications protocols
- Small controller size: approximately 100mm x 70mm
- Flash memory for software updates and configuration storage
- Auto configurable / software programmable
- Eight LED indicators display power, COM port activity, RF activity, Subnet16 Node ID, system diagnostics, error codes and controller status
- Reads/Writes ISO 14443A and ISO 15693 compatible RFID tags (*LRP, HMS and T-Series* RFID tags from EMS)
- FCC/CE/TELEC agency compliance certification (*PENDING*)
- IP67 rated enclosure and M12 interface connector (*8-pin for RS232; 5-pin for RS485/USB*)
- Fully encapsulated electronics

1.2 ABOUT THIS MANUAL

This document provides guidelines and instructions on how to install and operate C1007-Series RFID Controllers.

This document does NOT include explicit details regarding each of the C1007's RFID commands. Specific RFID command related information is available in the ***ABx Fast Command Protocol – Reference Manual*** and the ***ABx Standard Command Protocol – Reference Manual***, both of which are available at www.ems-rfid.com.

However, this manual does explain the process of issuing commands from a host PC to a C1007 RFID controller.

NOTE:

Occasionally in this manual, the C1007-Series RFID Controller is referred to as the *C1007 Controller*, the *C1007* or just simply the *controller*.

1.2.1 Who Should Read this Manual?

This manual should be read by those who will be installing, configuring and operating C1007-Series RFID Controllers. This may include the following people:

- Hardware Installers
- System Integrators
- Project Managers
- IT Personnel
- System and Database Administrators
- Software Application Engineers
- Service and Maintenance Engineers

1.2.2 HEX Notation

Throughout this manual, numbers expressed in Hexadecimal notation are prefaced with "**0x**"**.** For example, the number "**10**" in decimal is expressed as "**0x0A**" in hexadecimal. See *Appendix D* for a chart containing Hex values, ASCII characters and their corresponding decimal integers.

1.3 COMMUNICATION OPTIONS

There are three distinct versions of the C1007 RFID Controller. Each model provides support for one specific communication interface requirement.

1.3.1 Connection and Communication Interface Options

CONTROLLER MODEL	CONNECTION TYPE	COMMUNICATION INTERFACE	MAX CABLE LENGTH
C1007-232-01	RS232	Point-to-Point, Host/Controller	15 Meters
C1007-485-01	RS485	Subnet16™ Multidrop bus architecture via Subnet16™ Gateway or Hub	300 Meters
C1007-USB-01	USB 2.0	Point-to-Point, Host/Controller	5 Meters

Table 1-1: Connection and Communication Interface Options

1.3.2 C1007 Controllers - Interface Connectors

CONTROLLER MODEL	INTERFACE CONNECTOR(S)
C1007-232-01	8-pin, male M12 connector
C1007-485-01	5-pin, male M12 connector
C1007-USB-01	5-pin, male, reverse-keyed M12 connector

Table 1-2: C1007 Controllers - Interface Connectors

Through the Subnet16 protocol, multiple C1007-485-01 controllers can be networked via a single bus that is connected to an EMS Subnet16 Gateway or Hub interface module.

See *Appendix B: Models & Accessories* for more information on model numbers, parts and accessories for all C1007-Series RFID Controllers.

CHAPTER 2: INSTALLING THE C1007

2.1 PREPARING FOR INSTALLATION

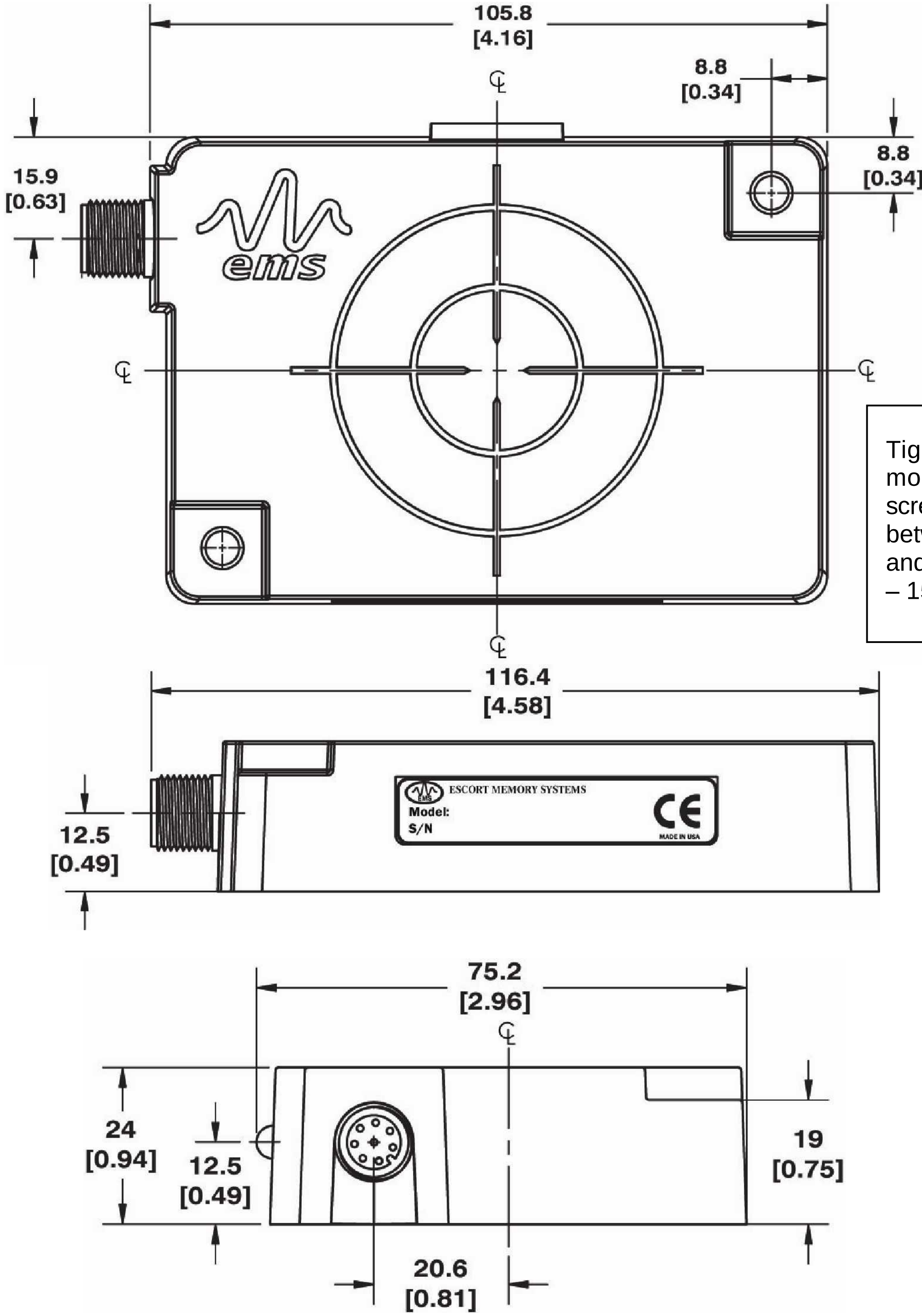
C1007-Series RFID Controllers support direct connections for point-to-point (host/controller) applications (RS232, RS485 and USB). Up to 16 C1007-485 units can be networked via Subnet16 Gateway interface module and Escort Memory Systems' Subnet16™ Multidrop Bus Architecture. Host/controller data transmission is achieved via 5-pin or 8-pin serial interface cable.

2.1.1 Installation Guidelines

- Conduct a test phase where you will construct a small scale, independent network that includes only the essential devices required to test your RFID application. To avoid possible interference with other devices, do not initially connect your RFID testing environment to an existing local area network.
- RF performance and read/write range can be negatively impacted by the proximity of metallic objects. Avoid mounting the controller within 60mm (2.36 inches) of any metallic object or surface.
- If electrical interference is encountered (as indicated by a reduction in read/write performance), relocate the controller to an area free from potential sources of interference.
- Route cables away from other unshielded cables and away from wiring carrying high voltage or high current. Avoid routing cables near motors and solenoids.
- Refrain from mounting the controller near sources of EMI (electro-magnetic interference) or near devices that generate high ESD (electro-static discharge) levels.
- Always use adequate ESD prevention measures to dissipate potentially high voltages. C1007 controllers are designed to withstand 8kV of direct ESD and 15kV of air gap discharge. However, it is not uncommon for some RFID applications to generate considerably higher ESD levels.
- For applications using multiple RFID controllers operating at the 13.56 MHz frequency, maintain a minimum distance of at least 20 centimeters between adjacent RF devices.

2.1.2 C1007 Controller Dimensions

The graphic below contains the dimensions of the Cobalt C1007-Series RFID Controllers. Dimensions are listed in millimeters and [inches].



Tighten mounting screws to between 1.3 and 1.7 Nm (12 – 15 lbf/in).

Figure 2-1: C1007 RFID Controller Dimensions

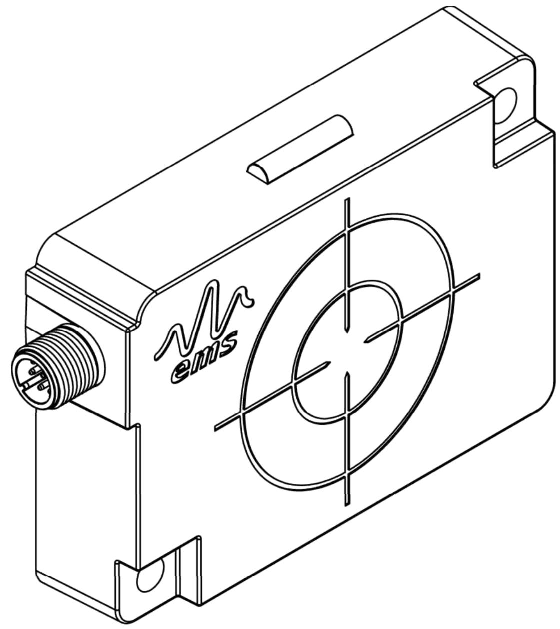
2.1.3 Mounting the Controller

C1007-Series RFID Controllers can be mounted to wood, plastic fixtures and metal plate surfaces. However, do not recess the C1007 in metal and allow at least 60mm clearance from metallic objects along the sides of the C1007.

To fasten the controller to the mounting surface you will need two M5 (*#10*) diameter screws, four flat washers, two spring lock washers and two nuts (*not included*).

NOTE: The controller may be mounted horizontally or vertically, but should be aligned in such a manner that the LED indicators can be seen during operation.

1. Select a suitable location to mount the C1007 Controller.
2. Place one flat washer on each screw and pass the screws through the mounting holes on the C1007.
3. From the backside, place one flat washer, one spring lock washer and one nut on each screw.
4. Tighten screws to between 1.3 and 1.7 Nm (*12-15 lbf/in*).



NOTE:

• To convert Newton metres to pound force inches
1 Nm = 8.851 lbf/in

• To convert pound force inches to Newton metres
1 lbf/in = 0.1129 Nm

Though the C1007 may be mounted directly to metallic plate surfaces, to avoid a potential drop in read/write range, do not affix the controller in such a manner that metal is within 60mm of the sides of the device.

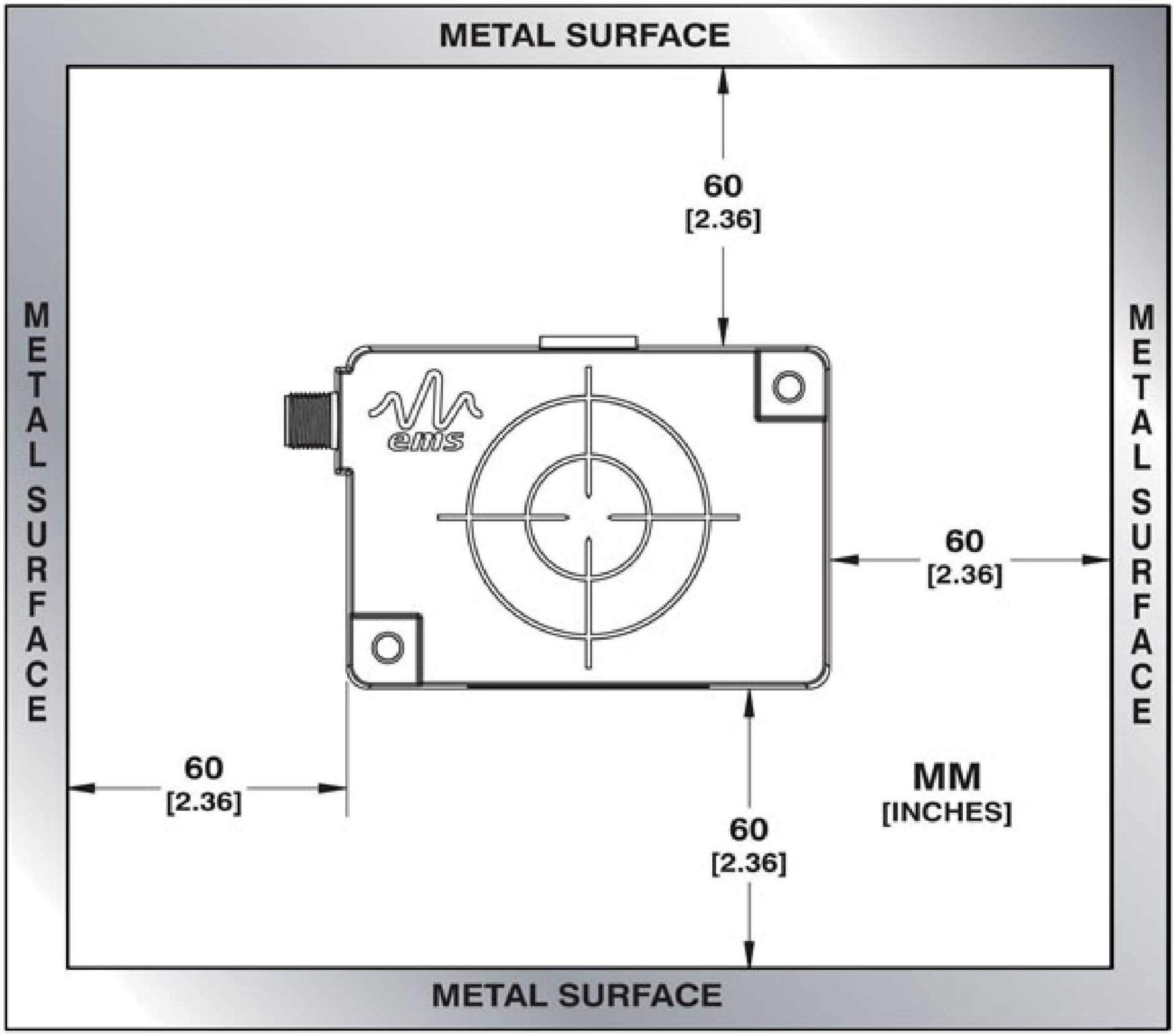


Figure 2-2: Mounting the Controller Near Metallic Surfaces

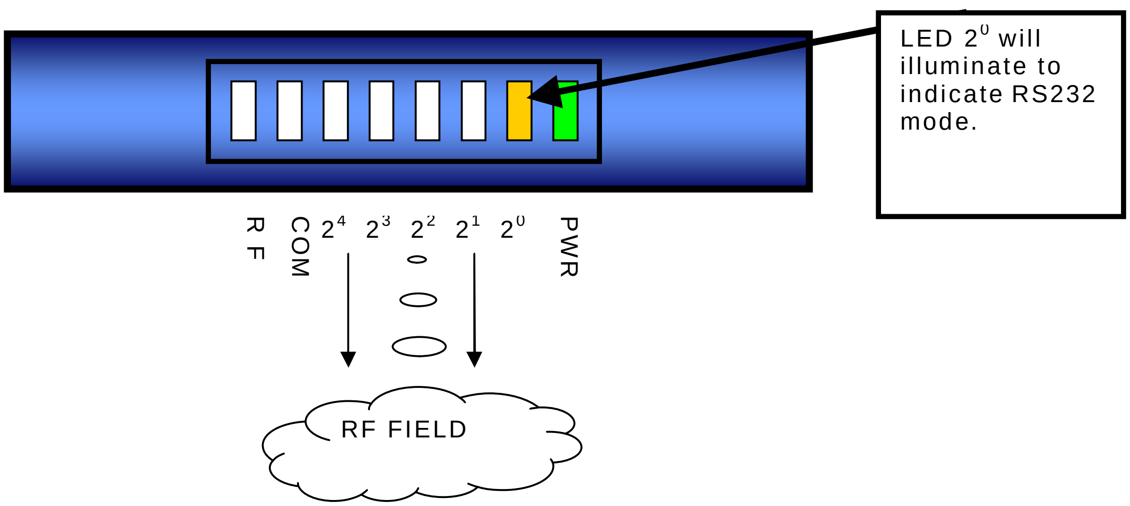
2.2 INSTALLING THE C1007-232-01 CONTROLLER

The ***C1007-232-01*** RFID Controller is designed for point-to-point RFID applications, where the distance from host to controller is less than 15 meters (50 feet). The controller connects directly to a serial communications port on a host computer via an RS232-compatible interface cable.

NOTE: review *Section 2.1.1 "Installation Guidelines"* prior to installing the controller.

2.2.1 Steps to Install the C1007-232-01

1. Attach the controller to the work area as noted in *Section 2.1.3 – "Mounting the Controller".*
2. Connect the 8-pin, female M12 connector from your serial interface cable (***EMS Cable P/N: CBL-1478:*** *8-pin, female M12 to RS232; with 2.5mm DC power jack, 2m*) to the 8-pin, male M12 connector on the C1007-232-01.
3. Connect the serial interface cable's DE9F D-Sub connector to a COM port on the host computer. Tighten the cable's two locking thumbscrews.
4. Provide a power supply for the controller that is capable of delivering 10~30VDC, 3.6W (*150mA @ 24VDC*).
5. Connect the 2.5mm DC power plug on the power supply transformer to the DC power jack receptacle on the serial interface cable. Tighten the locking ring to prevent power from becoming disconnected during use.
6. Plug the power supply transformer into a suitable AC power source. Apply power to the controller after all cable connections have been made. The LEDs on the unit should flash. For the C1007-232 model, the amber LED **2^0** should stay lit indefinitely to indicate that the controller is in RS232 mode.



7. On the host computer, set COM port parameters to: 9600 baud, 8 data bits, 1 stop bit, no parity and no handshaking.
8. To verify operations, download the ***Cobalt HF Serial Dashboard Utility*** from Escort Memory Systems' website (www.ems-rfid.com). The *Dashboard Utility* allows users to send RFID commands to the controller for testing purposes.

2.2.2 C1007-232-01 Cabling Information

The C1007-232-01 has one 8-pin, male M12 interface connector.

C1007-232-01 Interface Connector – Pinout

PIN #	DESCRIPTION
1	10~30VDC POWER
2	0VDC (POWER GROUND)
3	NOT CONNECTED
4	NOT CONNECTED
5	NOT CONNECTED
6	RX
7	TX
8	SGND (SIGNAL GROUND)

Table 2-1: C1007-232-01 Interface Connector - Pinout

C1007-232-01 Interface Connector – Diagram

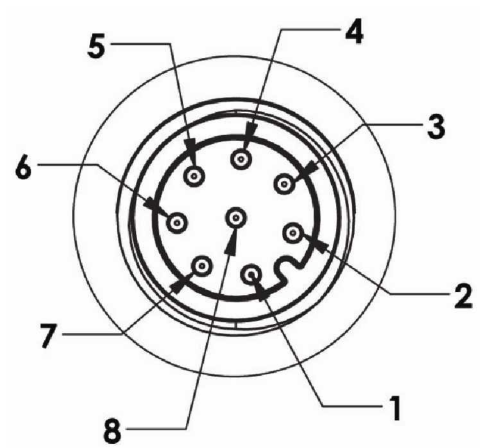


Figure 2-3: C1007-232-01 Interface Connector - Diagram

Cabling Part Numbers for the C1007-232-01

- **CBL-1478**: Cable Assembly (8-pin, female M12 to RS232; with 2.5mm DC power jack, 2m)
- **CBL-1488-XX**: Cable (8-pin, female M12 to bare wire leads)
- **CBL-1492-XX**: Cable (8-pin, right-angle female M12 to bare wire leads)
- **CBL-1493:** Connector (8-pos, straight female M12, field mountable)

(*XX = Cable Length in Meters*)

RS232 Serial Interface Cable Schematic

If you intend to assemble your own RS232 serial interface cable, follow the schematic below. Note that signals and electrical loads applied to Pin 6 (RX) and Pin 7 (TX) should conform to RS232 specifications. For bulk RS232 cable, see Belden cable P/N: **9941** (*www.belden.com*).

