ESCORT MEMORY SYSTEMS

A Datalogic Group Company

Cobalt C0405-Series

High Frequency Passive RFID Controllers

Operator's Manual

Document P/N: 17-1328

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RFID AT WORK™

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ESCORT MEMORY SYSTEMS

Cobalt C0405-Series

C0405-XXX-01 RFID Controller - Operator's Manual

For C0405-Series RFID Controllers

Publication P/N: 17-1328 REV 02 (08/07)

ESCORT MEMORY SYSTEMS

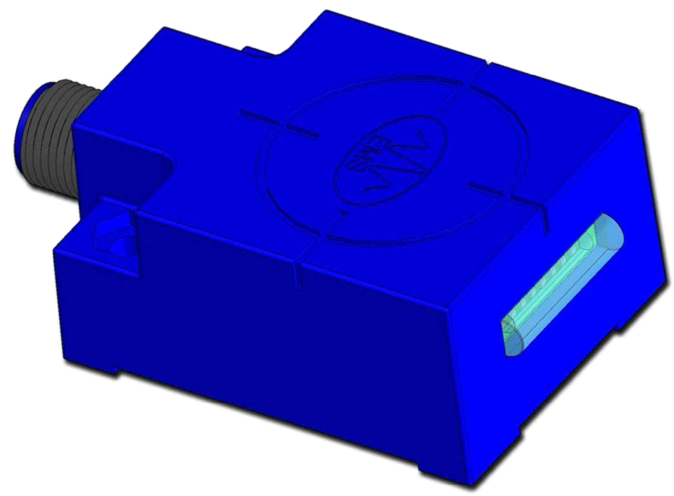
COBALT C0405-SERIES

RFID CONTROLLERS

High Frequency, Multi-Protocol, Passive RFID Controllers

For C0405 models:

- **C0405-232-01**
- **C0405-485-01**
- **C0405-USB-01**



OPERATOR'S MANUAL

How to Install, Configure and Operate
Cobalt C0405-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. Cert #: (*PENDING*)

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CHAPTER 1: GETTING STARTED

1.1 INTRODUCTION

Welcome to the ***C0405-Series RFID Controllers - Operator's Manual***. This manual will assist you in the installation, configuration and operation of Escort Memory Systems' C0405-Series RFID Controllers.

The C0405-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.

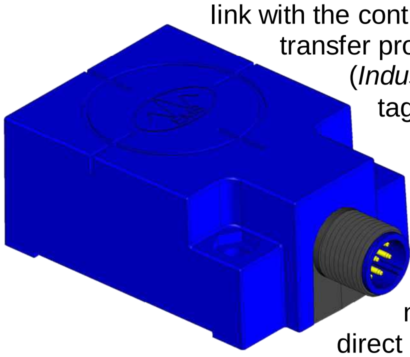
By consistently delivering an extended selection of high quality, highly durable RFID devices, Escort Memory Systems has built a solid reputation.

Escort Memory Systems' headquarters in Scotts Vallev. CA.

1.1.2 The C0405-Series RFID Controller

Escort Memory Systems' C0405-Series RFID Controllers are 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 C0405 Controller uses 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 C0405-Series controllers provide cost effective RFID data collection and control solutions to shop floor, item-level tracking and material handling applications. They are compatible with all LRP and HMS and T-Series RFID tags from Escort Memory Systems.

1.1.3 C0405 RFID Controller Features

- High performance, low-cost, 13.56MHz RFID controller with integrated RF antenna
- Supports multiple RF, ABx, air and serial communications protocols
- Small controller size: approximately 40mm x 50mm - internal antenna dimensions: 36mm x 36mm
- 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 - range up to 50mm with ISO 144433 tags and 90mm with ISO 15693 tags
- Reads/Writes *LRP, HMS,* and *T-Series* tags from EMS
- FCC/CE/TELEC agency compliance certification (*PENDING*)
- IP67 rated M12 interface connector (*8-pin for RS232, 5-pin for RS485/USB*)
- Fully encapsulated electronics

1.1.4 About this Manual

This manual provides guidelines and instructions on how to install and operate C0405-Series RFID Controllers. Also included are descriptions of the RFID command set with instructions describing how to issue commands to the C0405-Series RFID Controllers.

NOTE:

Occasionally in this manual, the C0405-Series RFID Controller is referred to as the *C0405 Controller*, the *C0405* or just simply the *controller*.

Who Should Read this Manual?

This manual should be read by those who will be installing, configuring and operating C0405-Series RFID Controllers. This may include the following people:

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

1.1.5 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.

1.1.6 Contents of the C0405 Product Package

Unpack the C0405 hardware and accessories. Inspect each item for evidence of damage. If an item appears to be damaged, notify your distributor or EMS.

The C0405 product package contains the following components:

QTY	DESCRIPTION
1	C0405-XXX-01 RFID Controller
1	C0405-XXX-01 RFID Controller – Installation Guide
1	Cobalt HF Configuration Tag (I-CODE SLi)
1	Mounting Bracket
2	Screws (M4, 20mm, PPH 18-8\302 SS)
2	Washers (M4 locking)
2	Nuts (M4, 18-8\302 SS)