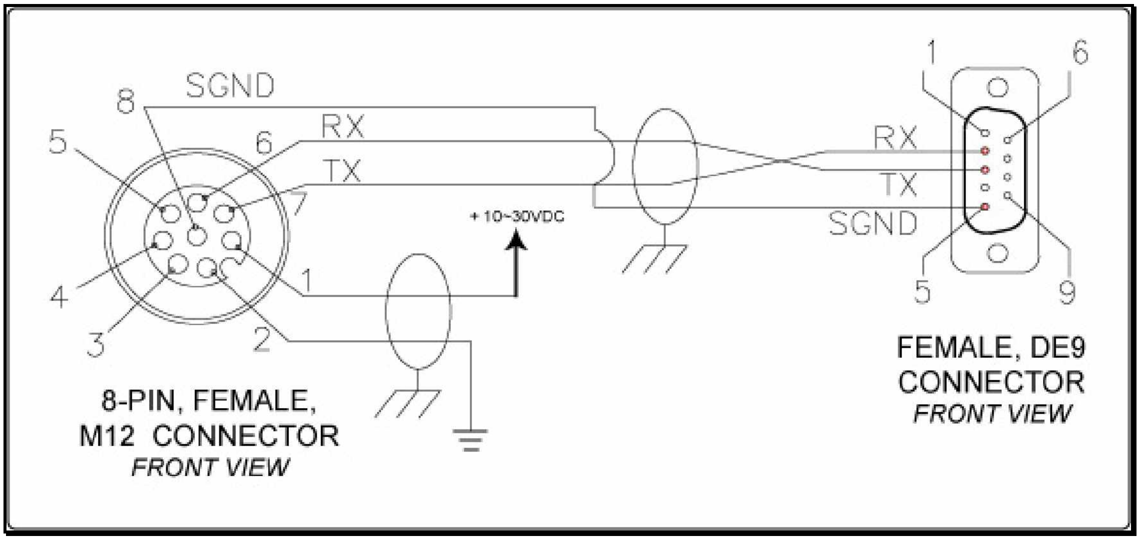


Figure 2-4: RS232 Interface Cable Schematic

CBL-1478: Serial Interface Cable

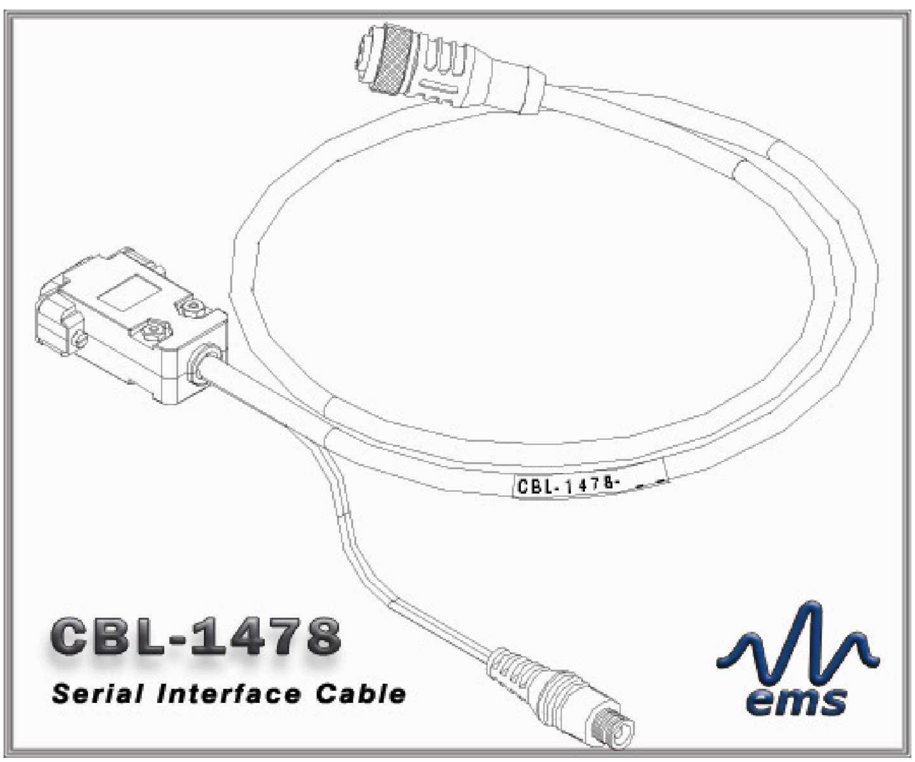


Figure 2-5: CBL-1478 Serial Interface Cable

CBL-1493: Field Mountable Connector

Figure 2-6: CBL-1493 Connector

The ***CBL-1493*** field mountable connector is available for connecting the C1007-232-01 to a host computer via bulk cable. *(*See Appendix B for more information regarding cables and connectors for the entire line of C1007-Series RFID Controllers).

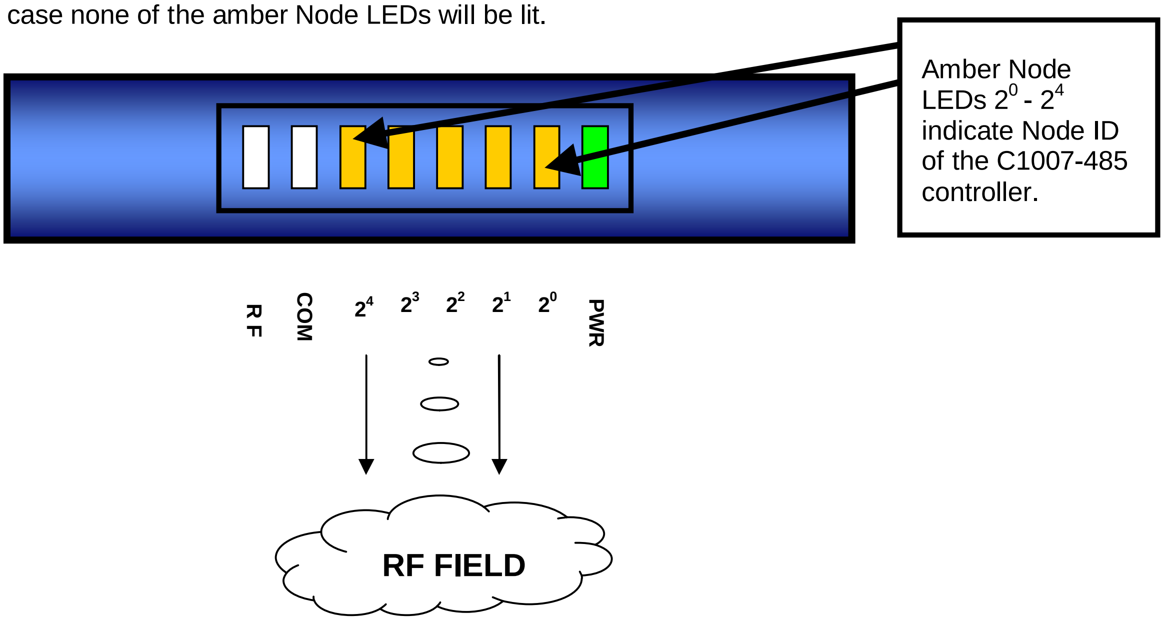
2.3 INSTALLING THE C1007-485-01 CONTROLLER

The C1007-485-01 supports RS485 communications and EMS' Subnet16™ Multidrop bus architecture and RFID network protocol. Through the Subnet16 protocol, multiple C1007-485-01 units can be connected to one Subnet16 RFID Gateway or Hub interface device. The Gateway or Hub assigns each attached C1007-485-01 a unique Node ID number through which communication with a host PC and/or Programmable Logic Controller (PLC) is achieved.

NOTE: review *Section 2.1.1 "Installation Guidelines"* prior to installing the controller.

2.3.1 Steps to Install the C1007-485-01

1. Attach the controller to the work area as noted in *Section 2.1.3 – "Mounting the Controller".*
2. Connect the 5-pin, female end of your Subnet16 compatible cable to the 5-pin, male M12 interface connector on the C1007-485. Connect the opposite end of this cable to an EMS Subnet16 Gateway or Hub device. Connect the Gateway or Hub to a host computer via Category 5E Ethernet cabling*.
3. Turn the power supply ON. The green power LED on the unit will illuminate when power is applied to the unit. The five amber Node LEDs, when lit, display the Node ID value (in binary format from right to left) currently assigned to the C1007-485 RFID Controller. Note: the default Node ID value is zero, in which case none of the amber Node LEDs will be lit.



4. To verify operations, download the ***Cobalt HF TCP/IP Dashboard Utility*** from Escort Memory Systems' website (*www.ems-rfid.com*). The *Dashboard Utility* allows ***Gateway/Hub*** users to send RFID commands to any connected Cobalt controller for testing purposes.

* For more information regarding the installation of a Subnet16 Gateway or Subnet16 Hub, refer to the Operator's Manual for each product, available online at *www.ems-rfid.com*.

2.3.2 C1007-485-01 Cabling Information

The C1007-485-01 has one 5-pin, male M12 interface connector.

C1007-485-01 Interface Connector - Pinout

PIN #	DESCRIPTION
1	SGND (SIGNAL GROUND)
2	10~30VDC POWER
3	0V (POWER GROUND)
4	TX/RX+
5	TX/RX-

Table 2-2: C1007-485-01 Interface Connector - Pinout

C1007-485-01 Interface Connector - Diagram

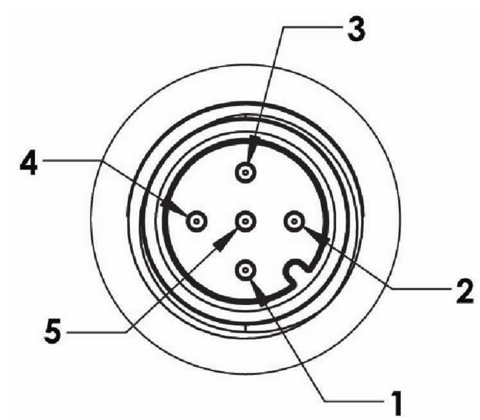


Figure 2-7: C1007-485-01 Interface Connector - Diagram

2.4 INSTALLING THE C1007-USB-01 CONTROLLER

The C1007-USB-01 RFID Controller is designed for point-to-point RFID applications that support USB 2.0 communications. Host/controller data is transmitted via standard USB cabling.

NOTE: review *Section 2.1.1 "Installation Guidelines"* prior to installing the controller.

2.4.1 Steps to Install the C1007-USB-01

1. Download the Cobalt USB driver software from the Escort Memory Systems website (*www.ems-rfid.com*). Extract the .zip file archive to a separate folder on the desktop of the host computer.
2. Install the Cobalt USB driver. For instructions, refer to *EMS document P/N:* ***17-3128*** *–****"Cobalt USB Driver - Installation Instructions,"*** which is included in the Cobalt USB driver archive.
3. Attach the controller to the work area as noted in *Section 2.1.3 – Mounting the Controller*.
4. Attach the 5-pin, female, reverse-keyed M12 connector from a suitable USB cable (*EMS P/N: CBL-1525, not included*) to the 5-pin, male, reverse-keyed M12 interface connector on the C1007-USB-01.

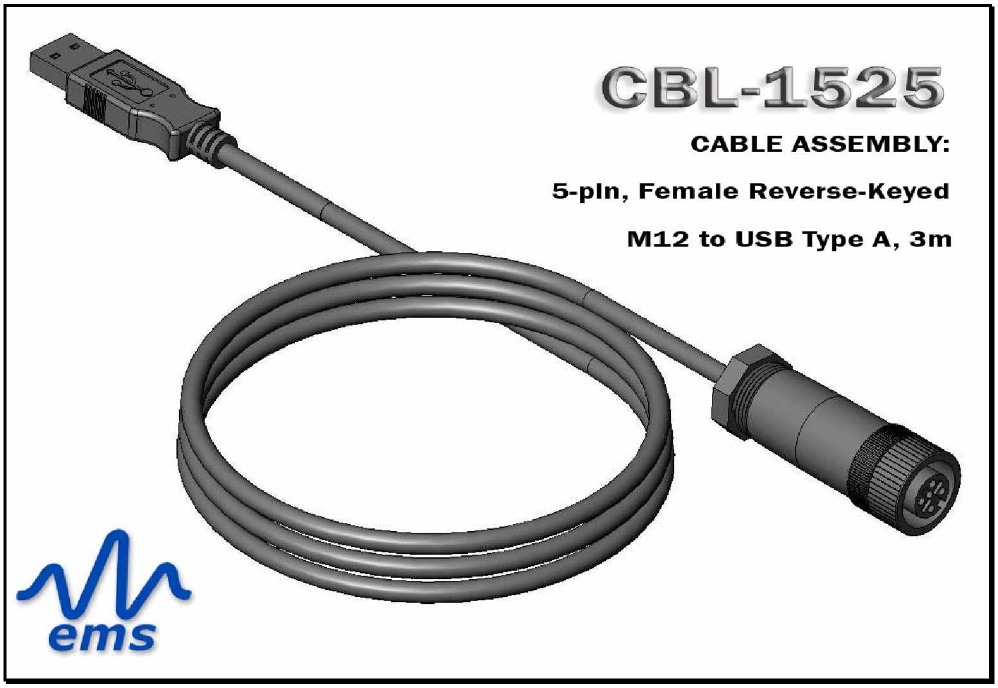
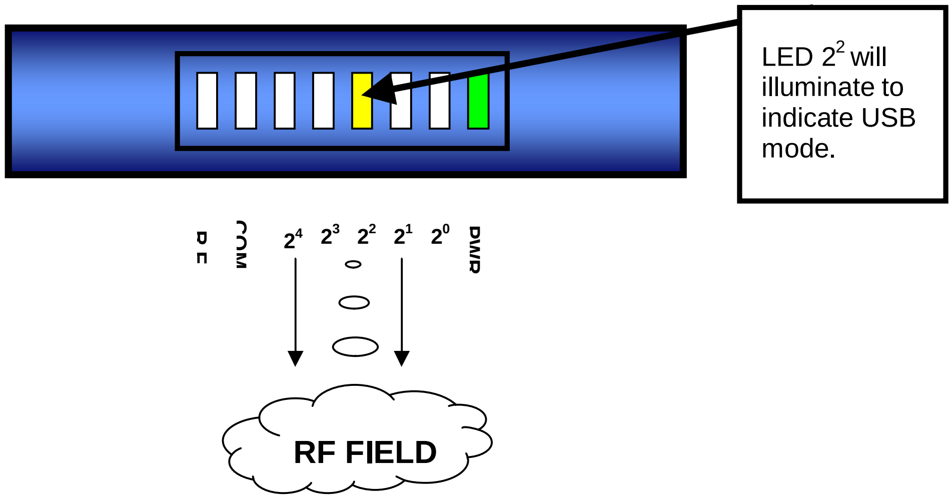


Figure 2-8: CBL-1525

5. Plug the remaining end of the USB interface cable into a USB port on the host computer. The LEDs on the unit should flash. For the C1007-USB model, the amber LED **2**[2] should illuminate to indicate that the controller is in USB mode.
6. To verify operations, download the ***Cobalt HF Serial Dashboard Utility*** from the EMS website (*www.ems-rfid.com*). The *Dashboard Utility* allows users to send RFID commands to the controller for testing purposes.



2.4.2 C1007-USB-01 Cabling Information

The C1007-USB-01 has one 5-pin, male, reverse-keyed, M12 interface connector.

C1007-USB-01 Interface Connector - Pinout

PIN #	DESCRIPTION
1	+5V
2	D-
3	D+
4	GND
5	SHIELD

Table 2-3: C1007-USB-01 Interface Connector - Pinout

C1007-USB-01 Interface Connector – Diagram

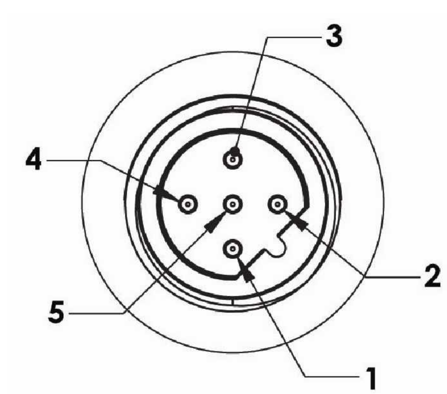


Figure 2-9: C1007-USB-01 Interface Connector - Diagram

Cabling Part Numbers for the C1007-USB-01

- **CBL-1514**: Connector (5-pin, straight male, reverse-keyed M12 for USB)
- **CBL-1525**: Cable Assembly (5-pin, female, reverse-keyed M12 to USB type A, 3m)

2.5 ANTENNA ENVIRONMENT

The antenna used to power and communicate with RFID tags is integrated within the housing module of the C1007 RFID Controller. Electro-magnetic interference (EMI) and the presence of metal near the antenna's RF field can negatively affect the communication range of the RFID controller.

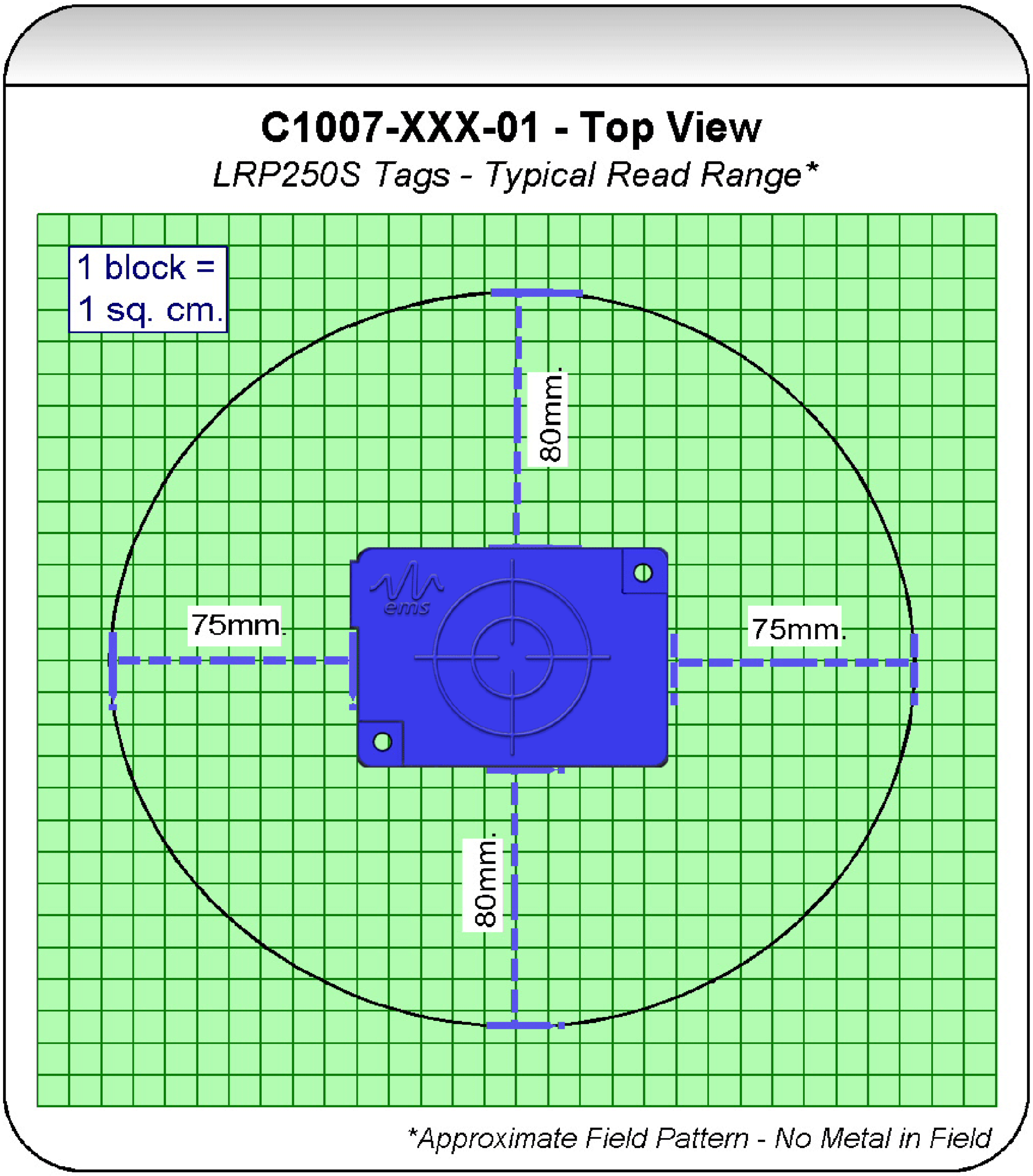


Figure 2-10: C1007 Top View - LRP250S Typical Read Range

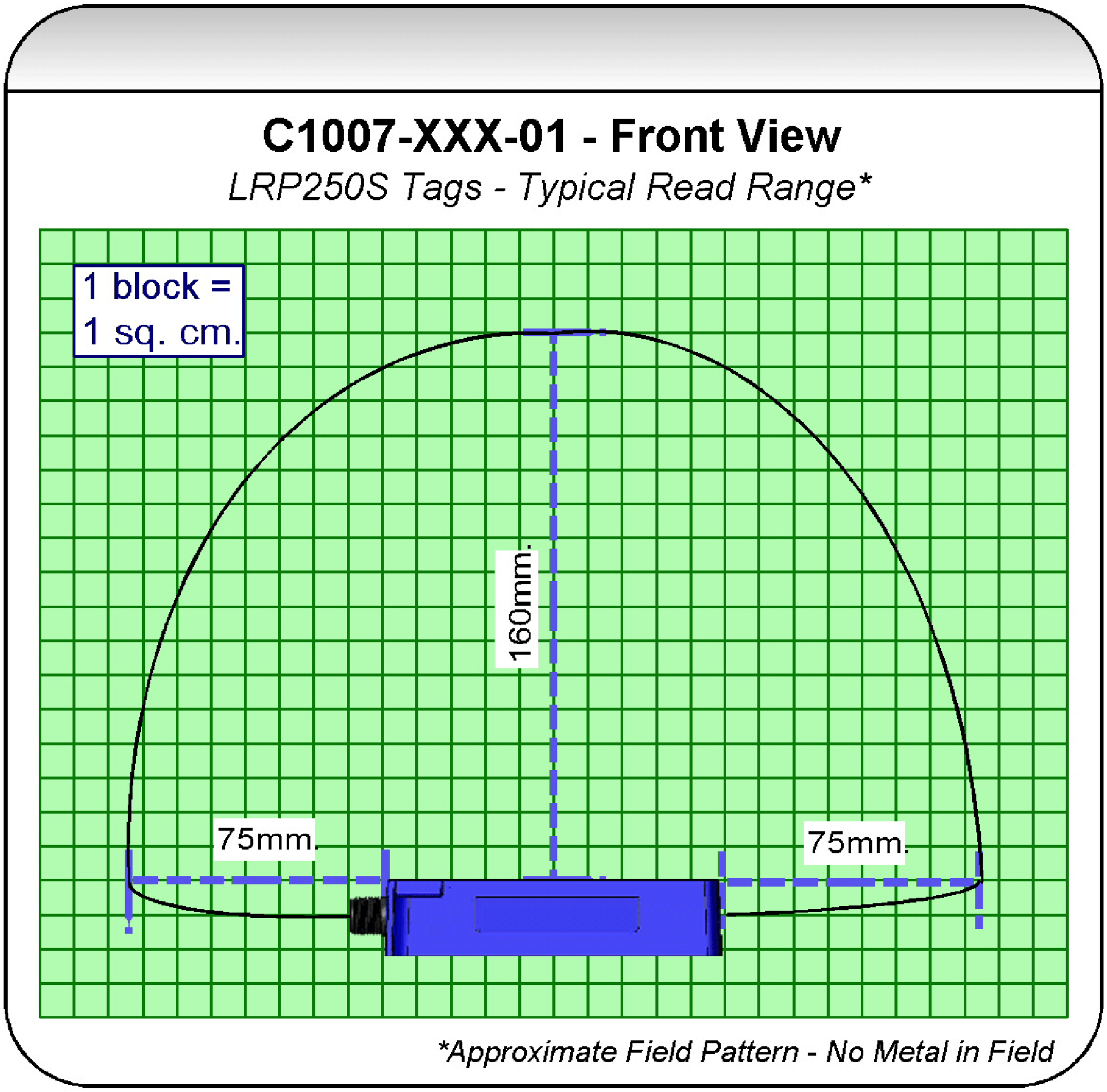


Figure 2-11: C1007 Front View - LRP250S Typical Read Range

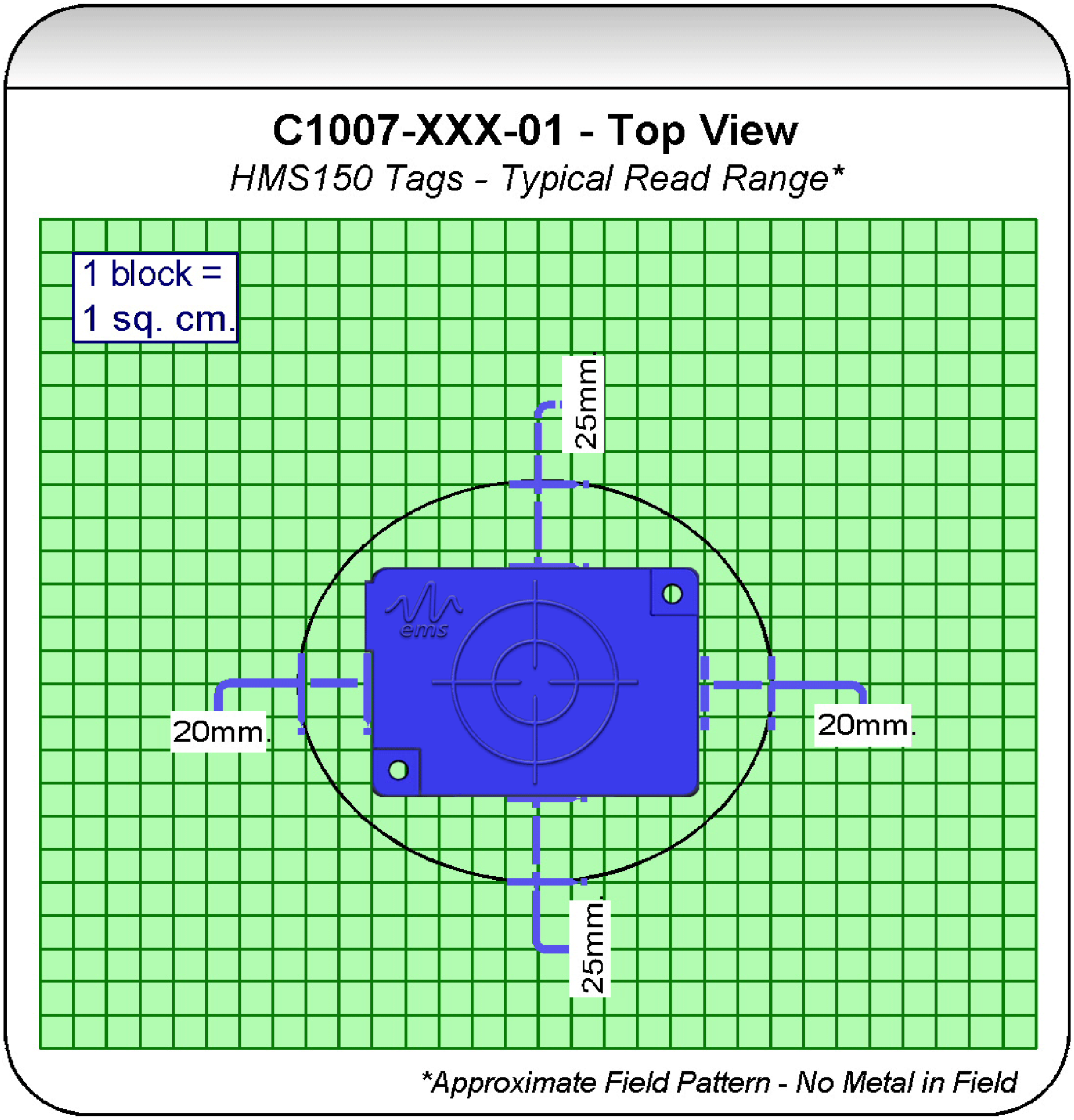


Figure 2-12: C1007 Top View - HMS150 Typical Read Range

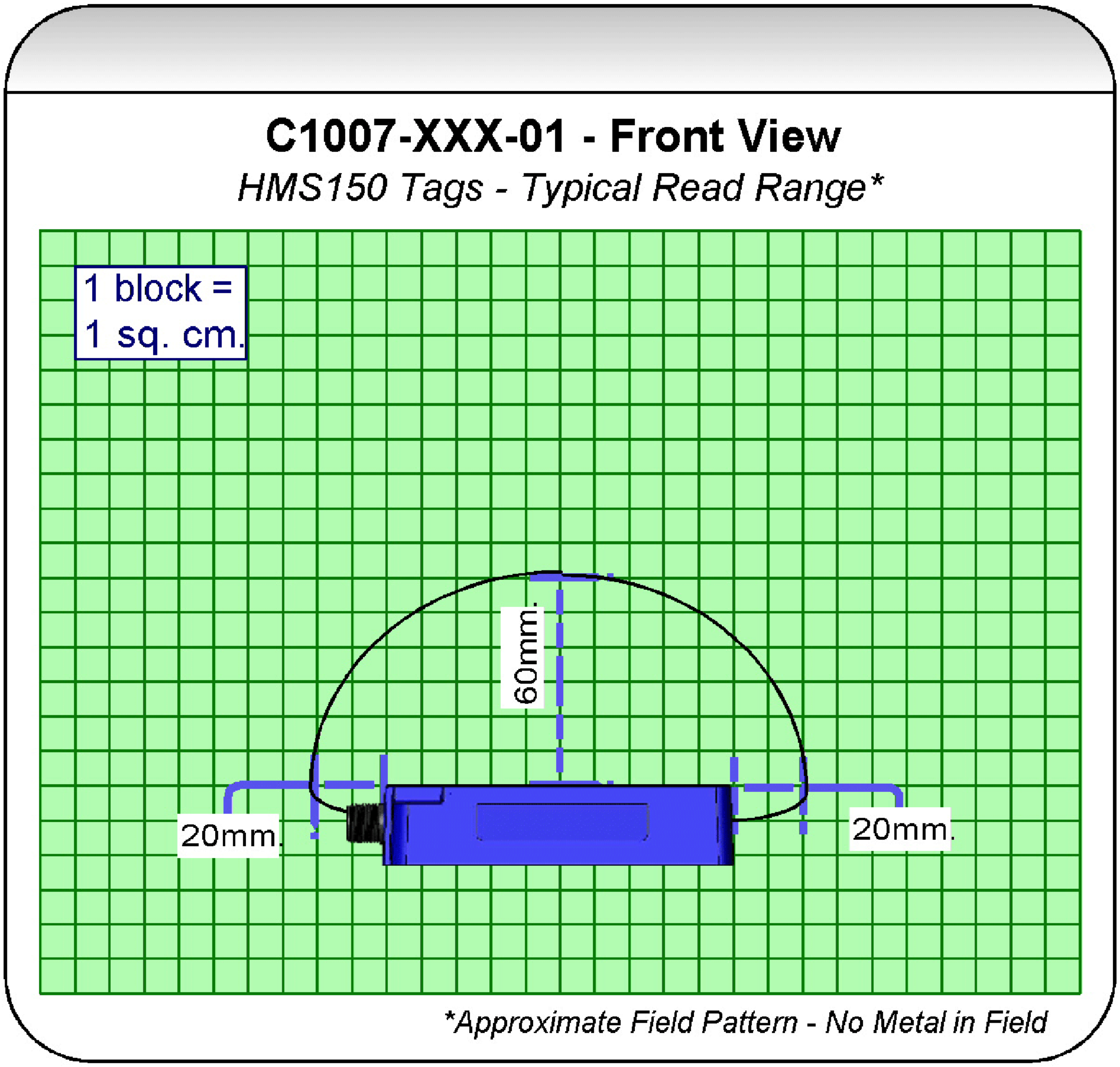


Figure 2-13: C1007 Front View - HMS150 Typical Read Range

CHAPTER 3: POWER & COMMUNICATION

3.1 POWER REQUIREMENTS

3.1.1 C1007-232-01/C1007-485-01 Power Requirements

C1007-232-01 and **C1007-485-01** RFID Controllers require an agency compliant LPS power supply capable of providing the following:

10~30VDC, 3.6W (150mA @ 24VDC)

EMS Power Supplies for C1007-232 and C1007-485 RFID Controllers

EMS PART NUMBER	DESCRIPTION
00-1166	45W, 1.88A max @ 24VDC
00-1167	100W, 4.17A max @ 24VDC
00-1168	120W, 5.0A max @ 24VDC

Table 3-1: EMS Power Supplies

3.1.2 C1007-USB-01 Power Requirements

The **C1007-USB-01** RFID Controller obtains power directly from the USB bus

Typical power consumption under normal conditions = ***2.5W (500mA @ 5VDC)***

CAUTION:

Do not connect or disconnect the C1007 while power is applied. Turn the power supply off at the source prior to connecting or disconnecting the unit. Reapply power only after the controller has been reconnected.

Use only high quality, shielded cables for power and interface connections. See *Appendix B* for a list of compatible cables and network components.

3.2 COBALT HF CONFIGURATION TAG

3.2.1 Configuration Tag Overview

In the past, RFID controllers had multiple jumpers and DIP-switches that were used to set various configuration parameters. C1007-Series RFID Controllers do not require jumpers or DIP-switches because they are software configurable via commands sent from a host PC as well as through the use of a ***Cobalt HF Configuration Tag***.

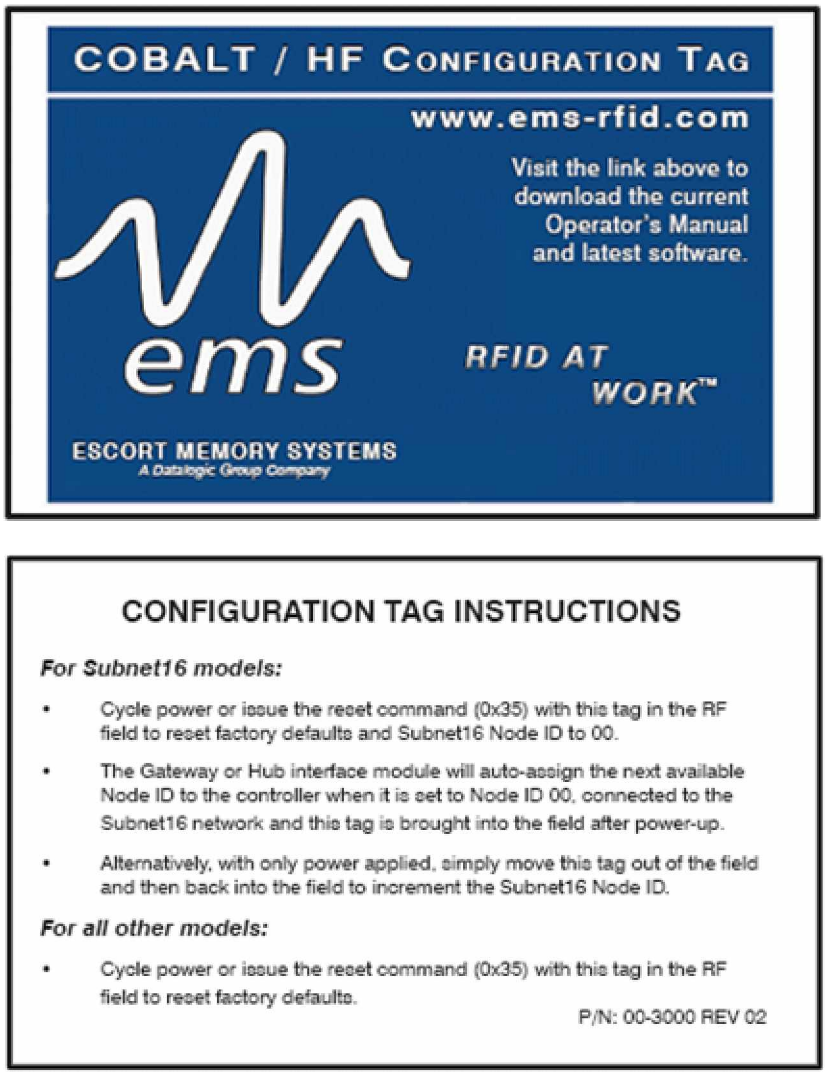


Figure 3-1: Cobalt HF Configuration Tag

In the event that serial communication parameters become improperly assigned, reset or cycle power to the RFID controller while holding the Configuration Tag in the controller's RF field. When power returns to the controller, factory default settings will be read from the Configuration Tag and the controller's internal configuration will be reset. For the C1007-485, the Configuration Tag can also be used to set the device's Node ID manually. It is recommended that you write the product model and serial number on the tag and store it in a safe place.

3.2.2 Configuration Tag Memory Map

Containing a Philips I-CODE SLi IC, the Configuration Tag is a 112-byte ISO 15693 compliant tag that has had much of its memory locked at the factory to prevent important data from being erased or overwritten. Of the 112 bytes of memory, the first 80 bytes (*addresses 0x0000 – 0x0079*) are allocated to storing factory default settings, product ID and manufacturing information. The first 16-bytes (*addresses 0x0000 through 0x0015*) contain specific data that the controller reads to identify this special tag.

You are welcome to experiment with the remaining 32 bytes available (*addresses 0x0080 – 0x0111*). All addresses on the Configuration Tag can be read and no user identifiable information is stored.

3.2.3 Using the Configuration Tag

Resetting the Controller Configuration to Default Values

The Configuration Tag can be used to reset factory defaults to all versions of the C1007. To restore factory default values, cycle power to the controller or issue the reset command (*Command 0x35*) while the Configuration Tag is in the RF field. Two seconds after power returns to the C1007, remove the Configuration Tag from the RF field. The controller's configuration will be reset to the following default values:

CONFIGURATION PARAMETER	DEFAULT VALUE
Command Protocol	ABx Fast – No Checksum
Tag Type	ISO 15693 (*I-Code SLi*)
Serial Communications	9600, N, 8, 1, N (*C1007-232 model*)
Node ID	zero (*C1007-485 model*)

Table 3-2: Controller Default Values

Setting Node ID Manually (C1007-485 Model Only)

To set the Node ID on C1007-485 models, cycle power to the controller or issue the reset command (*Command 0x35*) while the Configuration Tag is in the RF field. Two seconds after power returns to the C1007, remove the Configuration Tag from the RF field. This will set the Node ID value back to the default value of Node ID 00.

- All amber Node LEDs should be off.

After power returns to the unit, move the Configuration Tag out of the RF field and then back into the RF field to increment the Node ID from zero to one.

- Amber Node LED 2^0 should now be lit.

Removing the Configuration Tag from the controller's RF field and then placing it back into the field will increment the Node ID value once each time the Configuration Tag re-enters the RF field.

- The amber Node LEDs will display, in binary, the Node ID assigned to the controller.

This procedure can be used to cycle through all 16 possible Node ID values. Note that after reaching Node ID 16, incrementing the value once more returns the controller to Node ID 00.

After selecting the desired Node ID value, reset the C1007 with the Configuration Tag out of RF range to allow the unit to reset completely and resume operation under its new Node ID.

See *Section 4.1 – "LED Functions Overview"* for more information regarding LED positions and colors.

Setting Node ID Automatically (C1007-485 Model Only)

To allow a Subnet16 Gateway or Hub to assign the Subnet Node ID to a C1007-485 automatically, reset the controller to Node ID 00, connect the controller to the network, and apply power to the Subnet16 bus. When the Gateway or Hub comes on line, hold the Configuration Tag in the RF field of the controller for several seconds to allow the Gateway or Hub to assign the next available Node ID value.

For more information on using a Subnet16 Gateway and Hub product to auto-assign Subnet Node ID values, please refer to the Operator's Manuals for the Subnet16 Gateway and/or subnet16 Hub.

CHAPTER 4: LED STATUS

4.1 LED FUNCTIONS OVERVIEW

C1007-Series RFID Controllers have eight LED indicators. The LEDs are conveniently located on the top panel of the device and display everything from antenna RF and communications activity to Node ID, diagnostic information and power status.