Table 1-1: C0405 Product Package Contents List

Note: XXX = 232, 485 or USB

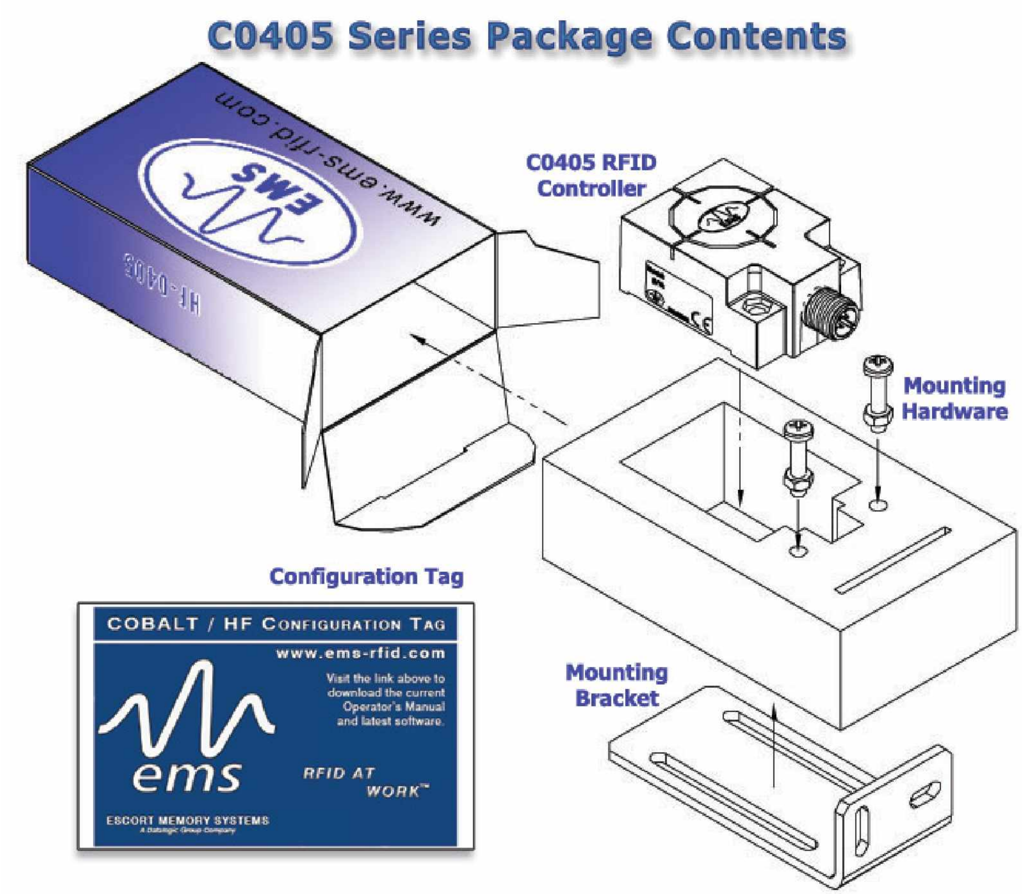


Figure 1-1: C0405 Package Contents Diagram

1.1.7 User Supplied Components

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

- HMS, LRP, or T-Series RFID tags
- Controller-to-Host communication interface cable: (*RS232, RS485 or USB*)
- Host device: (*PC, PLC, MUX32, TCP/IP, Ethernet/IP, Subnet16™ Gateway or Hub*)
- LPS (*Limited Power Source*) power supply: 10~30VDC, 2.4W *(100mA @ 24VDC)* - per controller
- Mating connectors: (*when applicable*)

1.2 COMMUNICATION OPTIONS

There are three distinct versions of the C0405-Series RFID Controller. Each model provides support for one specific communication interface requirement.

Through the Subnet16 protocol, multiple C0405-485-01 controllers can be networked via a single bus that is connected to an EMS Subnet16 Gateway or Hub interface module.

1.2.1 Connection and Communication Interface Options

CONTROLLER MODEL	CONNECTION TYPE	COMMUNICATION INTERFACE	MAX CABLE LENGTH
C0405-232-01	RS232	Point-to-Point, Host/Controller	15 Meters
C0405-485-01	RS485	Subnet16 Multidrop bus architecture via Subnet16™ Gateway or Hub	300 Meters
C0405-USB-01	USB 2.0	Point-to-Point, Host/Controller	5 Meters

Table 1-2: Connection and Communication Interface Options

1.2.2 C0405 Controllers - Interface Connectors

CONTROLLER MODEL	INTERFACE CONNECTOR
C0405-232-01	8-pin, male M12 connector
C0405-485-01	5-pin, male M12 connector
C0405-USB-01	5-pin, male, reverse keyed M12 connector

Table 1-3: C0405 Controllers - Interface Connectors

See *Appendix B: Models & Accessories* for more information on model numbers, parts and accessories for all C0405-Series RFID Controllers.

CHAPTER 2: INSTALLING THE C0405

2.1 PREPARING FOR INSTALLATION

C0405-Series RFID Controllers support direct connections for point-to-point (host/controller) applications (RS232, RS485 and USB). Up to 16 C0405-485 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 44mm (1.75 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. Cobalt controllers are designed to withstand 8kV of direct electro-static discharge (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 C0405 Controller Dimensions

The images below contain the dimensions of the Cobalt C0405-Series RFID Controllers in millimeters and [inches].