LED COLOR	Red	Green	Amber	Amber	Amber	Amber	Amber	Green
FUNCTION	**RF** Activity	**COM** Activity	**Node** 2^4 (16)	**Node** 2^3 (8)	**Node** 2^2 (4)	**Node** 2^1 (2)	**Node** 2^0 (1)	**Power** On

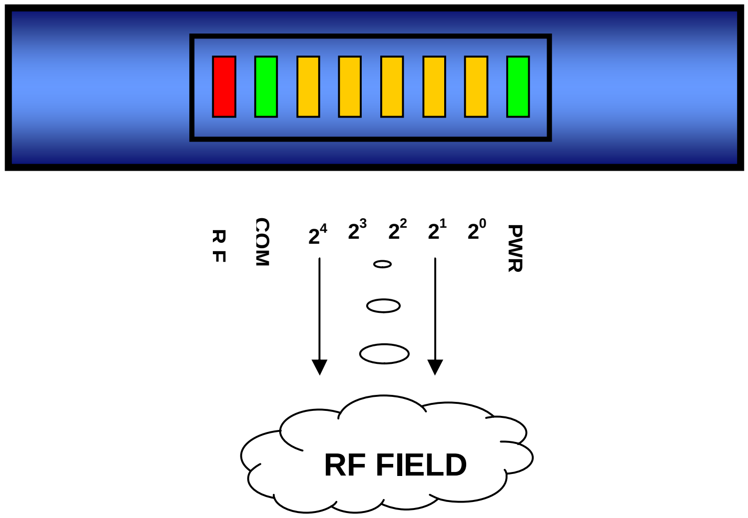
4.1.1 LED Descriptions

RF LED: Color is red. The RF LED will illuminate while RF power is being transmitted by the antenna, and will stay ON during the entire RF operation. By default, this occurs each time an RF command is being executed.

COM LED: Color is green. The COM LED indicates that data is being transmitted between the host and the C1007. On receipt of a command, the COM LED will begin flashing ON and OFF rapidly. After the controller generates the command response, COM LED flashing will halt. When in Continuous Read mode, the COM LED will remain ON and will turn OFF briefly only while a tag is in the antenna field and data is being read or written to the tag.

Node LEDs: Colors are amber. These five LEDs indicate the serial communications type for C1007-232 and -USB models. For the C1007-485 model, the five amber LEDs indicate (in binary from right to left) the current Node ID value assigned to the controller. The five amber LEDs also flash an error code when a fault occurs (see *Section 4.3 – "LED Displayed Error Codes"*).

Power LED: Color is green. The Power LED will remain ON while power is applied to the C1007-Series RFID Controller.



4.1.2 C1007-232/USB LED Status

C1007-232 - amber **Node LED 2^0** will illuminate. Node LED 2^0 indicates RS232 mode.

C1007-USB - amber **Node LED 2^3** will illuminate. Node LED 2^3 indicates USB mode.

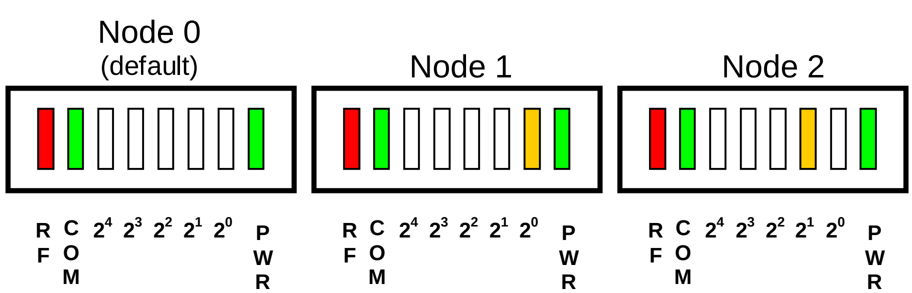
4.1.3 C1007-485 LED Status

When used in conjunction with a Subnet16 Gateway or Subnet16 Hub, the five amber Node LEDs on the C1007-485 model indicate (in binary, weighted by powers of two, from right to left) the Node ID value currently assigned (for which there are 16).

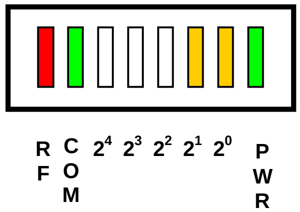
For example, 2^0 (0x01) = Node ID 1, 2^1 (0x02) = Node ID 2, 2^2 (0x04) = Node ID 4, 2^3 (0x08) = Node ID 8, 2^4 (0x10) = Node ID 16.

By default, C1007-485 RFID Controllers ship with their Node ID value set to zero (none of the five amber Node LEDs will be lit). After the controller is connected to a Subnet16 bus and has been recognized by a Subnet16 Gateway or Hub, it will be automatically assigned the next available Node ID (1 through 16). For configuring or resetting the Node ID using the Configuration Tag, see *Chapter 3 – Section 3.2: Cobalt HF Configuration Tag.*

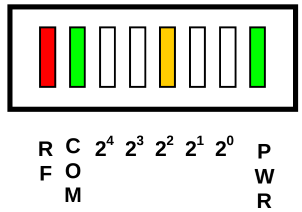
Node ID Values for the C1007-485



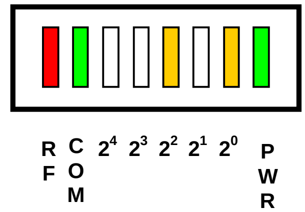
Node 3



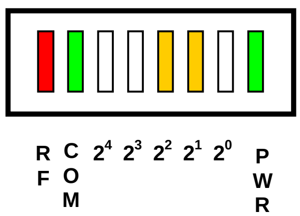
Node 4



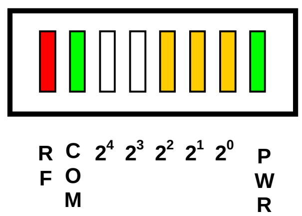
Node 5



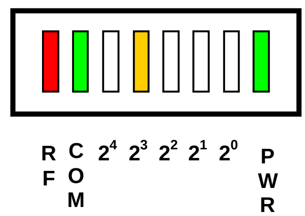
Node 6



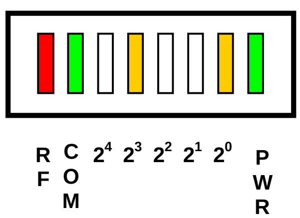
Node 7



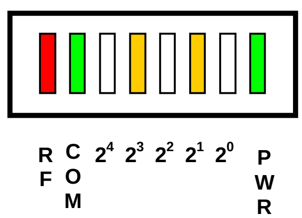
Node 8



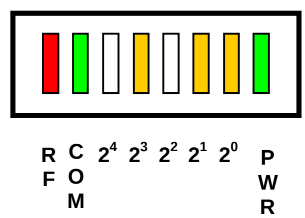
Node 9



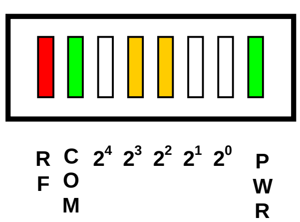
Node 10



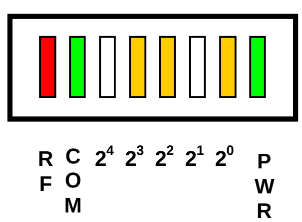
Node 11



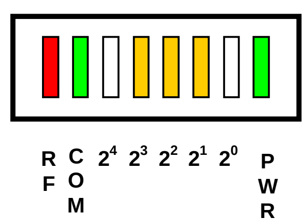
Node 12



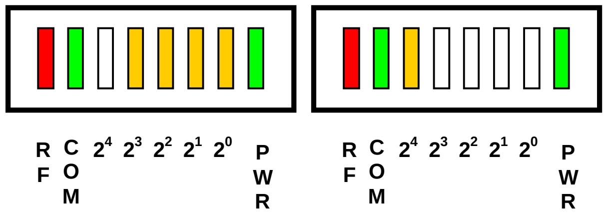
Node 13



Node 14



Node 15 Node 16

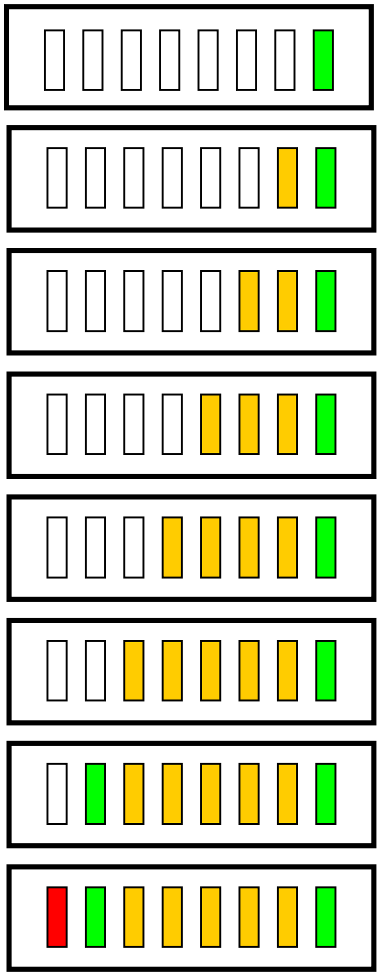


NOTE:

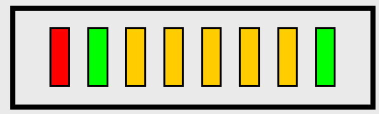
Node ID 00 is the default Node ID for C1007-485 controllers. In this state the controller will be unable to perform commands until it has been initialized by a Gateway or Hub, at which time it will be assigned a Node ID value between 1 and 16.

4.2 SPECIAL LED FUNCTIONS

4.2.1 Updating the Controller's Firmware

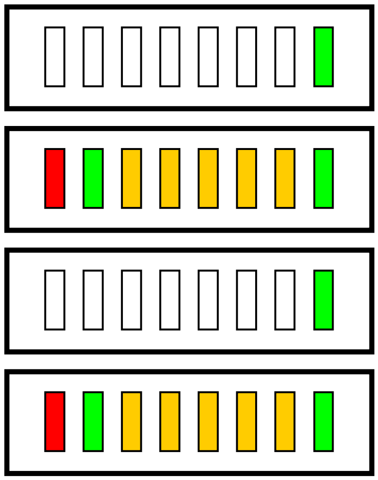


Updating Firmware (Part 1)

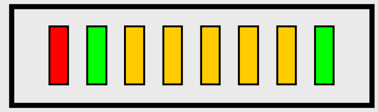


With the PWR LED on the right, the remaining LEDs will illuminate one at a time sequentially from right to left to indicate that new firmware code is being copied to internal memory.

The LEDs will repeat this R to L sequence until the C1007 has completely received the firmware installation file.



Updating Firmware (Part 2)



After the new firmware has been copied to internal memory, the LEDs will blink ON and OFF repeatedly during which time the new code is being written to flash memory.

Warning: do not cancel or abort this operation, AND do not unplug or remove power from the controller under any circumstance until this procedure is completed.

4.2.2 Continuous Read Mode – LED Behavior

The table below describes the behavior of the LEDs when the C1007 is in *Continuous Read Mode (Command 0x0D)*.

LED	BEHAVIOR	DESCRIPTION
PWR	ON	Controller is powered and functioning
COM	ON	Duplicate Read Delay ≥ 1 and a tag has entered the RF field. COM LED will remain ON while a tag is in the RF field. After the tag has exited the RF field the COM light will remain ON for the duration of the Duplicate Read Delay before turning OFF
COM	BLINKING	Duplicate Read Delay = 0 and a tag is in the RF field
RF	ON	Continuous Read mode is enabled

Table 4-1: Continuous Read Mode - LED Behavior

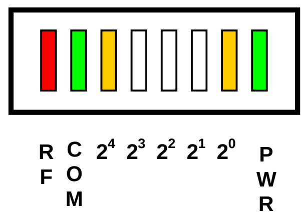
4.3 LED DISPLAYED ERROR CODES

When an error occurs, other than a Timeout, the red RF LED and one or more amber Node LEDs will flash in unison. The amber Node LEDs flash a binary representation of the one-byte error code value of the fault that transpired. The COM LED will also be illuminated after an error occurs to help orient the binary LED positions. See *Chapter 8: "ABx Error Codes"* for a complete list of errors and their descriptions.

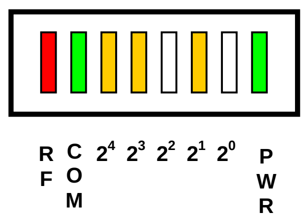
To display the single-byte error code in binary, the two left-most amber Node LEDs (LED 2^4 and LED 2^3) represent the first or most significant digit (MSD) of the error code. The three remaining amber Node LEDs (LED 2^2, LED 2^1 and LED 2^0) are combined to represent the second or least significant digit (LSD) of the error code.

Examples:

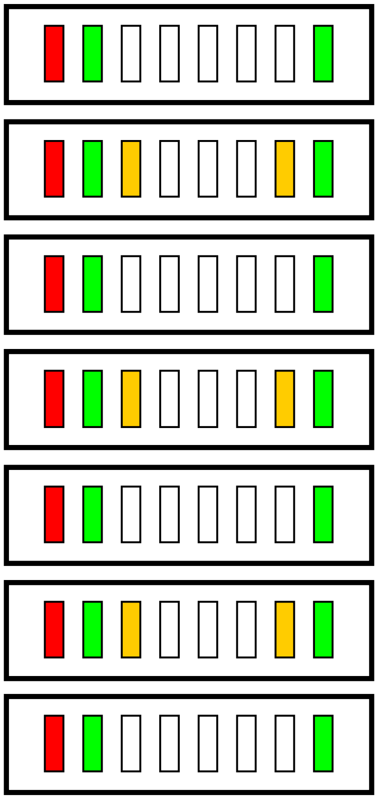
- If the five amber Node LEDs (from L to R) = **ON, OFF, OFF, OFF, ON,** the first digit of the error code is a "***2*** " and the second digit is a "***1,***" meaning that error code **0x21** occurred (*error code 0x21 = command syntax error*).

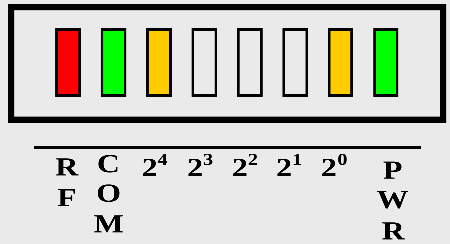


- If the five amber Node LEDs (from L to R) = **ON, ON, OFF, ON, OFF,** the first digit of the error code is a "***3*** " and the second digit is a "***2,***" meaning that error code **0x32** occurred (*error code 0x32 = invalid programming address*).



The red RF LED and amber Node LEDs will continue to flash until a valid command is received by the controller. If an unrecoverable error occurs, the LEDs will continuously flash the error code until the C1007 has been reset.





This example depicts Error 0x21.

When an error occurs, the green COM LED will remain ON to help orient the binary LED positions. The green power LED will also be ON while power is applied to the C1007.

CHAPTER 5: RFID TAGS

5.1 RFID TAG OVERVIEW

RFID tags, which are also referred to as transponders, smart labels, or inlays, come in a variety of sizes, memory capacities, read ranges, frequencies, temperature survivability ranges and physical embodiments. C1007-Series RFID Controllers are capable of reading Escort Memory Systems' HMS, LRP and T-Series RFID tags as well as most tags made by other manufacturers.

5.1.1 RFID Standards

ISO 14443A

RFID integrated circuits (ICs) designed to meet the ISO 14443A standard were originally intended for use in smart cards used in secure transactions such as credit cards, passports, bus passes, ski lift tickets, etc. For this reason there are many security authentication measures taken within the air protocol between the RFID controller and the tag. Escort Memory Systems was the first company to adopt ISO 14443A RFID ICs with this technology for industrial automation applications. Because these applications do not require the level of security monetary or passport applications require, many of these features have not been implemented in current controllers. It is important to understand the requirements of an ISO 14443A application before assuming the C1007-Series controller is suitable.

ISO 14443A compliant tags and controllers incorporate security authentication and use software "keys" during the transfer of data to and from a tag. Both the RFID controller and the tag must use the same security keys for communication to be authenticated. The C1007 controller's operating system manages these security features, making their existence essentially transparent to the user.

However, it is important to understand the implications associated with ISO 14443A when using a third party manufacturer's tags. Because of the aforementioned security "*features*," an ISO 14443A tag made by one manufacturer might not be readable by C1007 controllers and likewise, an EMS ISO 14443A compliant tag might not be readable by another manufacturer's RFID controller. C1007-Series Controllers support EMS' security keys for use on Mifare-based ISO 14443A tags.

ISO 15693

ISO 15693 was established at a time when the RFID industry identified that the lack of standards was preventing market growth and further adoption of RFID technologies. Philips Semiconductor and Texas Instruments were the major manufacturers producing RFID ICs for the *Industrial, Scientific, and Medical* (ISM) frequency of 13.56MHz, but each used a unique protocol and modulation algorithm. Texas Instruments Tag-it™ and Philips Semiconductor's I-CODE™ product lines were eventually standardized on the mutually compatible ISO 15693 standard. After the decision was made to standardize, the door opened for other silicon manufacturers to enter the RFID business, many of which have since contributed to RFID ISO definitions. This healthy competition has led to rapid growth in the industry and has pushed the development of other standards, such as ISO 18000 for *Electronic Product Code* (EPC) applications.

ISO 18000-3.1

The ISO 18000 standard has not been implemented in C1007-Series RFID Controllers at the time of publication of this manual. It is a planned product enhancement for future release. This will provide support for EPC and *Unique Identification* (UID) tag applications.

ADDITIONAL INFORMATION:

Because ISO 14443A and ISO 15693 standards leave many features open to the discretion and interpretation of the RFID equipment manufacturer, EMS can not guarantee that all 13.56MHz RFID tags will be compatible with Cobalt controllers. When using any tag other than those supplied by Escort Memory Systems, you should ensure compatibility of those tags with your RFID system provider.

5.2 EMS RFID TAGS

As of the publication of this manual, tags that contain the following RFID integrated circuits are compatible with Cobalt C1007-Series RFID Controllers.

5.2.1 HMS-Series Tags

- **Philips Mifare Classic:** 1KB total IC memory, + 32-bit tag ID. Of this memory, 736 bytes are available for user data (ISO 14443A compliant).
- **Philips Mifare Classic:** 4KB total IC memory, + 32-bit tag ID. Of this memory, 3,440 bytes are available for user data (ISO 14443A compliant).

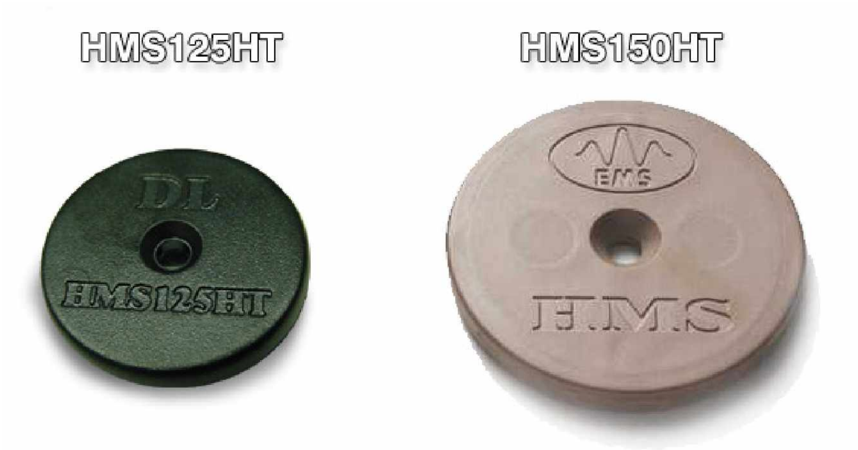


Figure 5-1: HMS125HT and HMS150HT tags

5.2.2 LRP-Series Tags

§ **Philips I-CODE 1:** 48 bytes total IC memory available for user data, + 64-bit tag ID.

§ **Philips I-CODE SLi:** 112 bytes total IC memory available for user data, + 64-bit tag ID (ISO 15693 compliant).

§ **Texas Instruments Tag-it:** 32 bytes total IC memory available for user data, + 64-bit tag ID (ISO 15693 compliant).

§ **Infineon My-D Vicinity:** 1KB total IC memory available for user data, + 64-bit tag ID (ISO 15693 compliant).