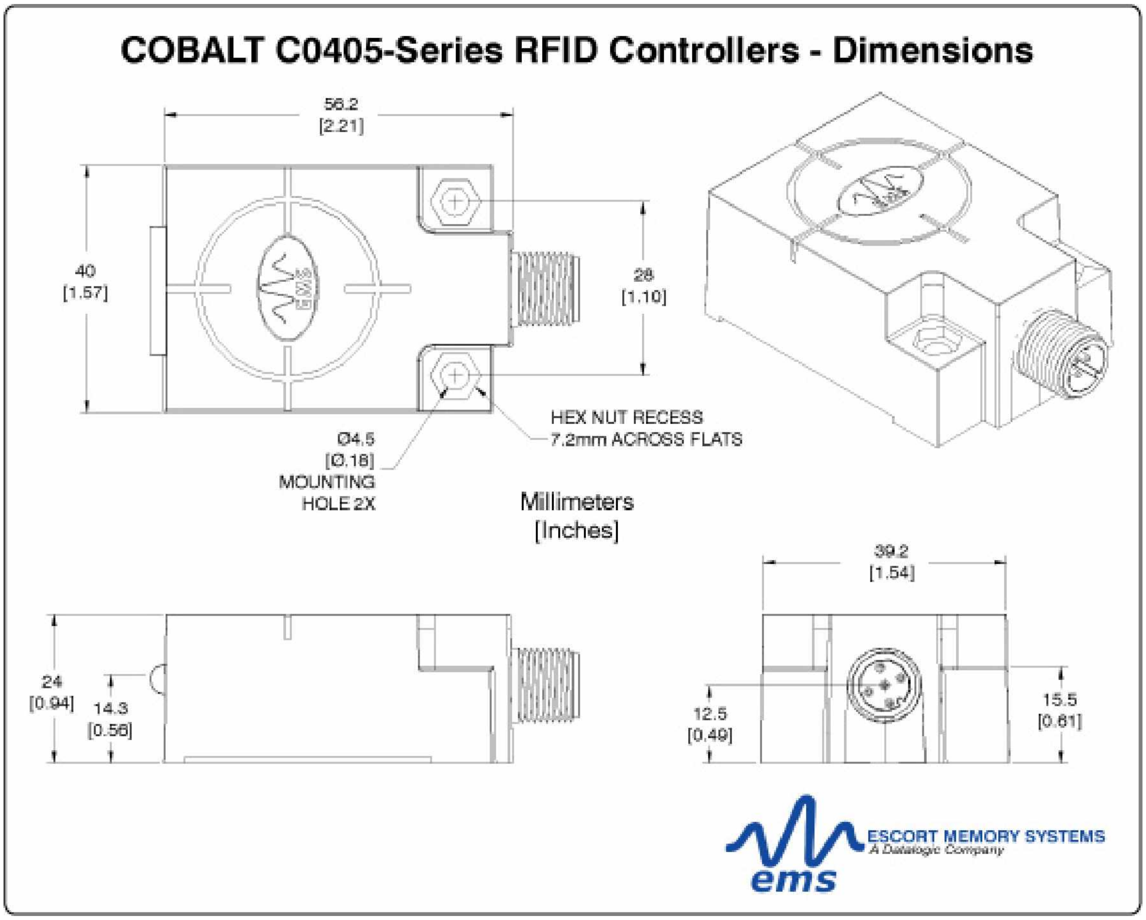


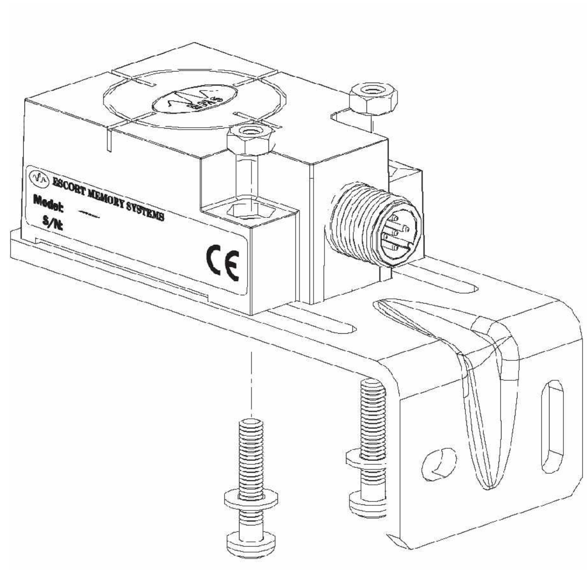
Figure 2-1: C0405 RFID Controller Dimensions

2.1.3 Mounting the Controller

C0405-Series RFID Controllers can be mounted to wood or plastic fixtures. The units' ship with an L-shaped, polycarbonate, mounting bracket and the necessary hardware required to fasten the controller to the bracket. The bracket is designed to help isolate the RFID controller from metal surfaces and the affect of spurious noise electronically conducted through metal.

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. **1.** Select a suitable location to mount the C0405 Controller.
2. **2.** Attach the C0405 Controller to the mounting bracket using the two sets of M4 screws, washers and nuts provided. Place the nuts in each of the two hex-shaped recessed cavities at the rear of the C0405.
3. **3.** After aligning the mounting bracket with the two mounting holes on the controller, insert both M4 screws (with washers) into the controller from the underside and tighten completely using a standard Phillips #2 head screwdriver.
4. **4.** Fasten the other end of the mounting bracket to your work area.



Torque Specification

Tighten the two M4 screws used to fasten the controller to the bracket (and any user provided screws used to mount the bracket to the work area) to the following torque setting: **0.7 Nm or equivalent to 6 lbs / inch**

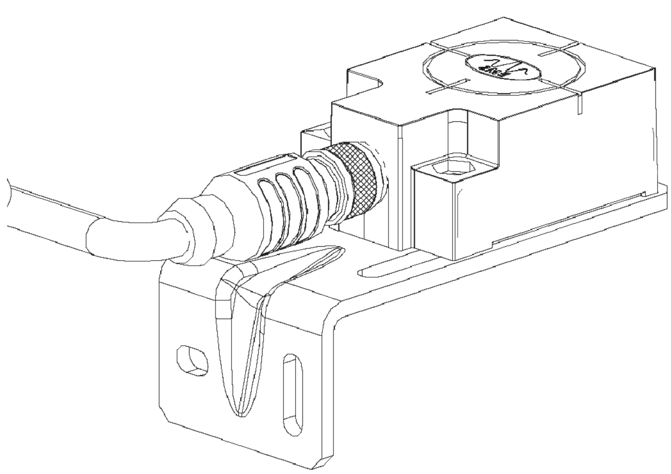


Figure 2-2: C0405 Controller Attached to Bracket with Cable Connected

2.1.4 Proximity to Metal

RFID devices can be negatively impacted by the presence of metallic objects. Avoid mounting the controller within 44mm (approximately 2 inches) of metal surfaces or near sources of electro magnetic interference (EMI) and electrical noise.