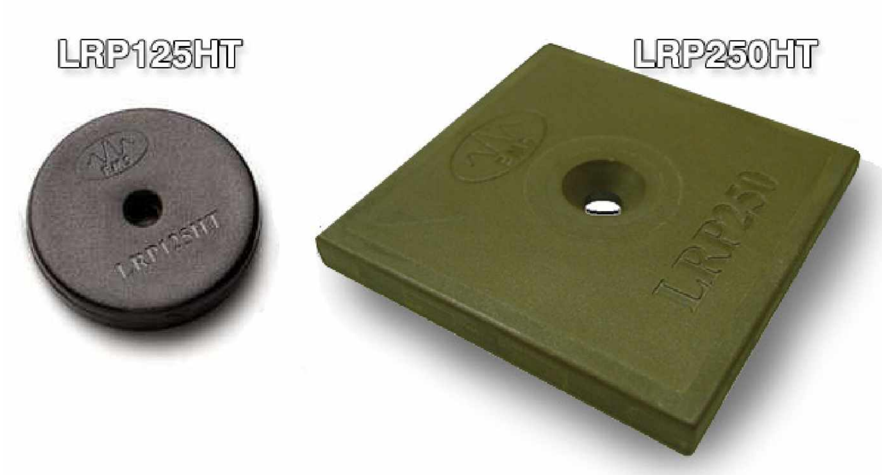


Figure 5-2: LRP-Series Tags

The HMS-Series and LRP-Series RFID tags listed in the above section are passive devices, meaning that they require no internal batteries. These tags are fully readable and writeable, except for the tag's unique ID number, which is read only.

There are no serviceable or repairable parts inside these tags, yet most are capable of providing over 100,000 write cycles and 10 years of data retention. In fact, tests resulting in over one million write cycles have been recorded by some tags.

Numerous tag-related factors can adversely affect RF range and data transmission between the controller and the tag, including the tag's integrated circuit (IC), the tag's antenna coil design, the tag's antenna conductor material, the tag's antenna coil substrate, the tag IC incorporated, the antenna coil bonding process and the embodiment material that is used.

Additionally, the mounting environment of the tag and controller can hinder performance due to other materials affecting the tuning of either antenna. Escort Memory Systems has performed extensive testing to produce tags that obtain optimum performance with our RFID devices. In most cases, optimal range will be obtained when mounting the tag and antenna in locations free from the influence of metals and EMI emitting devices.

5.3 TAG EMBODIMENTS

RFID tags are designed, produced and distributed in a variety of sizes and packages.

5.3.1 Printed Circuit Board RFID Tags

RFID tags that incorporate Printed Circuit Board technology are designed for encasement inside totes, pallets, or products that can provide the protection normally associated with injection-molded enclosures.

These tags are made primarily from etched copper PCB materials (FR-4, for example) and are die-bonded by means of high quality wire bonding. This procedure ensures reliable electrical connections that are superior to flip-chip assembly methods. The RFID tag's integrated circuit is then encapsulated in epoxy to protect it and the electrical connections.

5.3.2 Molded RFID Tags

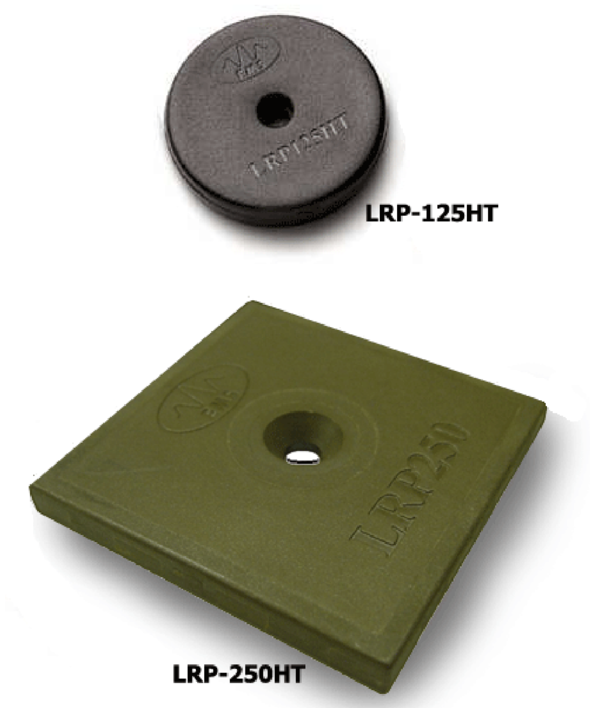
Molded tags utilize PCB tags and are the most rugged and reliable of the tags offered by Escort Memory Systems. These tags are designed for closed-loop applications where the tag is reused; thereby the cost of the tag can be amortized over the life of the production line. Typically, molded tags will be mounted to a pallet or carrier that transports (and accompanies) the product through the entire production process. Other applications for these tags include (but are not limited to) embedding tags within concrete floors for location identification, shelf identification for storage and retrieval systems, and tool identification.

Escort Memory Systems offers a wide variety of molded tags that have been developed over the years for real world applications. High temperature tags using patented processes and specialized materials allow tags to survive elevated temperatures, such as those required for automotive paint and plating applications.

5.4 TAG MEMORY

Tag memory addressing begins at address zero (0x0000), with the highest addressable memory location equal to one less than the total number of bytes in the tag. Each address is equal to one byte (8-bits), where the byte is the smallest addressable unit of data. So for example, writing 8-bytes to a tag beginning at address 0 will fill addresses 0 to 7 with 64-bits of data in all.

Depending on the manufacturer, RFID labels, molded tags and embedded PCBs can have differing memory storage capacities and organization. Tag memory is grouped into blocks of bytes that can vary in organization from manufacturer to manufacturer. Even when compliant to ISO standards, byte memory addressing can differ from one manufacturer to another (for example, tag memory can be organized in blocks of 4 or 8 bytes, depending on the RFID IC). Additionally, all bytes may not be available for data storage as some bytes may be used for security and access conditions. For more information regarding a specific RFID tag's memory allocation, please refer to each IC manufacturer's datasheet or Website.



Escort Memory Systems has taken great care to simplify tag memory addressing. The mapping from logical address to physical address is handled by the C1007-Series Controller's operating system. Users only need to identify the starting address location on the tag and the number of bytes to be read or written. However, extra attention needs to be paid to the memory block structure when memory lock commands are used. When data is locked, it cannot be altered. Caution should be exercised when using memory lock commands as locked data cannot be unlocked, even by Escort Memory Systems.

5.4.1 Mapping Tag Memory

Customers need to take into account that there are some RFID tag manufacturers that measure and specify their tag memory sizes by the total number of ***bits***, as this method generates a much larger (8X) overall number designed to inflate their specifications. Escort Memory Systems, on the other hand, prefers to specify total tag memory sizes in terms of ***bytes*** (rather than in bits), as this method more closely reflects how data is stored and retrieved from a tag and is typically what our customers really want to know.

5.4.2 Creating an RFID Tag Memory Map

Creating a ***tag memory map*** is much like creating a spreadsheet that outlines the actual data you plan to capture as well as the specific tag memory locations in which you wish to store said data. Tag memory maps should be carefully planned, simple and straightforward. It is advisable to utilize more storage space than is initially required, as inevitably a need will arise to hold more data.

Tag Memory Map Example

In the example below, 90-bytes of a 112-byte tag have been allocated to areas of the memory map (leaving roughly 20% free for future uses). Because a short paragraph of alphanumeric characters could quickly use all 90 bytes, creating an efficient mapping scheme, which utilizes all 720-bits out of the 90-bytes allocated, will provide a better use of tag space.

TAG ADDRESS	DESCRIPTION OF USAGE
00 - 15	Serial Number
16 - 47	Model Number
48 - 63	Manufacturing Date
64 - 71	Lot Number
72 - 89	Factory ID
90 - 111	Reserved

Table 5-1: Tag Memory Map Example

5.4.3 Optimizing Tag Memory

Data is always stored in tag memory in a binary form (1's and 0's). Binary numbers are notated using the hexadecimal numbering system (otherwise it would be too confusing looking at a screen full of 1's and 0's).

Below is an example of how hexadecimal notation simplifies the expressing of byte values for the decimal number 52,882.

DECIMAL	BINARY	HEXADECIMAL
52,882	1100111010010010	CE92

In the above example, instead of using 5-bytes of data to store the ASCII bytes representing characters 5, 2, 8, 8, and 2 (ASCII bytes: 0x35, 0x32, 0x38, 0x38, 0x32) by simply writing two Hex bytes (0xCE and 0x92), 60% less tag memory is used to store the same information.

When an alphabetical character is to be written to a tag, the ASCII value of the given character is written to the tag. For example, to write a capital “D” (ASCII value 0x44), the binary equivalent of the ASCII character 0x44 is written to the tag.

Additionally, if a database with look up values is used in the RFID application, the logic level of the individual bits in the tag can be used to maximize tag memory.

(Note: refer to Appendix D in this document for a complete chart of ASCII characters and their corresponding Hex values).

The graphic below illustrates how a single byte (8-bits) can be efficiently used to track an automobile’s inspection history at eight inspection stations. The number one (1) represents a required operation and the number zero (0) represents an operation that is not required for that particular vehicle.

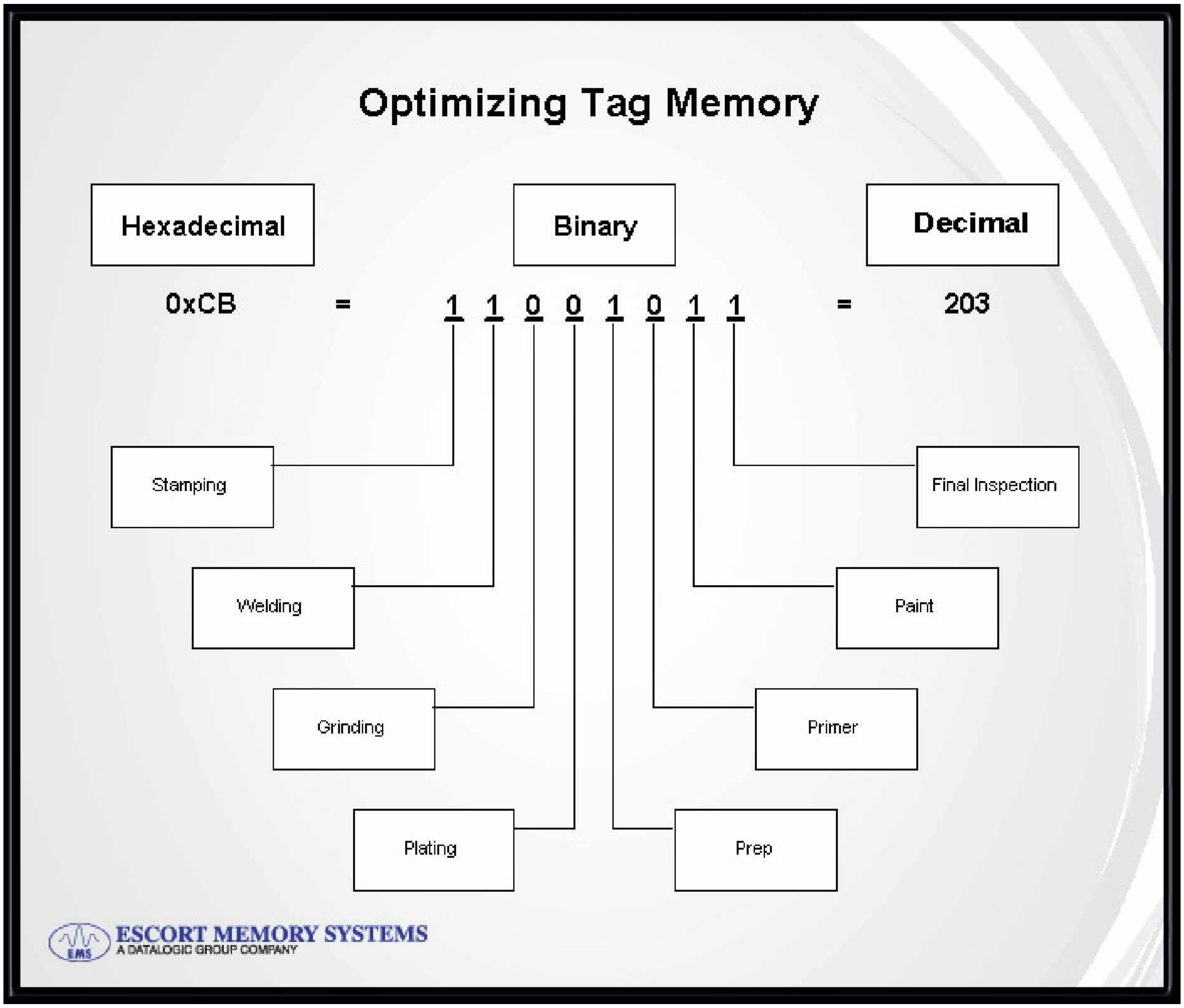


Figure 5-3: Optimizing Tag Memory

CHAPTER 6: COMMAND PROTOCOLS

6.1 COMMAND PROTOCOLS OVERVIEW

When an RFID command is issued, the host computer instructs the RFID controller to perform a given task. After performing that task, the RFID controller will normally reply back with a Command Response message indicating the status or results of the attempted command. This response notifies the host as to whether the command was successfully completed or if the RFID controller failed to complete the command.

To understand and execute RFID commands, the C1007 and the host must be able to communicate using the same language. The language that is used to communicate RFID commands is referred to as the *Command Protocol*. The type of Command Protocol that is used is known as the ABx Command Protocol, of which there are two primary variations. The two versions of the ABx Command Protocol that are supported by the C1007-Series RFID Controller are:

- **ABx Fast** (*default*)
- **ABx Standard**

The ***ABx Fast Command Protocol*** is the default command protocol used by C1007 RFID Controllers. It has a single-byte based packet structure that permits the execution of RFID commands while transferring fewer total bytes than ABx Standard requires. It can be used with or without a checksum byte.

The ***ABx Standard Command Protocol*** uses a double-byte, word based format that shares a common syntax with most existing RFID systems produced by Escort Memory Systems. This protocol offers legacy support, which may be required by existing PLC applications that only support a 2-byte word packet format. If your application requires compatibility with existing or legacy RFID devices from Escort Memory Systems', use ABx Standard. ABx Standard does not support the use of a checksum byte.

NOTE:

By default, the C1007 is configured to use the *ABx Fast Command Protocol*. ABx Fast (as the name suggests) is the faster and more efficient of the two ABx protocols, offering increased communication speed and error immunity.

6.1.1 ABx Protocols - Command Structures

All ABx-based RFID commands contain certain fundamental packet elements, including a ***Command Header***, a ***Command ID***, one or more ***Command Parameters*** (when applicable) and a ***Command Terminator***.

Command Packet Structure = [Command Header + Command ID + Command Parameters + Command Terminator]

6.1.2 ABx Protocols - Headers and Terminators

In ***ABx Fast,*** commands begin with the two-byte command header "***0x02, 0x02***" and end with the one-byte command terminator "***0x03.***"

In ***ABx Standard***, commands begin with the one-byte command header "***0xAA***," and end with the two-byte command terminator "***0xFF, 0xFF***".

ABx Protocols - Headers and Terminators

ABX PROTOCOL	HEADER	TERMINATOR
ABx Fast	0x02, 0x02	0x03
ABx Standard	0xAA	0xFF, 0xFF

Table 6-1: ABx Protocols - Headers and Terminators

6.1.3 ABx Protocols - Response Structures

After completing an ABx command, the C1007 generates a host-bound, response packet that indicates the status and/or results of the attempted command. The response packet structure for all ABx protocols consists of a ***Response Header,*** a ***Command Echo***, one or more ***Response Values*** (when applicable), and a ***Response Terminator***.

Response Packet Structure = [Response Header + Command Echo + Response Values + Response Terminator]

Note that for each ABx protocol, **Response Header** and **Response Terminator** parameters are the same as their **Command Header** and **Command Terminator** counterparts.

6.2 ABX FAST COMMAND PROTOCOL

The default command protocol used by C1007-Series RFID Controllers for Point-to-Point data transmission is known as the *ABx Fast Command Protocol.* ABx Fast has a single-byte oriented packet structure that permits the rapid execution of RFID commands while requiring the transfer of a minimal number of bytes.

ABx Fast supports the inclusion of an optional checksum byte. When increased data integrity is required, the checksum should be utilized. See *Section 6.2.4. – "Checksum,"* for more information on using the checksum parameter.

6.2.1 ABx Fast - Command / Response Procedure

After an RFID command is issued by the host, a packet of data, called the "*Command Packet*" is sent to the controller. The command packet contains information that instructs the controller to perform a certain task.

The controller automatically parses the incoming data packet, searching for a specific pair of start characters, known as the "*Command Header.*" In ABx Fast, the Command Header / Start Characters are *0x02, 0x02*. When a valid Command Header is recognized, the controller then checks for proper formatting and for the presence of a "*Command Terminator*" byte. In ABx Fast, the Command Terminator byte is *0x03*.

Having identified a valid command, the controller will attempt to execute the given instructions. After which the controller will generate a host-bound response message containing *EITHER* the results of the attempted command or an error code if the operation failed.

NOTE: For RFID applications that use an EMS Gateway or Hub Interface Module, the *CBx Command Protocol* applies. Please refer to the Gateway or Hub Operator's Manuals and the CBx Command Protocol Reference Manual (all of which are available at www.ems-rfid.com) for further information regarding CBx commands.

6.2.2 ABx Fast - Command Packet Structure

The packet structure of all ABx Fast command contains certain basic elements, including *Command Header, Command Size, Command ID* and *Command Terminator*. Additional options are available depending on the command being performed.

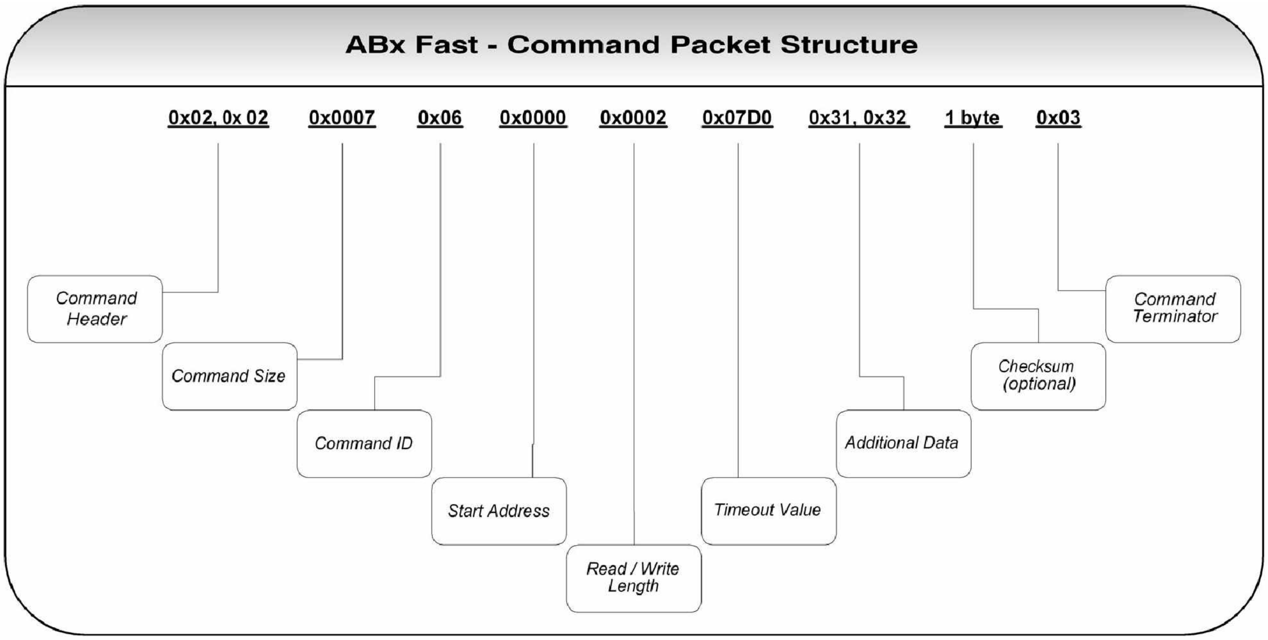


Figure 6-1: ABx Fast - Command Packet Structure

COMMAND PACKET ELEMENT	CONTENT	SIZE
COMMAND HEADER: The first two bytes of an ABx Fast command packet	0x02, 0x02	2 bytes
COMMAND SIZE: This 2-byte integer defines the number of bytes in the packet (excluding header, command size, checksum and terminator).	0x0007 + (number of bytes of additional data)	2-byte integer
COMMAND ID: This single-byte value indicates the RFID command to execute.	0x06 (*Write Data*)	1 byte
START ADDRESS: This two-byte parameter indicates the location of tag memory where a read or write operation shall begin.	0x0000	2-byte integer
READ-WRITE LENGTH / BLOCK SIZE: This two-byte parameter represents the number of bytes that are to be retrieved from or written to the RFID tag.	0x0001	2-byte integer
TIMEOUT VALUE: This two-byte parameter indicates the maximum length of time for which the controller will attempt to complete the command. Measured in milliseconds, this value can have a range of 0x0001 to 0xFFFE or between 1 and 65,534 msecs.	0x07D0 (*0x07D0 = 2000 x .001* = *2 seconds*)	2-byte integer

ADDITIONAL DATA: This parameter uses one byte to hold a single character for fill operations and supports the use of multiple bytes when several characters are needed for write commands (when applicable).	0x00	One or more bytes (when applicable)
CHECKSUM: This optional parameter holds a single-byte checksum (only applicable when using *ABx Fast with Checksum*).	Optional	1 byte (when applicable)
COMMAND TERMINATOR: Single-byte command packet terminator (*always 0x03*)	0x03	1 byte

Table 6-2: ABx Fast - Command Packet Structure

6.2.3 ABx Fast - Response Packet Structure

After performing a command, the C1007, in most cases, will generate a host-bound response packet. ABx Fast responses contain a ***Response Header, Response Size, Command Echo***, one or more ***Response Values*** (when applicable), an optional ***Checksum*** and a ***Response Terminator.***

RESPONSE PACKET ELEMENT	CONTENT	SIZE
RESPONSE HEADER: First two bytes of an ABx Fast response packet	0x02, 0x02	2 bytes
RESPONSE SIZE: This two-byte integer defines the total number of bytes in the response packet (excluding header, size, checksum and terminator).	0x0001	2-byte integer
COMMAND ECHO: The single-byte parameter identifies the command for which the response packet was generated.	0x06	1 byte
RETRIEVED DATA: This parameter is used to hold one or more bytes of data that was requested by the command (when applicable).	Data	1 or more bytes (when applicable)
CHECKSUM: This optional parameter holds a single-byte checksum (only applicable when using *ABx Fast with Checksum*).	Optional	1 byte (when applicable)
RESPONSE TERMINATOR: Single-byte response packet terminator (*always 0x03*)	0x03	1 byte

Table 6-3: ABx Fast - Response Packet Structure

6.2.4 ABx Fast - Command Packet Parameters

Command Size

The ABx Fast protocol requires that the byte count, known as the "***Command Size***," be specified as a two-byte integer. To calculate the Command Size, add the total number of bytes within the command packet while excluding the Header, Command Size, Checksum (if present) and Terminator (see example below).