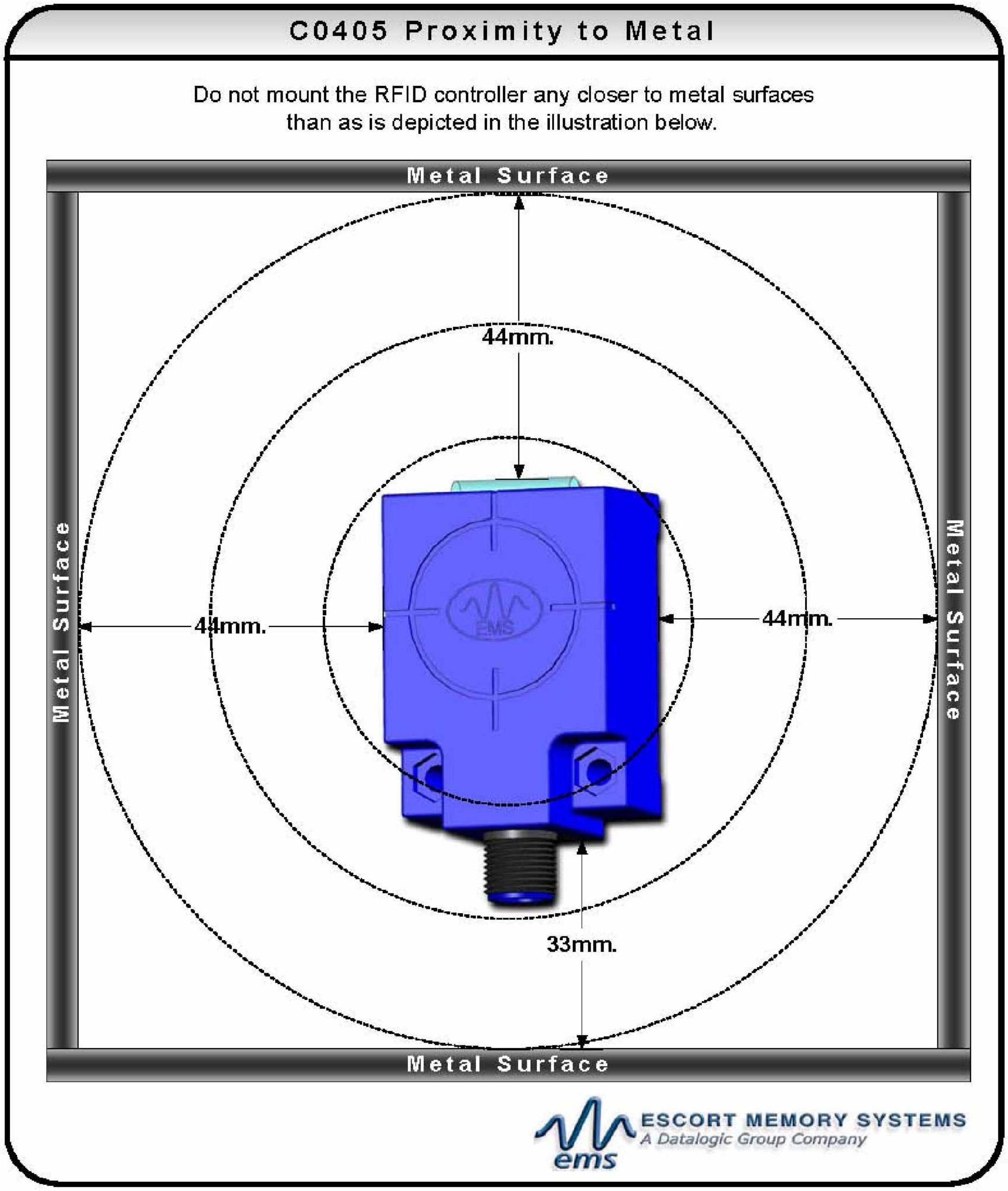


Figure 2-3: C0405 Proximity to Metal

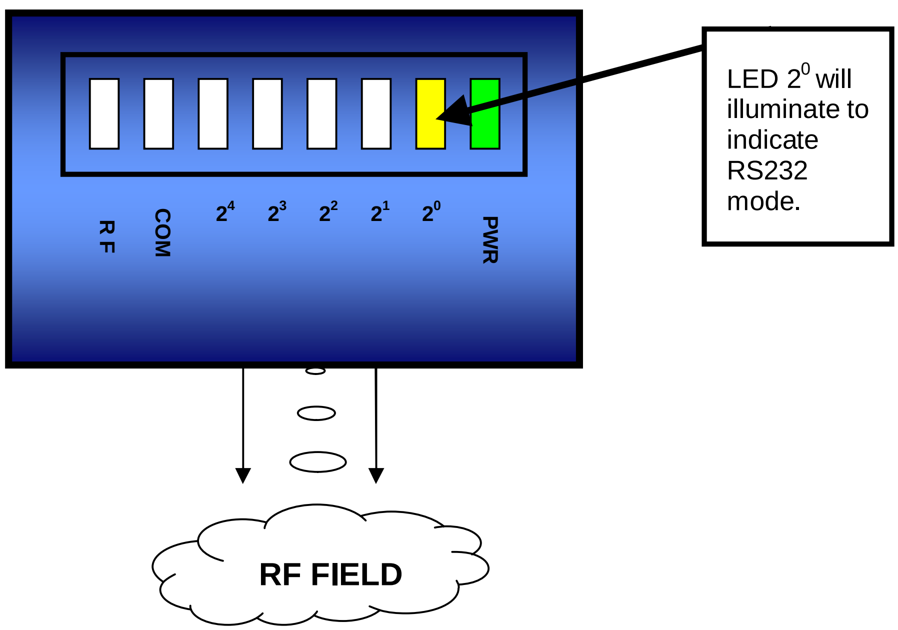
2.2 INSTALLING THE C0405-232-01 CONTROLLER

The ***C0405-232-01 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 C0405-232-01

1. Attach the controller to the mounting bracket and 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 P/N: CBL-1478*) to the 8-pin, male M12 connector on the C0405-232-01.
3. Connect the serial interface cable's female DE9 D-Sub connector to a COM port on the host computer. Tighten the cable's two locking thumbscrews.
4. 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.
5. 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 will flash. For the C0405-232 model, the amber Node $\mathbf{2^0}$ LED will remain light to indicate that the controller is in RS232 mode.



6. On the host computer, set COM port parameters to: ***9600 baud, 8 data bits, 1 stop bit, no parity and no handshaking***.
7. To verify operations, download the serial version of the ***Cobalt HF Dashboard Utility*** software application 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 C0405-232-01 Cabling Information

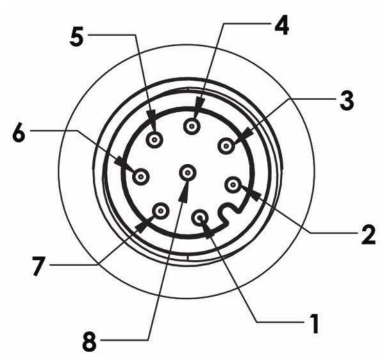
The C0405-232-01 has one 8-pin, male M12 interface connector.

C0405-232-01 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: C0405-232-01 Interface Connector – Pinout

C0405-232-01 Interface Connector - Diagram



Cabling Part Numbers for the C0405-232-01

- **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*).

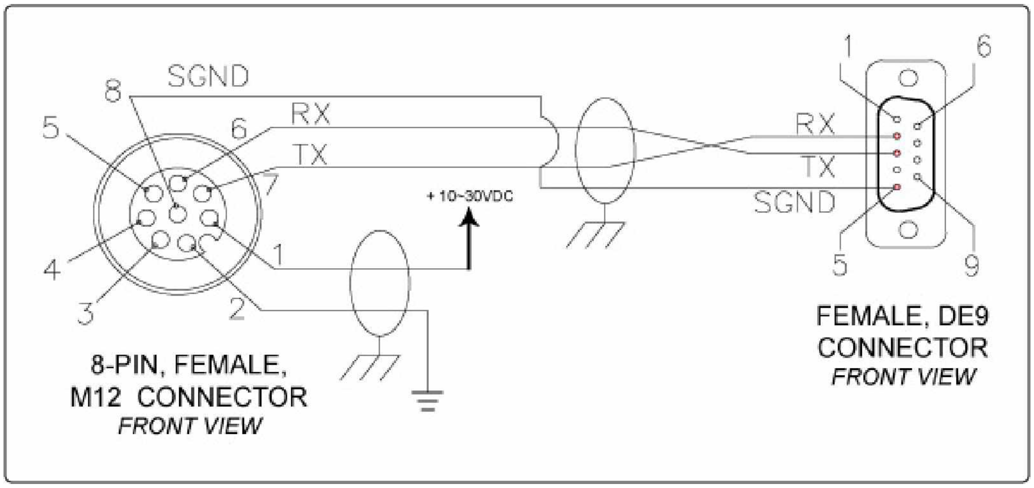


Figure 2-4: RS232 Interface Cable Schematic

CBL-1493: Field Mountable Connector

Figure 2-5: CBL-1493 Connector

The ***CBL-1493*** field mountable connector is available for connecting the C0405-232 to a host PC via bulk cable. *(*See Appendix B for more information regarding cables and connectors for the entire line of C0405-Series RFID Controllers).