Command Size = number of bytes in these fields

COMMAND ELEMENT	# OF BYTES	INCLUDED IN COMMAND SIZE?
Command Header	2	No
Command Size	2	No
Command ID	***1***	***Yes***
Start Address	***2***	***Yes***
Read/Write Length (Block Size)	***2***	***Yes***
Timeout Value	***2***	***Yes***
Additional Data Bytes	***1***	***Yes***
Checksum	1	No
Command Terminator	1	No

The ***Command Size*** for this example is ***0x0008***.

Start Address

The ***Start Address*** parameter holds a two-byte integer representing the tag memory address location where a read or write operation will begin.

Read/Write Length (Block Size)

The two-byte ***Read/Write Length (Block Size)*** integer indicates the number of bytes that are to be read from or written to the RFID tag.

Timeout Value

A two-byte ***Timeout Value*** parameter (measured in one-millisecond increments) is used to set the length of time that the controller will attempt to complete the specified operation.

The maximum supported Timeout Value is 0xFFFE or 65,534ms (slightly longer than one minute). Setting a long Timeout Value does not necessarily mean that a command will take any longer to execute. This value only represents the period of time for which the controller will attempt to complete the command.

IMPORTANT: During write commands, the tag must remain within the antenna's RF field until the write operation completes successfully, or until the timeout value has expired. If a write operation is not completed before the tag leaves the controller's RF field, data may be incompletely written.

Checksum

ABx Fast and ABx ASCII Command Protocols support the inclusion of an additional ***Checksum*** byte that is used to verify the integrity of data being transmitted between host and controller.

The Checksum is calculated by adding together (summing) the byte values in the command packet (less the Header, Checksum and Terminator), and then subtracting the total byte sum from 0xFF. Therefore, when the byte values of each packet element (from Command Size to Checksum) are added together, the byte value sum will equal 0xFF.

CHECKSUM EXAMPLE

The following example depicts *Command 0x05* (*Read Data*) using a Checksum (*Start Address: 0x0001, Read Length: 0x0004, Timeout Value: 0x07D0*).

Checksum = [0xFF – (sum of these fields)]

COMMAND PACKET ELEMENT	CONTENTS	USED IN CHECKSUM
Command Header	0x02, 0x02	n/a
Command Size	0x0007	0x00, 0x07
Command ID	0x05	0x05
Start Address	0x0001	0x00, 0x01
Read Length	0x0004	0x00, 0x04
Timeout Value	0x07D0	0x07, 0xD0
Checksum	0x17	n/a
Command Terminator	0x03	n/a

Add the byte values from the Command Size, Command ID, Start Address, Read Length and Timeout Value parameters together and subtract from 0xFF. Resulting value will be the Checksum.

[0x07 + 0x05 + 0x01 + 0x04 + 0x07 + 0xD0] = **0xE8**

The Checksum equation is: [0xFF – 0xE8] = **0x17**

6.2.5 ABx Fast Multi-Tag Command Packet Structure

ABx Fast Multi-tag Commands are capable of interrogating one or more RFID tags, when numerous tags are simultaneously within RF range. These commands also allow users to retrieve data from or write data to several tags at once. Below is the structure of a basic ABx Fast Multi-tag command packet.

ABx Fast Multi-tag Command Packet Structure

COMMAND PACKET ELEMENT	CONTENT	SIZE
COMMAND HEADER: The first two bytes of an ABx Fast command.	0x02, 0x02	2 bytes
COMMAND SIZE: This two-byte integer defines the number of bytes in the packet (*excluding Header, Command Size and Terminator*).	0x0007 + (number of additional data bytes)	2-byte integer
COMMAND ID: This single-byte value indicates the command to perform.	0x87 (Multi-Tag Inventory)	1 byte
FAMILY CODE: This single-byte value is used to specify a subset of tags when many are identified simultaneously in RF range. Zero = broadcast to all tags in RF range (*see description in Section 6.2.6*)	0x00	1 byte
ANTI-COLLISION MODE: This single-byte value allows the user to enable the use of 16 time slots for retrieving data, choices are: 0x01 = use 16 time slots, 0x00 = use single slot (*see description in Section 6.2.6*)	0x01	1 byte
TAG LIMIT: This single byte specifies the maximum # of tags expected in RF range, up to 100; 0x64 = 100 tags expected max, when applicable (*see description in Section 6.2.6*)	0x64	1 byte
START ADDRESS: This two-byte integer indicates the location of tag memory where a read or write operation shall begin.	0x0000	2-byte integer
BLOCK SIZE: This two-byte integer represents the number of bytes that are to be read from or written to an RFID tag during the operation, when applicable.	0x0001	2-byte integer
TIMEOUT VALUE: This two-byte integer indicates the maximum length of time for which the controller will attempt to complete the command. Measured in milliseconds, this value can have a range of 0x0001 to 0xFFFE or between 1 and 65,534 msecs.	0x07D0 (*0x07D0 = 2000 x .001 = 2 seconds*)	2-byte integer
ADDITIONAL DATA: This parameter uses one byte for fill operations and supports the use of multiple bytes when several characters are needed for write commands, when applicable.	0x00	1 or more bytes
COMMAND TERMINATOR: The single-byte command packet terminator is always *0x03*.	0x03	1 byte

Table 6-4: ABx Fast Multi-Tag Command Packet Structure

6.2.6 ABx Fast Multi-Tag Command Packet Elements

Family Code

The ***Family Code*** parameter is a one-byte value (*0x00 – 0xFF*) that can be used in multi-tag commands to specify a subset of tags when many are identified simultaneously in RF range. The parameter allows the user to filter tags based on a pre-written value stored at a special location on the tag.

For example, if the Family Code value is set to one (*0x01*), only those tags with the value *0x01* will respond to the given command. When a Family Code value of zero (*0x00*) is entered for this parameter, the command will be broadcast to all tags in RF range.

Anti-Collision Mode

Tag collision in RFID applications occurs when numerous passive RFID tags become simultaneously active or energized (by the RFID controller) and thus reflect their respective signals back to the reader at the same time, such that the reader cannot differentiate between tags.

EMS' RFID readers make use of **anti-collision algorithms** to enable a single reader to read more than one tag in the reader's field.

The ***Anti-collision Mode*** parameter controls the tag-reading algorithm used to achieve the fastest reading speed for the number of tags expected in RF range at any given moment. This parameter helps the reader/antenna avoid data collisions when simultaneously reading multiple tags

The choices for this parameter are one (**0x01**) for *Multi-Slot* and zero (**0x00**) for *Single-Slot*.

- ***ONE***: Setting this parameter to one (0x01) implements a system of 16 time slots. To avoid data collisions when the controller encounters multiple tags simultaneously, data requested from each tag is transferred to the host only during the time slot that matches a specific pattern in the tag ID number.
- ***ZERO***: Setting this parameter to zero (0x00) utilizes a single time slot under which the requested data from all tags is transferred to the host as soon as it becomes available to the controller. This setting can result in faster tag read performance when only a few tags are expected in the RF field

The Anti-Collision Mode parameter immediately follows the "*Family Code*" parameter in the command packet string.

Tag Limit

The ***Tag Limit*** parameter holds a one-byte value that indicates the maximum number of tags expected simultaneously in RF range for the given command operation. This parameter allows users to limit the number of attempted read/write operations the controller will make per execution.

The *Tag Limit* value should be set in relation to the maximum number of tags that could possibly be present in the reading field at any one time. Users do not have to wait for the timeout to expire. Setting the value higher increases the number of tags expected to be read in the antenna's RF field. Lowering the value, however, can speed up tag read operations for a small group of tags.

Setting the proper value is therefore a tradeoff between the number of expected tags in the reading field, and the time required to read/write to them. The permitted values range from zero to 100 (0x00 – 0x64). The *Tag Limit* parameter resides directly after the "*Anti-collision Mode*" parameter in the command string (when applicable).

Timeout Value

Multi-tag commands also contain a two-byte *Timeout Value* parameter that is used to limit the length of time for which the controller will attempt to complete a given operation.

It is important to set a realistic *Timeout Value* that permits enough time for the controller to read/write to all tags specified in the command. Processing multiple-tag operations requires a longer time period than does the execution of single-tag commands.

The value is expressed in one-millisecond increments, with a maximum value of 0xFFFE (65,534 milliseconds) or approximately 60 seconds. For most single tag read/write commands, a Timeout Value of at least 1000ms is recommended. However, it is recommended that you allow an additional **100ms** per tag for multi-tag read operations and **150ms** per tag for multi-tag writes.

Using a *Timeout Value* that is too short may cause the controller to inadvertently "time out" before the data has been successfully read from or written to all tags in RF range. Setting a long *Timeout Value* does not necessarily mean that the command will take any longer to complete. The value only represents the period of time in which the controller will attempt to complete the particular operation. If all required tags are in RF range when the command is sent, the time necessary to complete the command will be approximately the same whether the *Timeout Value* is 1000ms or 10,000ms.

For time critical applications, the optimal *Timeout Value* should be obtained through rigorous performance testing.

TIMEOUT VALUE EXAMPLE

When writing to 16 different tags in RF range, for example, set the two-byte *Timeout Value* to at least **0x0D48** (16 x 150ms + 1000ms = 3400ms or 3.4 seconds). A *Timeout Value* of zero (0x0000) will cause the controller to return a syntax error message.

Tag ID / Serial Number

Several multi-tag commands are available that will retrieve or allow the user to specify, a tag's ID number. The tag ID number is a unique read-only, 64-bit (eight-byte) number stored in tag memory. Tag ID commands can be used to selectively read from or write to one or more specific tags, identified by their distinctive tag IDs. Targeted tags can be recognized with a previously issued Read Tag ID command.

6.2.7 ABx Fast Multi-Tag Response Packet Structures

When executing multi-tag commands designed to retrieve information from several tags at once (for example *ABx Fast Command 0x82: Multi-Tag Read ID and Data All)*, the RFID controller will generate separate host-bound response packets for each tag that has been read, followed by a final termination packet.

Below is the structure of a basic ABx Fast multi-tag response packet.

ABx Fast Multi-tag Response Packet Structure (One Packet for Each Tag Read)

RESPONSE PACKET ELEMENT	CONTENT	SIZE
RESPONSE HEADER: The first two bytes of an ABx Fast response	0x02, 0x02	2 bytes
RESPONSE SIZE: This two-byte integer defines the number of bytes in the packet (*excluding Header, Response Size and Terminator*).	0x0009 + (number of Read Data bytes)	2-byte integer
COMMAND ECHO: This single-byte value indicates the RFID command that was performed.	0x82 (Multi-Tag Read ID and Data All Command)	1 byte
TAG ID: 8-bytes, when applicable	<8-byte tag ID>	8 bytes
READ DATA	<N-bytes>	N-bytes
RESPONSE TERMINATOR: The single-byte response packet terminator is always *0x03* for ABx Fast.	0x03	1 byte

Table 6-5: ABx Fast Multi-Tag Response Packet Structure

6.2.8 ABx Fast Multi-Tag Response Final Termination Packet Structure

After the RFID controller has issued response packets for each tag identified and/or read, a final termination packet is generated.

Below is the structure of a standard ABx Fast multi-tag response final termination packet.

ABx Fast Multi-tag Response Final Termination Packet Structure

RESPONSE PACKET ELEMENT	CONTENT	SIZE
RESPONSE HEADER: The first two bytes of an ABx Fast response	0x02, 0x02	2 bytes
RESPONSE SIZE: This two-byte integer defines the number of bytes in the packet (*excluding Header, Response Size and Terminator*).	0x0003	2-byte integer
FINAL TERMINATION PACKET IDENTIFIER: 0xFF indicates that this packet is the final termination packet.	0xFF	1 byte
NUMBER OF TAGS READ/WRITTEN: One-byte value indicates the number of tags that were read or written to during the operation.	<N-tags>	1 byte
STATUS: 0x00 = operation completed successfully, 0x07 = Read Tag ID failed / Tag Not Found	0x00	1 byte
RESPONSE TERMINATOR: The single-byte response packet terminator is always *0x03* for ABx Fast.	0x03	1 byte

Table 6-6: ABx Fast Multi-Tag Response Final Termination Packet Structure

6.3 ABX STANDARD COMMAND PROTOCOL

The ABx Standard Command Protocol is a binary, double-byte, "*word*" oriented protocol where data is transmitted in 2-byte increments: a Most Significant Byte (MSB) or "*High Byte*" and a Least Significant Byte (LSB) or "*Low Byte*".

For ABx Standard commands, the first data word sent to the controller contains the Command Header and Command ID, followed by parameters such as Start Address, Read/Write Length and Timeout Value.

Note that at no time can the complete command packet string (including Terminator) exceed 50 words or 100 bytes.

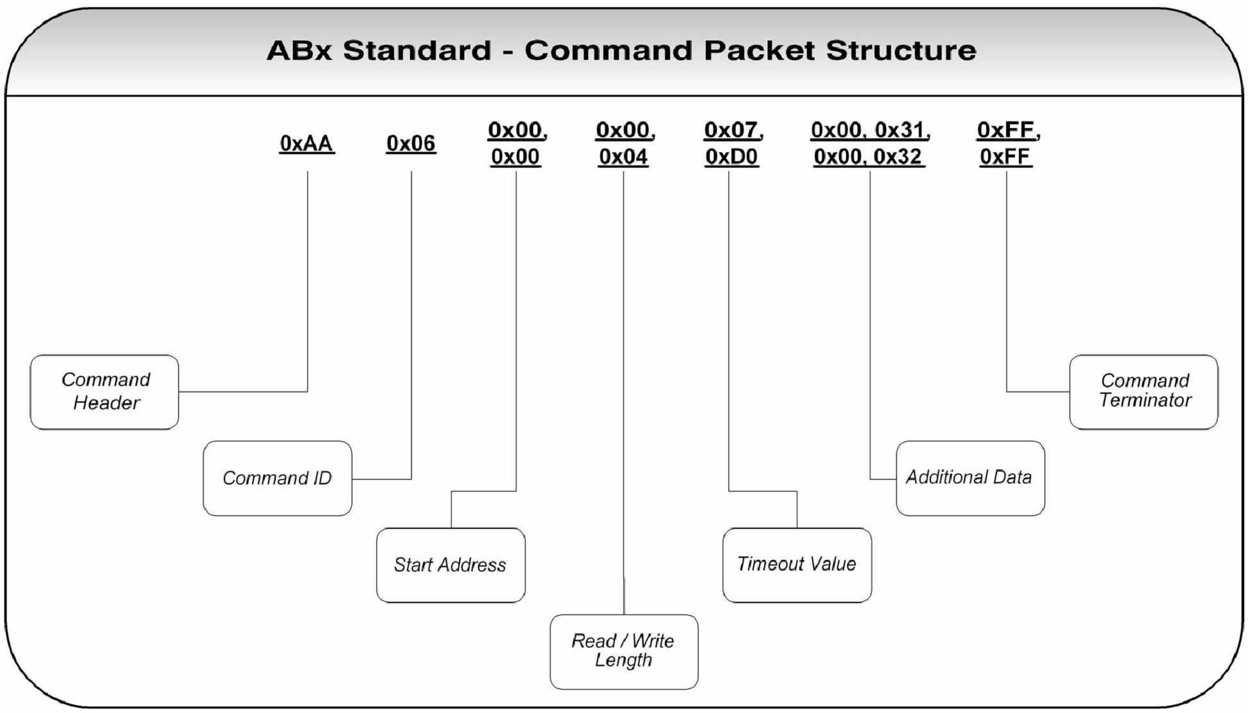


Figure 6-2: ABx Standard - Command Packet Structure

6.3.1 ABx Standard - Command Packet Structure

COMMAND PACKET ELEMENT	CONTENT	BYTE COUNT
COMMAND HEADER: 0xAA is always the MSB of the first word of an ABx Standard command.	0xAA	1
COMMAND ID: The Command ID is always the LSB of the first word and indicates the RFID command to execute.	0x06 (*Write Data*)	1
START ADDRESS: This two-byte parameter indicates the location of tag memory where a read or write operation shall begin.	0x0000	2

READ/WRITE LENGTH (BLOCK SIZE): This two-byte parameter represents the number of bytes that are to be retrieved from or written to the RFID tag.	0x0001	2
TIMEOUT VALUE: This two-byte integer indicates the maximum length of time for which the controller will attempt to complete the command. Measured in milliseconds, this value can have a range of 0x0001 to 0xFFFE or between 1 and 65,534 msecs (*0x07D0 = 2000 x .001* **=** *2 seconds*).	0x07D0	2
ADDITIONAL DATA: This parameter uses two bytes to hold a single character (data to be written to the tag is included in the LSB only, MSB = 0x00).	0x00, 0x00	2 (or more when applicable)
COMMAND TERMINATOR: Double-byte command packet terminator	0xFF, 0xFF	2

Table 6-7: ABx Standard - Command Packet Structure

6.3.2 ABx Standard - Response Packet Structure

RESPONSE PACKET ELEMENT	CONTENT	BYTE COUNT
RESPONSE HEADER: 0xAA is always the MSB of the first word of an ABx Standard response packet	0xAA	1
COMMAND ECHO: The command echo is always the LSB of the first word and indicates the RFID command that was executed.	0x06 (*Write Data*)	2
ADDITIONAL DATA: This parameter uses two bytes to hold a single character of retrieved data (data is returned in the LSB only, MSB = 0x00).	0x00, 0x00	2 (or more when applicable)
RESPONSE TERMINATOR: Double-byte command packet terminator	0xFF, 0xFF	2

Table 6-8: ABx Standard - Response Packet Structure

6.3.3 ABx Standard - Command Example

The example below depicts the packet structure of the ABx Standard command and response messages for *Command 0x08 (Tag Search)*. In this example, the RFID controller is instructed to search for a tag in the RF field. A Timeout Value of two seconds (0x07D0) is set for the completion of this operation.

Command from Host

COMMAND ELEMENT	CONTENT
Command Header and Command ID (MSB/LSB)	0xAA, 0x08 (Tag Search)
Timeout Value	0x07D0
Command Terminator	0xFF, 0xFF

Response from Controller

RESPONSE ELEMENT	CONTENT
Response Header and Command Echo (MSB/LSB)	0xAA, 0x08 (Tag Search)
Response Terminator	0xFF, 0xFF

If the Timeout Value expires before the controller finds a tag, it will return an error code, *0x07 (Tag Not Found)*.

CHAPTER 7: RFID COMMANDS AND ERROR CODES

7.1 ABx Fast RFID Command Table

The table below lists the ABx Fast RFID commands supported by C1007-Series RFID Controllers.

COMMAND ID	COMMAND NAME	DESCRIPTION
Single-Tag RFID Commands		
0x04	Fill Tag	Fills a specified tag address range with a one-byte value
0x05	Read Data	Reads a specified length of data from a contiguous (sequential) area of tag memory
0x06	Write Data	Writes a specified number of bytes to a contiguous area of tag memory
0x07	Read Tag ID	Retrieves a tag's unique identification (Tag ID) number
0x08	Tag Search	Instructs the controller to search for a tag in its RF field
0x0D	Start Continuous Read	Instructs the controller to start or stop *Continuous Read* mode.
0x0E	Read Tag ID and Data	Reads a tag's ID number as well as a specified number of bytes of tag memory
0x0F	Start Continuous Read Tag ID and Data	Instructs the controller to start or stop *Continuous Read Tag ID and Data* mode.
0x27	Lock Memory Block	Write protects a block of tag memory
RFID Controller Commands		
0x35	Reset Controller	Resets power to the controller
0x36	Set Controller Configuration	Used to set (configure or modify) the controller's configuration parameters and settings
0x37	Get Controller Configuration	Retrieves the controller's configuration settings
0x38	Get Controller Info	Retrieves hardware, firmware and serial number information from the controller

COMMAND ID	COMMAND NAME	DESCRIPTION
0x51	**Set Controller Time**	Used to set the time for the controller
0x72	**Execute Controller Macro**	Instructs the controller to execute one of its eight macros
	Multi-Tag RFID Commands	
0x82	**Multi-Tag Read ID and Data All**	Retrieves a contiguous segment of data and the tag ID from all RFID tags in range
0x85	**Multi-Tag Block Read All**	Retrieves a contiguous segment of data from all RFID tags in range
0x86	**Multi-Tag Block Write All**	Writes a contiguous segment of data to all RFID tags in range
0x87	**Multi-Tag Get Inventory**	Retrieves the tag ID from all RFID tags in range
0x88	**Multi-Tag Search All**	Checks for the presence of any RFID tags in range
0x95	**Multi-Tag Block Read by ID**	Reads a contiguous segment of data from a specific RFID tag identified by its tag ID
0x96	**Multi-Tag Block Write by ID**	Writes a contiguous segment of data to a specific RFID tag identified by its tag ID

Table 7-1: ABx Fast RFID Command Table

7.2 ABx Standard RFID Command Table

The table below lists the ABx Standard RFID commands supported by C1007-Series RFID Controllers.

COMMAND ID	COMMAND NAME	DESCRIPTION
RFID Tag Commands		
0x04	Fill Tag	Fills a specified tag address range with a one-byte value
0x05	Read Data	Reads a specified number of bytes from a contiguous (sequential) length of tag memory
0x06	Write Data	Writes a specified number of bytes to a contiguous length of tag memory
0x07	Read Tag ID	Retrieves a tag's unique identification (Tag ID) number
0x08	Tag Search	Instructs the controller to search for a tag in its RF field
0x0D	Start Continuous Read	Instructs the controller to start and stop Continuous Read mode.
0x0E	Read Tag ID and Data	Retrieves the tag ID and a specified number of bytes from the tag
0x0F	Start Continuous Read Tag ID and Data	Instructs the controller to start and stop Continuous Read Tag ID and Data mode.
RFID Controller Commands		
0x35	Reset Controller	Resets power to the controller
0x36	Set Controller Configuration	Used to modify and update the configuration settings of the controller
0x37	Get Controller Configuration	Retrieves configuration settings from the controller
0x38	Get Controller Info	Retrieves hardware, firmware and serial number information from the controller

Table 7-2: ABx Standard RFID Command Table

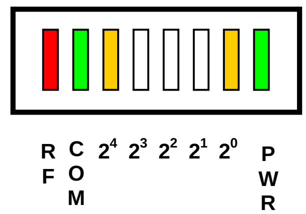
7.3 ERROR CODES

If the C1007 encounters a fault during operation, it will generate a response that includes a one-byte ABx error code. Entering an invalid Start Address for a Read Data command, for example, will generate ABx Error Code 0x32 (Invalid Programming Address).

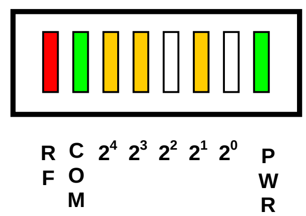
To display the single-byte error code in binary, the two left-most amber Node LEDs (LED 2^4 and LED 2^3) represent the first or most significant digit (MSD) of the error code. The three remaining amber Node LEDs (LED 2^2, LED 2^1 and LED 2^0) are combined to represent the second or least significant digit (LSD) of the error code.

Examples:

- If the five amber Node LEDs (from L to R) = **ON, OFF, OFF, OFF, ON,** the first digit of the error code is a "***2*** " and the second digit is a "***1,***" meaning that error code **0x21** occurred (*error code 0x21 = command syntax error*).



- If the five amber Node LEDs (from L to R) = **ON, ON, OFF, ON, OFF,** the first digit of the error code is a "***3*** " and the second digit is a "***2,***" meaning that error code **0x32** occurred (*error code 0x32 = invalid programming address*).



The RF LED and amber Node LEDs will continue to flash until a valid command is received by the controller. The green COM LED will remain ON to help orient the binary LED positions. If an unrecoverable error occurs, the LEDs will continuously flash the error code until the C1007 has been reset.

7.4 ABX ERROR CODE TABLE

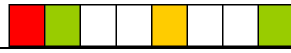
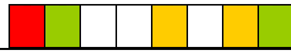
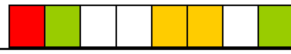
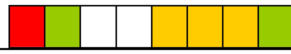
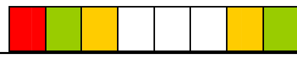
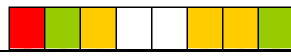
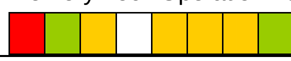
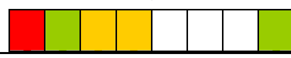
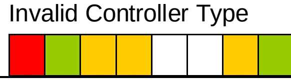
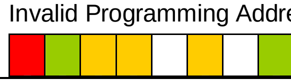
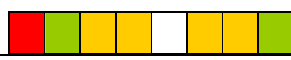
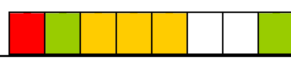
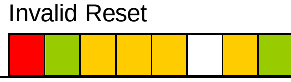
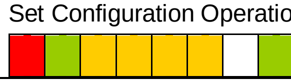
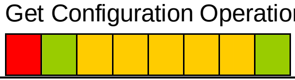
ERROR CODE	DESCRIPTION
0x04	Fill Operation not Completed 
0x05	Read Operation not Completed 
0x06	Write Operation not Completed 
0x07	Read Tag ID Operation not Completed (Tag not Found) 
0x21	Command Syntax Error 
0x23	Unsupported Tag Type / Unsupported RF Command 
0x27	Memory Lock Operation not Completed (Memory Locked) 
0x30	Internal Error, Buffer Overflow 
0x31	Invalid Controller Type 
0x32	Invalid Programming Address 
0x33	Invalid CRC Value 
0x34	Invalid Software Version 
0x35	Invalid Reset 
0x36	Set Configuration Operation not Completed 
0x37	Get Configuration Operation not Completed 

Table 7-3: ABx Error Codes

7.5 ABx Fast Error Response Structure

ABx Fast error responses contain a two-byte Header, a two-byte Response Size parameter followed by a single-byte **Error Flag** (0xFF) and a single-byte **Error Code** parameter, which identifies the error that occurred.

ERROR RESPONSE ELEMENT	CONTENT
Header	0x02, 0x02
Response Size	0x0002
Error Flag	0xFF
Error Code	Single-byte Error Code
Checksum	Optional
Terminator	0x03

Table 7-4: ABx Fast - Error Response Structure

ABx Fast Error Response Example

Below is an example of an ABx Fast error response for a failed Write Data command (error code 0x06).

ERROR RESPONSE ELEMENT	CONTENT
Header	0x02, 0x02
Response Size	0x0002
Error Flag	0xFF
Error Code	0x06
Checksum	Optional
Terminator	0x03

7.6 ABX STANDARD ERROR RESPONSE STRUCTURE

In ABx Standard, the error code will be returned in the LSB of the second word of the response.

Below is the structure of an ABx Standard error response.

ERROR RESPONSE ELEMENT	CONTENT (MSB/LSB)
Error Response Header (MSB/LSB)	0xAA, 0xFF
Error Code (MSB/LSB)	0x00, <1-byte error code value>
Terminator (MSB/LSB)	0xFF, 0xFF

Table 7-5: ABx Standard - Error Response Structure

ABX STANDARD ERROR RESPONSE EXAMPLE

Below is an example of an ABx Standard error response message for a failed Write Data operation (error code: 0x06).

ERROR RESPONSE ELEMENT	CONTENT (MSB/LSB)
Error Response Header (MSB/LSB)	0xAA, 0xFF
Error Code (MSB/LSB)	0x00, 0x06
Terminator (MSB/LSB)	0xFF, 0xFF

APPENDIX A: TECHNICAL SPECIFICATIONS

ELECTRICAL

Supply Voltage	10~30VDC
Power Consumption: C1007-232-01 and C1007-485-01	3.6W (150mA @ 24VDC)
Power Consumption: C1007-USB-01	5VDC (from USB bus)

COMMUNICATION

Communication Interfaces	Point-to-Point: *RS232, USB* Multi-drop, Subnet16, MUX32: *RS485*
RFID Interface	Cobalt C1007-Series RFID System
RF Output Power	100mW
Air Protocols	ISO 15693, ISO 14443A
Air Protocol Speed	26.5k Baud / 106k Baud with CRC error detection
RS232/RS485 Baud Rates	9600 (default), 19.2k, 38.4k, 57.6k, 115.2k

MECHANICAL

Dimensions	116.4mm x 73.1mm x 24mm (4.58in x 2.88in x .94in)
Weight	210 grams (7.4 ounces)
Enclosure	Polycarbonate

ENVIRONMENTAL

Operating Temperature	-20° to 49°C (-4° to 120°F),
Storage Temperature	-40° to 85°C (-40° to 185°)
Humidity	100%
Protection Class	IP67
Shock Resistance	IEC 68-2-27, Half-sine 30 G, 11ms, 3 shocks each axis
Vibration Resistance	IEC 68-2-6, Test FC 1.5mm; 10 to 55Hz; 2 hours each axis

NOTE: Specifications are subject to change without notice

C1007-SERIES RFID CONTROLLER DIMENSIONS

Dimensions are listed in millimeters and [inches].

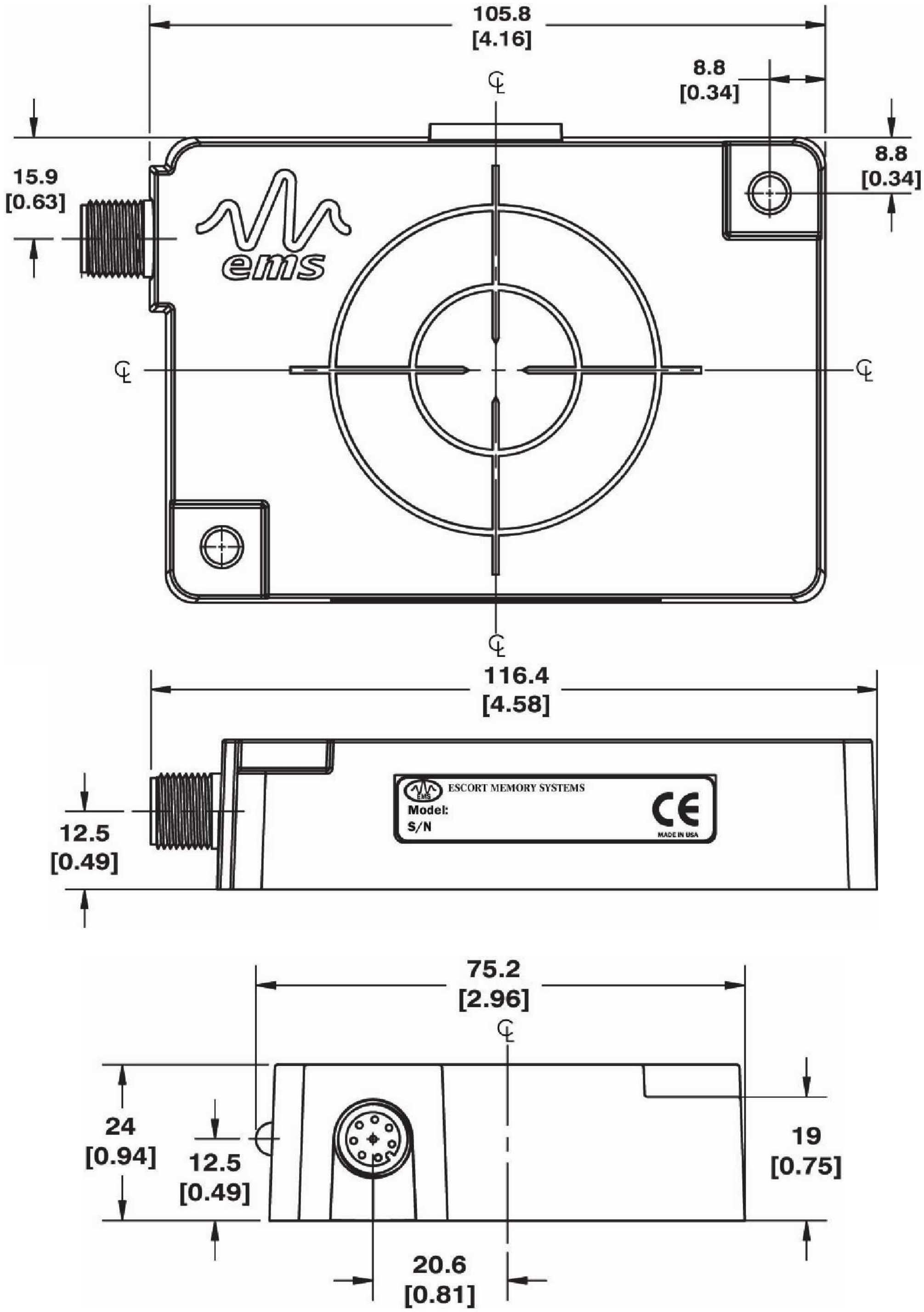


Figure Appendix A-0-1: C1007-Series RFID Controller Dimensions

APPENDIX B: MODELS & ACCESSORIES

Escort Memory Systems designs, manufactures and distributes a wide range of high frequency (HF) RFID equipment including RFID controllers, network interface modules (Gateways and Hubs), RFID tags and the cables needed to make it all work.

This portion of the manual lists the products and accessories available for the C1007-Series RFID product family. To purchase any of the items listed below contact your EMS distributor, call us directly at **(800) 626-3993** or visit our Web site: http://www.ems-rfid.com. Please let us know if you have any questions.

EMS HARDWARE

C1007-Series RFID Controllers

There are three models of the C1007-Series RFID Controller:

- **C1007-232-01**
- **C1007-485-01**
- **C1007-USB-01**

The C1007 product package contains the following components:

EMS P/N	QTY	DESCRIPTION
C1007-XXX-01	1	C1007-Series RFID Controller
00-3000	1	Configuration Tag for C1007 (I-CODE SLi)
17-3140/2/3	1	C1007-Series RFID Controller – Installation Guide

Note: XXX = 232, 485 or USB

Subnet16™ Gateway Interface Modules

GWY-01-TCP-01
Subnet16™ TCP/IP Gateway

GWY-01-IND-01
Subnet16™ Industrial Ethernet Gateway

Subnet16™ Hub Interface Modules

HUB-04-TCP-01
Subnet16™ 4-Port TCP/IP Hub

HUB-04-IND-01
Subnet16™ 4-Port Industrial Ethernet Hub

COBALT FAMILY SOFTWARE & DEMONSTRATION KITS

7.6.1 Software Applications

Visit the Escort Memory Systems website (www.ems-rfid.com) for download instructions.

Cobalt HF Dashboard (for TCP/IP or Serial Connections)

Communicate in real time with one or more readers directly or via Multi-drop network. Allows users to configure, monitor and control their RFID devices from anywhere on their network.

C-Macro Builder

C-Macro Builder is an easy to use, GUI-driven utility that provides rapid development and implementation of custom RFID command macros.

7.6.2 Demonstration Kits

00-1202

C1007-USB-01 Demo Kit (includes one C1007-USB-01 controller, one CBL-1525 USB interface cable, one LRP125VS tag, one LRP250S tag and one T7036 tag.

00-1203

Gateway TCP Demo Kit (includes one GWY-01-TCP-01 TCP Gateway interface module, one C0405-485-01 controller, one C1007-485-01 controller, one HF-0405-485-01 controller, LRP125S, LRP250 and T7036 RFID tags, interface cables, display board, power supply and carrying case).

00-1218

Conveyor Demo Kit (includes one GWY-01-IND-01 Industrial Gateway interface module, one C0405-485-01 controller, one C1007-485-01 controller, one HF-CNTL-485-01 controller, one HF-ANT-1010-01 antenna, one LRP108S tag, three LRP250S tags, one LRP525S tag, two T5050 tags, three T7036 tags, interface cables and power supply).

Cable and Network Accessories

EMS P/N	COMPONENT	DESCRIPTION
CBL-1478	Cable Assembly	8-pin, female M12 to RS232; with 2.5mm DC power jack, 2m
CBL-1480-XX	Cable	5-pin, male M12 to 5-pin, female M12 (ThinNet)
CBL-1481-XX	Cable	5-pin, male M12 to 5-pin, male M12 (ThinNet)
CBL-1481-02	Cable	5-pin, male M12 to 5-pin, male M12, 2m (ThinNet, Gateway to Drop-T)
CBL-1482-XX	Cable	5-pin, male M12 to 5-pin, female, right-angle M12 (ThinNet)
CBL-1483-XX	Cable	5-pin, male 7/8–16 to 5-pin, female 7/8-16 (ThickNet)
CBL-1484-XX	Cable	5-pin, male, right-angle 7/8-16 to bare wire leads (ThickNet)
CBL-1485	Drop-T Connector	5-pin, female 7/8-16 / female M12 / male 7/8-16 (ThickNet to ThinNet)
CBL-1486	Drop-T Connector	5-pin, female M12 / 5-pin, female M12 / 5-pin, male M12 (ThinNet to ThinNet)
CBL-1487	Field Mountable Connector	5-pos, straight female M12
CBL-1488-XX	Cable	8-pin, female M12 to bare wire leads
CBL-1489	Termination Resistor Plug	5-pin, male 7/8-16 (ThickNet)
CBL-1490	Termination Resistor Plug	5-pin, male M12 (ThinNet)
CBL-1491	Field Mountable Connector	5-pos, right-angle female M12
CBL-1492-XX	Cable	8-pin, right-angle female M12 to bare wire leads
CBL-1493	Field Mountable Connector	8-pos, straight female M12
CBL-1494-01	Cable	5-pin, female M12 to bare wire leads, 1m (ThinNet)
CBL-1495-XX	Cable	5-pin, female 7/8-16 to bare wire leads
CBL-1496	Termination Resistor Plug	5-pin, female M12 (ThinNet)

CBL-1497	Termination Resistor Plug	5-pin, female 7/8-16 (ThickNet)
CBL-1498-02	Cable	5-pin, male M12 to bare wire leads, 2m (ThinNet)
CBL-1514	Connector	5-pin, straight male, reverse-keyed M12 (for USB)
CBL-1515-05	Cable	CAT5E shielded Ethernet to 5-Pin, male, D-Code M12, 5m
CBL-1524	Connector	5-pin, straight female, reverse-keyed M12
CBL-1525	Cable Assembly	5-pin, female, reverse-keyed M12 to USB Type A, 3m

XX = Length in Meters

POWER SUPPLIES

00-1166

45W, 24VDC, 1.88A max, universal input (90-264VAC, 47-63Hz), 5.5x2.5mm plug, positive tip; requires country specific power cord to mate to IEC 320 power cord receptacle.

00-1167

100W, 24VDC, 4.17A max, universal input (90-264VAC, 47-63Hz), 5.5x2.5mm plug, positive tip; requires country specific power cord to mate with IEC 320 power cord receptacle.

00-1168

120W, 24VDC, 5.0A max, universal input (88-132VAC/176-264VAC switch selectable, 47-63Hz) DIN rail mount; AC wire receptacles are spring clamped for direct wire connection.

7.6.3 Escort Memory Systems' RFID Tags

Escort Memory Systems designs and manufactures several lines of RFID tags. LRP, HMS and T-Series passive read/write RFID tags are specially suited for the C1007-Series product line.