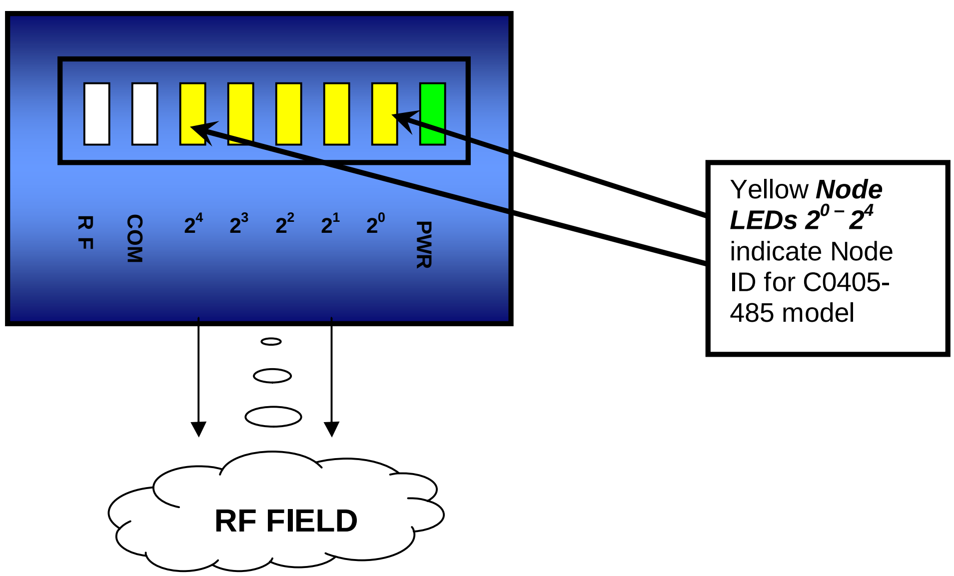
2.3 INSTALLING THE C0405-485-01 CONTROLLER

The C0405-485-01 RFID Controller supports RS485 communications and Escort Memory Systems' Subnet16™ Multidrop bus architecture and RFID network protocol. Through the Subnet16 protocol, multiple C0405-485-01 units can be connected to one Subnet16™ RFID Gateway or Hub interface device. The Gateway or Hub assigns each attached C0405-485-01 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 C0405-485-01

1. Attach the controller to the mounting bracket and 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 C0405-485. 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 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 C0405-485 RFID Controller. Note: the default Node ID is Node 00; in which case none of the amber Node ID LEDs will be lit.



4. To verify operations, download the TCP/IP version of the ***Cobalt HF Dashboard Utility*** software application from Escort Memory Systems' website (www.ems-rfid.com). The *Cobalt HF Dashboard Utility* allows ***Gateway/Hub*** users to send RFID commands to any connected 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 C0405-485-01 Cabling Information

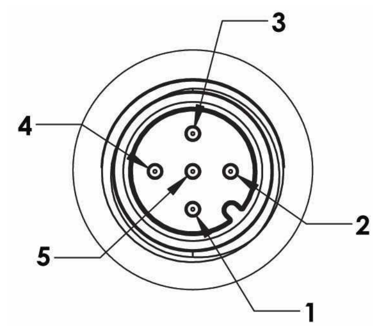
The C0405-485-01 has one 5-pin, male M12 interface connector.

C0405-485-01 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: C0405-485-01 Interface Connector - Pinout

C0405-485-01 Interface Connector - Diagram



2.4 INSTALLING THE C0405-USB-01 CONTROLLER

The C0405-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.

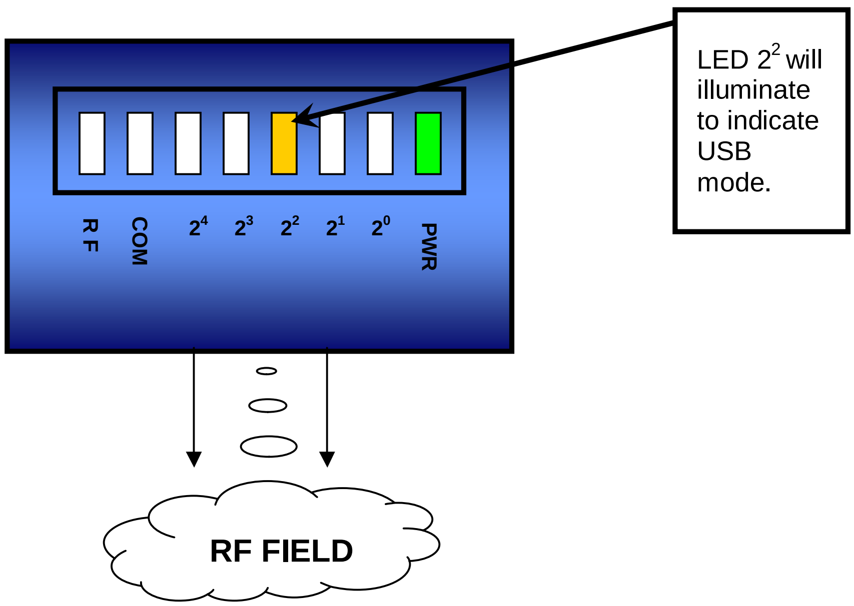
2.4.1 Steps to Install the C0405-USB-01

1. Download the Cobalt USB driver software bundle 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. Attach the controller to the mounting bracket and work area as noted in *Section 2.1.3 – Mounting the Controller*.

3. Attach the, 5-pin, reverse keyed female M12 interface connector from a suitable USB interface cable (*EMS P/N*: *CBL-1525*) to the 5-pin, reverse keyed male M12 connector on the C0405-USB.