APPENDIX C: NETWORK DIAGRAMS

Subnet16 Gateway – C1007-485-01 ThinNet Network Diagram

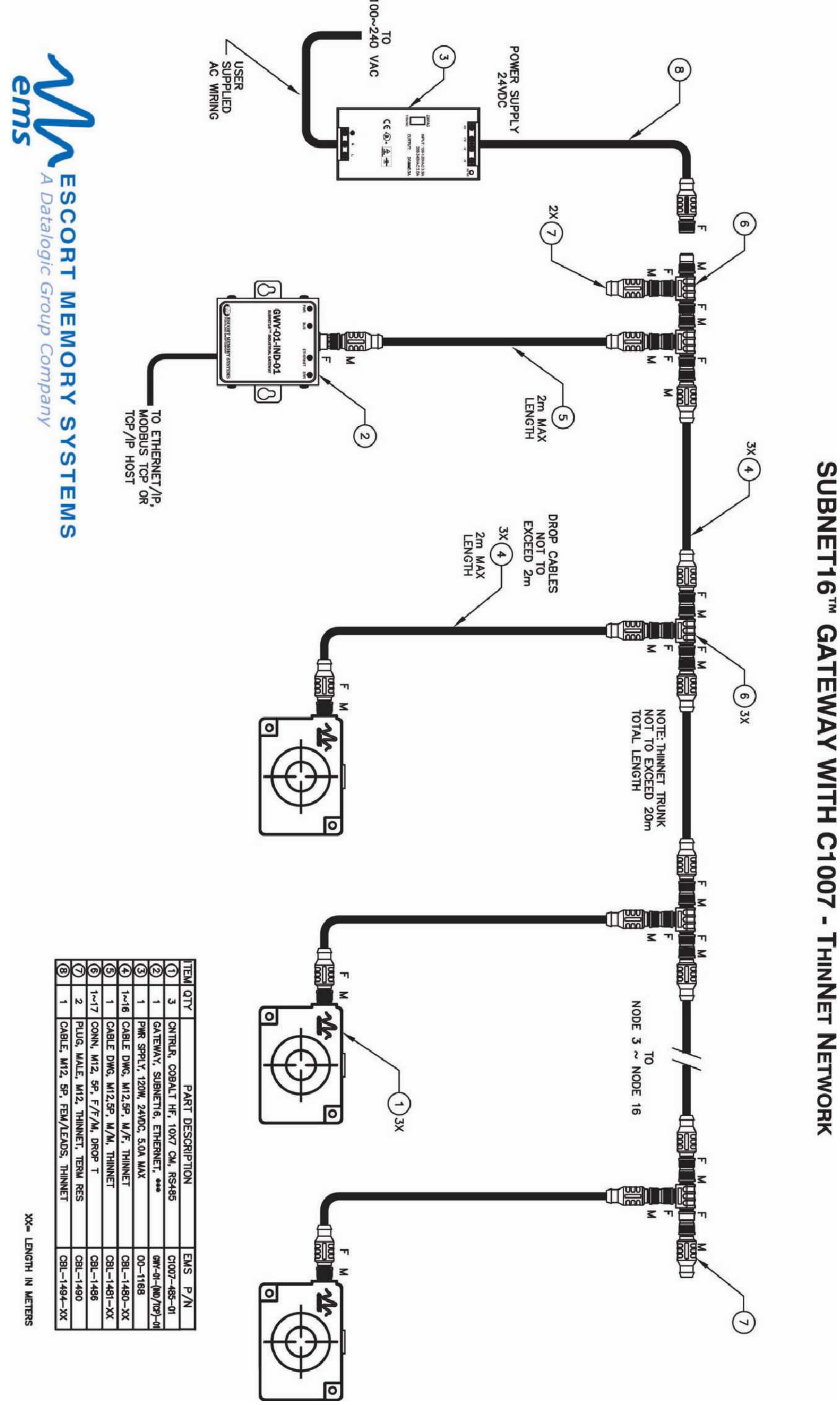
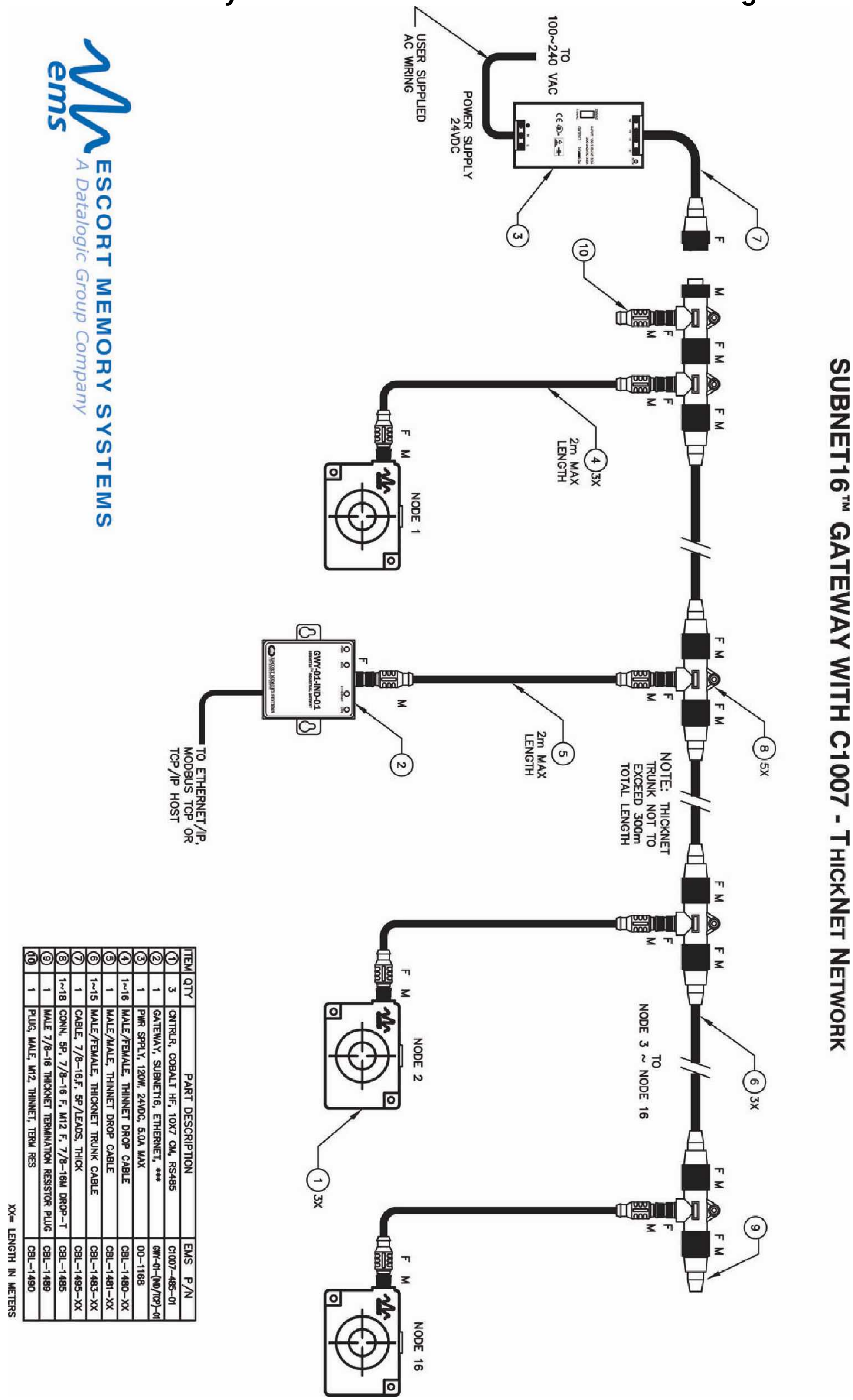


Figure Appendix C-0-1: Subnet16 Gateway - C1007-485-01 ThinNet Network Diagram

ITEM	QTY	PART DESCRIPTION	EMS P/N
1	3	CNTRLR, COBALT HF, 10X7 CM, RS485	C1007-485-01
2	1	GATEWAY, SUBNET16, ETHERNET, ***	GWY-01-(IND/TCP)-01
3	1	PWR SPPLY, 120W, 24VDC, 5.0A MAX	00-1168
4	1~16	CABLE DWG, M12,5P, M/F, THINNET	CBL-1480-XX
5	1	CABLE DWG, M12,5P, M/M, THINNET	CBL-1481-XX
6	1~17	CONN, M12, 5P, F/F/M, DROP T	CBL-1486
7	2	PLUG, MALE, M12, THINNET, TERM RES	CBL-1490
8	1	CABLE, M12, 5P, FEM/LEADS, THINNET	CBL-1494-XX

XX= LENGTH IN METERS

Subnet16 Gateway – C1007-485-01 ThickNet Network Diagram

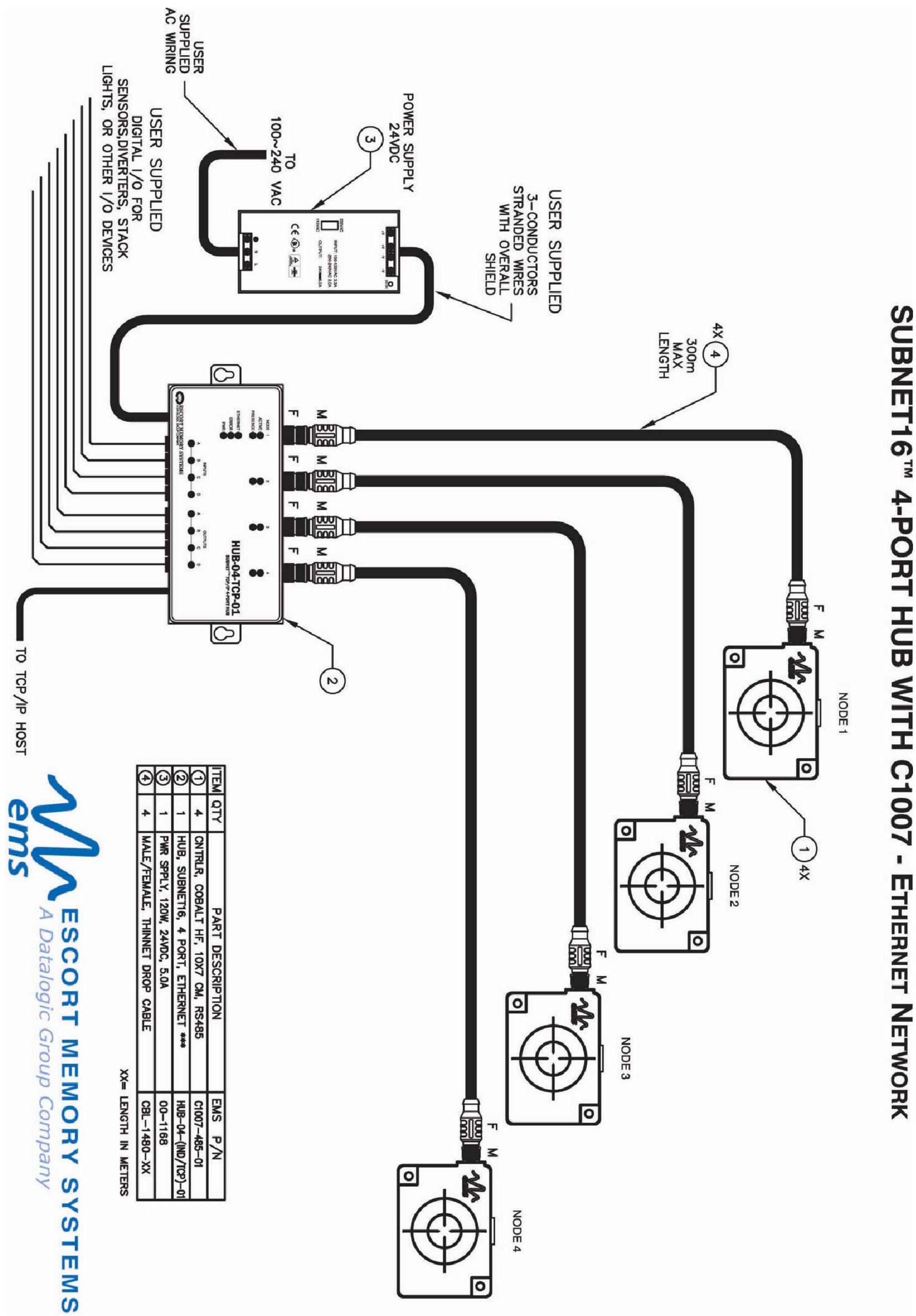


ITEM	QTY	PART DESCRIPTION	EMS P/N
1	3	CNTRLR, COBALT HF, 10X7 CM, RS485	C1007-485-01
2	1	GATEWAY, SUBNET16, ETHERNET, ***	GWY-01-(IND/TCP)-01
3	1	PWR SPPLY, 120W, 24VDC, 5.0A MAX	00-1168
4	1~16	MALE/FEMALE, THINNET DROP CABLE	CBL-1480-XX
5	1	MALE/MALE, THINNET DROP CABLE	CBL-1481-XX
6	1~15	MALE/FEMALE, THICKNET TRUNK CABLE	CBL-1483-XX
7	1	CABLE, 7/8-16,F, 5P/LEADS, THICK	CBL-1495-XX
8	1~18	CONN, 5P, 7/8-16 F, M12 F, 7/8-16M DROP-T	CBL-1485
9	1	MALE 7/8-16 THICKNET TERMINATION RESISTOR PLUG	CBL-1489
10	1	PLUG, MALE, M12, THINNET, TERM RES	CBL-1490

XX= LENGTH IN METERS

Figure Appendix C-0-2: Subnet16 Gateway - C1007-485-01 ThinNet Network Diagram

Subnet16 Hub – C1007-485-01 Network Diagram



ITEM	QTY	PART DESCRIPTION	EMS P/N
1	4	CNTRLR, COBALT HF, 10X7 CM, RS485	C1007-485-01
2	1	HUB, SUBNET16, 4 PORT, ETHERNET ###	HUB-04-(IND/TCP)-01
3	1	PWR SPPLY, 120W, 24VDC, 5.0A	00-1168
4	4	MALE/FEMALE, THINNET DROP CABLE	CBL-1480-XX

XX= LENGTH IN METERS

Figure Appendix C-0-3: Subnet16 Hub - C1007-485-01 Network Diagram

APPENDIX D: ASCII CHART

ASCII Chart

Decimal	Hex	Character
000	00	NUL
001	01	SOH
002	02	STX
003	03	ETX
004	04	EOT
005	05	ENQ
006	06	ACK
007	07	BEL
008	08	BS
009	09	HT
010	0A	LF
011	0B	VT
012	0C	FF
013	0D	CR
014	0E	SO
015	0F	SI
016	10	DLE
017	11	DC1
018	12	DC2
019	13	DC3
020	14	DC4
021	15	NAK
022	16	SYN
023	17	ETB
024	18	CAN
025	19	EM
026	1A	SUB
027	1B	ESC
028	1C	FS
029	1D	GS
030	1E	RS

Decimal	Hex	Character
031	1F	US
032	20	(SPACE)
033	21	!
034	22	"
035	23	#
036	24	$
037	25	%
038	26	&
039	27	’
040	28	(
041	29	)
042	2A	*
043	2B	+
044	2C	,
045	2D	-
046	2E	.
047	2F	/
048	30	0
049	31	1
050	32	2
051	33	3
052	34	4
053	35	5
054	36	6
055	37	7
056	38	8
057	39	9
058	3A	:
059	3B	;
060	3C	<
061	3D	=

Decimal	Hex	Character
062	3E	>
063	3F	?
064	40	@
065	41	A
066	42	B
067	43	C
068	44	D
069	45	E
070	46	F
071	47	G
072	48	H
073	49	I
074	4A	J
075	4B	K
076	4C	L
077	4D	M
078	4E	N
079	4F	O
080	50	P
081	51	Q
082	52	R
083	53	S
084	54	T
085	55	U
086	56	V
087	57	W
088	58	X
089	59	Y
090	5A	Z
091	5B	[
092	5C	\
093	5D	]
094	5E	^

<table>
<tr><th>Decimal</th><th>Hex</th><th>Character</th></tr>
<tr><td>095</td><td>5F</td><td>_</td></tr>
<tr><td>096</td><td>60</td><td>‘</td></tr>
<tr><td>097</td><td>61</td><td>a</td></tr>
<tr><td>098</td><td>62</td><td>b</td></tr>
<tr><td>099</td><td>63</td><td>c</td></tr>
<tr><td>100</td><td>64</td><td>d</td></tr>
<tr><td>101</td><td>65</td><td>e</td></tr>
<tr><td>102</td><td>66</td><td>f</td></tr>
<tr><td>103</td><td>67</td><td>g</td></tr>
<tr><td>104</td><td>68</td><td>h</td></tr>
<tr><td>105</td><td>69</td><td>i</td></tr>
<tr><td>106</td><td>6A</td><td>j</td></tr>
<tr><td>107</td><td>6B</td><td>k</td></tr>
<tr><td>108</td><td>6C</td><td>l</td></tr>
<tr><td>109</td><td>6D</td><td>m</td></tr>
<tr><td>110</td><td>6E</td><td>n</td></tr>
<tr><td>111</td><td>6F</td><td>o</td></tr>
<tr><td>112</td><td>70</td><td>p</td></tr>
<tr><td>113</td><td>71</td><td>q</td></tr>
<tr><td>114</td><td>72</td><td>r</td></tr>
<tr><td>115</td><td>73</td><td>s</td></tr>
<tr><td>116</td><td>74</td><td>t</td></tr>
<tr><td>117</td><td>75</td><td>u</td></tr>
<tr><td>118</td><td>76</td><td>v</td></tr>
<tr><td>119</td><td>77</td><td>w</td></tr>
<tr><td>120</td><td>78</td><td>x</td></tr>
<tr><td>121</td><td>79</td><td>y</td></tr>
<tr><td>122</td><td>7A</td><td>z</td></tr>
<tr><td>123</td><td>7B</td><td>{</td></tr>
<tr><td>124</td><td>7C</td><td>|</td></tr>
<tr><td>125</td><td>7D</td><td>}</td></tr>
<tr><td>126</td><td>7E</td><td>~</td></tr>
<tr><td>127</td><td>7F</td><td>DEL</td></tr>
</table>

EMS WARRANTY

Escort Memory Systems warrants that all products of its own manufacturing conform to Escort Memory Systems' specifications and are free from defects in material and workmanship when used under normal operating conditions and within the service conditions for which they were furnished. The obligation of Escort Memory Systems hereunder shall expire one (1) year after delivery, unless otherwise specified, and is limited to repairing, or at its option, replacing without charge, any such product that in Escort Memory Systems' sole opinion proves to be defective within the scope of this Warranty. In the event Escort Memory Systems is not able to repair or replace defective products or components within a reasonable time after receipt thereof, Buyers shall be credited for their value at the original purchase price. Escort Memory Systems must be notified in writing of the defect or nonconformity within the warranty period and the affected product returned to Escort Memory Systems factory or to an authorized service center within thirty (30) days after discovery of such defect or nonconformity. Shipment shall not be made without prior authorization by Escort Memory Systems.

This is Escort Memory Systems' sole warranty with respect to the products delivered hereunder. No statement, representation, agreement or understanding oral or written, made by an agent, distributor, representative, or employee of Escort Memory Systems which is not contained in this warranty, will be binding upon Escort Memory Systems, unless made in writing and executed by an authorized Escort Memory Systems employee.

Escort Memory Systems makes no other warranty of any kind what so ever, expressed or implied, and all implied warranties of merchantability and fitness for a particular use which exceed the aforementioned obligation are here by disclaimed by Escort Memory Systems and excluded from this agreement. Under no circumstances shall Escort Memory Systems be liable to Buyer, in contract or in tort, for any special, indirect, incidental, or consequential damages, expenses, losses or delay however caused. Equipment or parts that have been subjected to abuse, misuse, accident, alteration, neglect, unauthorized repair or installation are not covered by warranty. Escort Memory Systems shall make the final determination as to the existence and cause of any alleged defect. No liability is assumed for expendable items such as lamps and fuses. No warranty is made with respect to equipment or products produced to Buyer's specification except as specifically stated in writing by Escort Memory Systems in the contract for such custom equipment. This warranty is the only warranty made by Escort Memory Systems with respect to the goods delivered hereunder, and may be modified or amended only by a written instrument signed by a duly authorized officer of Escort Memory Systems and accepted by the Buyer.

Extended warranties of up to four years are available for purchase for most Escort Memory Systems products. Contact Escort Memory Systems or your distributor for more information.

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