4. Plug the remaining end of the USB interface cable into a USB port on the host computer. The LEDs on the Cobalt should illuminate. For the C0405-USB model, the amber LED **2^2** will illuminate to indicate that the controller is in USB mode.



5. Install the Cobalt USB driver. Refer to the ***Cobalt USB Driver Installation Instructions*** (*EMS Publication P/N: 17-3128*) that are included in the Cobalt USB driver archive.

6. To verify operations, download the serial version of the ***Cobalt HF 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 C0405-USB-01 Cabling Information

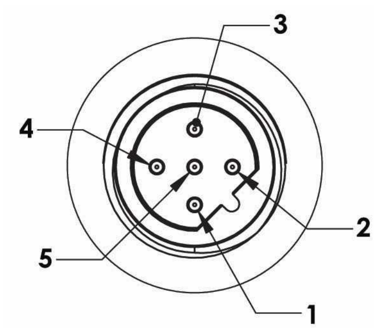
The C0405-USB-01 has one 5-pin, reverse keyed male M12 interface connector.

C0405-USB-01 Interface Connector - Pinout

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

Table 2-3: C0405-USB-01 Interface Connector - Pinout

C0405-USB-01 Interface Connector - Diagram



Cabling Part Numbers for the C0405-USB-01

- **CBL-1513**: Cable Assembly (5-pin, reverse keyed male M12 to USB Type A, 3m)
- **CBL-1514**: Connector (5-pin, reverse keyed male M12 connector for USB)
- **CBL-1525**: Cable Assembly (5-pin, reverse keyed female M12 to USB Type A, 3m)

2.5 ANTENNA ENVIRONMENT

The antenna used to communicate with RFID tags is integrated within the C0405 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.

2.5.1 Typical Read Range - Front View* for SLi 54x86mm RFID Tags

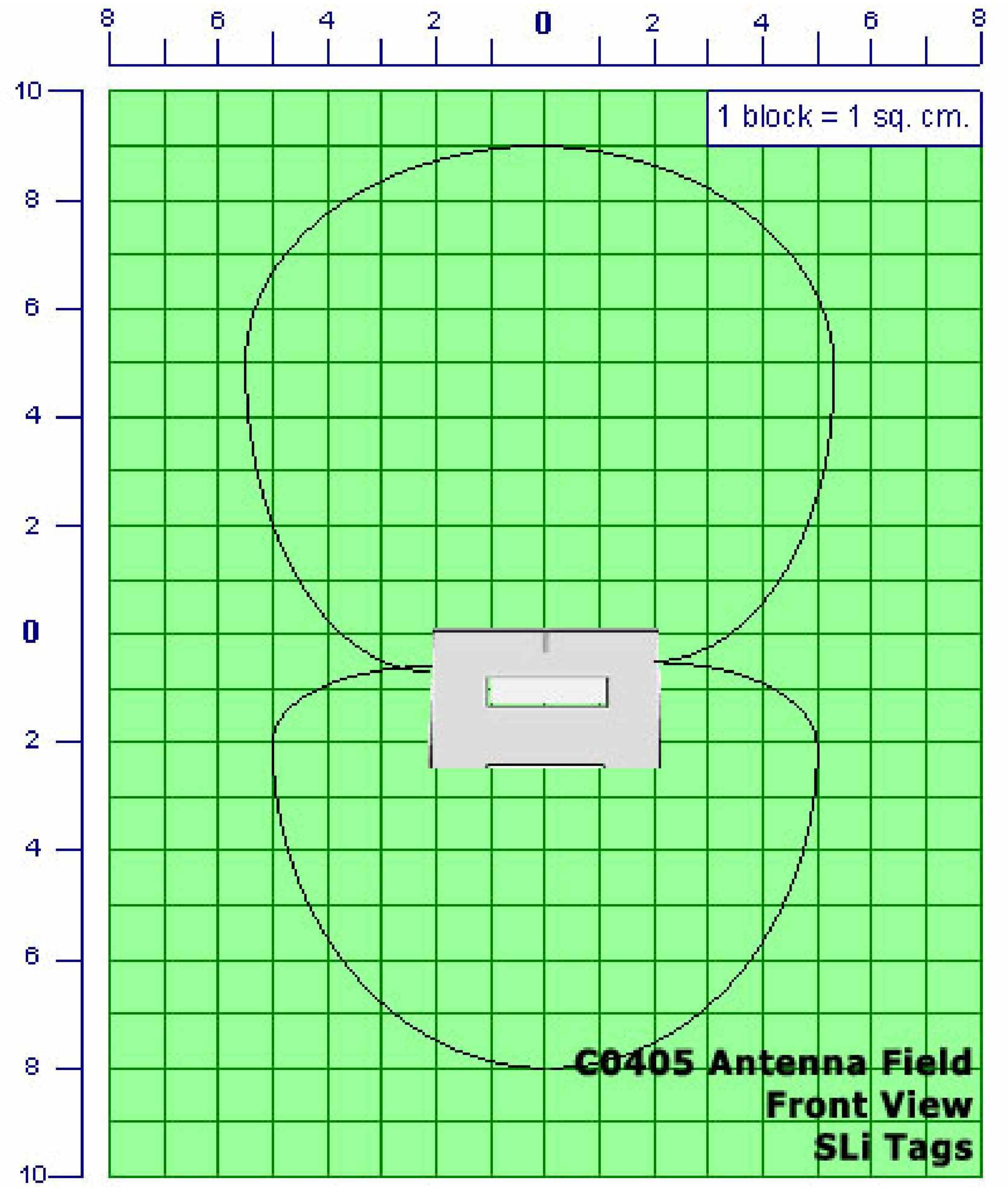


Figure 2-6: Typical Read Range - Front View for SLi 54x86mm Tags*

**Approximate Free Air H-Field Pattern*

2.5.2 Typical Read Range - Side Profile* for SLi 54x86mm RFID Tags

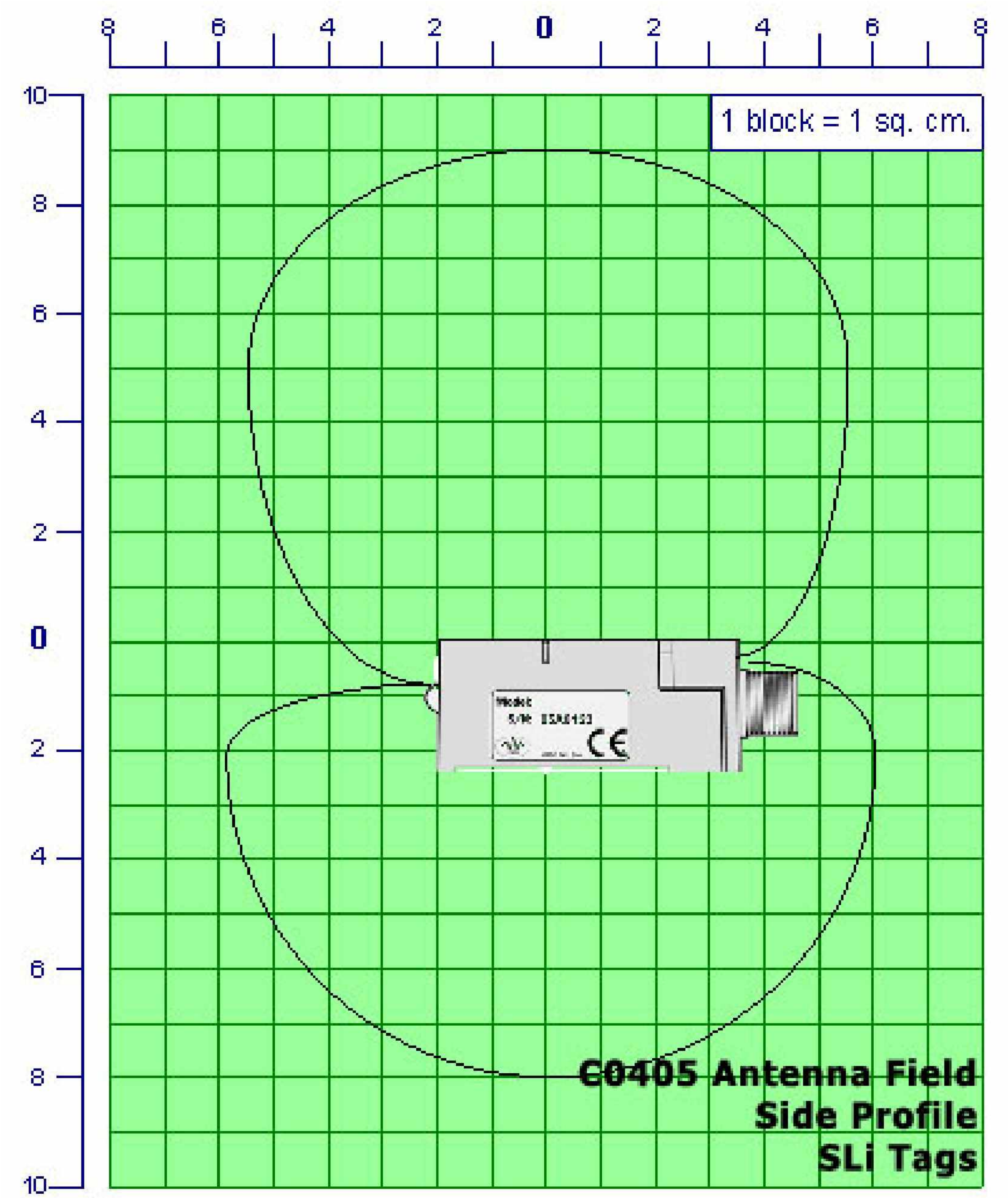


Figure 2-7: Typical Read Range - Side Profile for SLi 54x86mm Tags*

**Approximate Free Air H-Field Pattern*

2.5.3 Typical Read Range - Front View* for HMS / Mifare RFID Tags

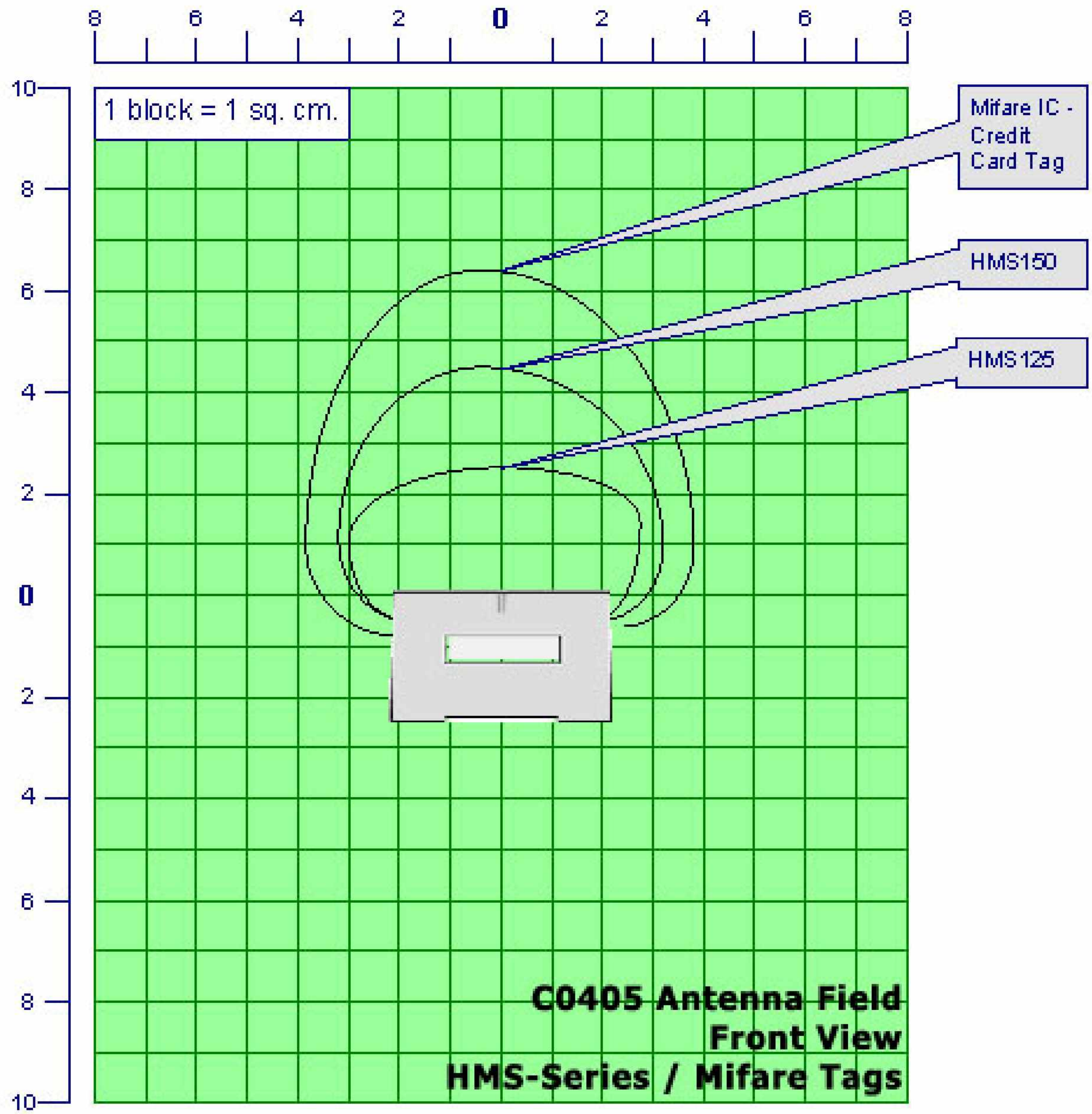


Figure 2-8: Typical Read Range - Front View for HMS / Mifare Tags*

**Approximate Free Air H-Field Pattern*

2.5.4 Typical Read Range - Side Profile* for HMS / Mifare RFID Tags

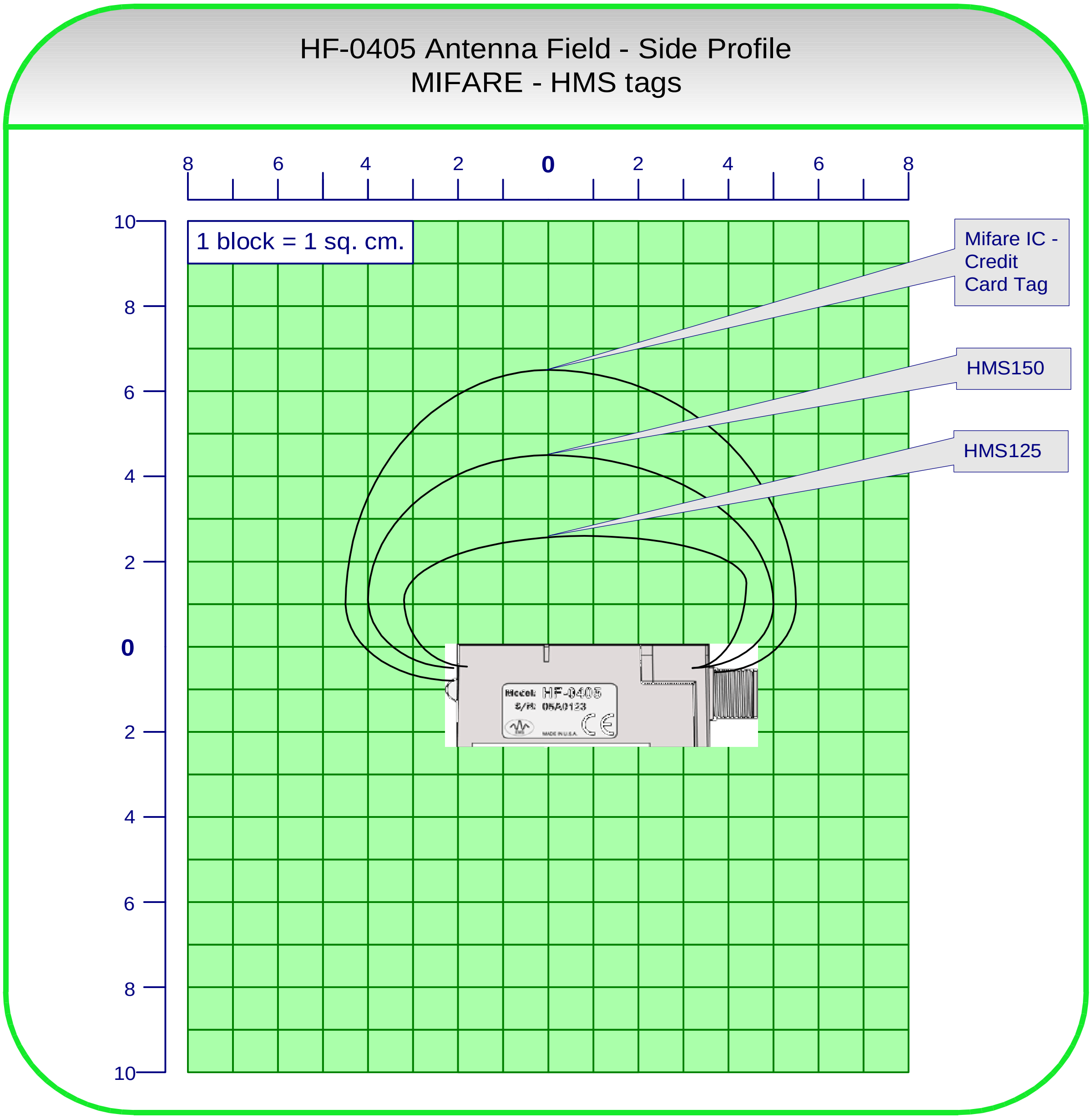


Figure 2-9: Typical Read Range - Side Profile for HMS / Mifare Tags*

**Approximate Free Air H-Field Pattern*

2.5.5 C0405 Antenna to EMS Tag Ranges

EMS TAG	RANGE
LRP125S	Up to 38mm
LRP250	Up to 60mm
LRP525 (HTS)	Up to 70mm
LRP-C5486S	Up to 74mm
HMS125	Up to 25 mm
HMS150	Up to 45mm

Table 2-4: C0405 Antenna to EMS Tag Ranges

CHAPTER 3: POWER & COMMUNICATION

3.1 POWER REQUIREMENTS

3.1.1 C0405-232-01/C0405-485-01 Power Requirements

C0405-232-01 and **C0405-485-01** RFID controllers requires an agency compliant LPS power supply capable of providing ***10~30VDC, 2.4W (100mA @ 24VDC)***.

EMS Power Supplies for C0405-232 and C0405-485 RFID Controllers

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 C0405-USB-01 Power Requirements

The **C0405-USB-01** RFID Controller obtains power directly from the USB bus.

Typical power consumption under normal conditions = ***1W (200mA @ 5VDC).***

CAUTION:

Do not connect or disconnect the C0405 while power is being 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 HF-SERIES CONFIGURATION TAG

3.2.1 Configuration Tag Overview

In the past, RFID controllers had multiple jumpers and DIP-switches that were used to set configuration parameters. C0405-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***.

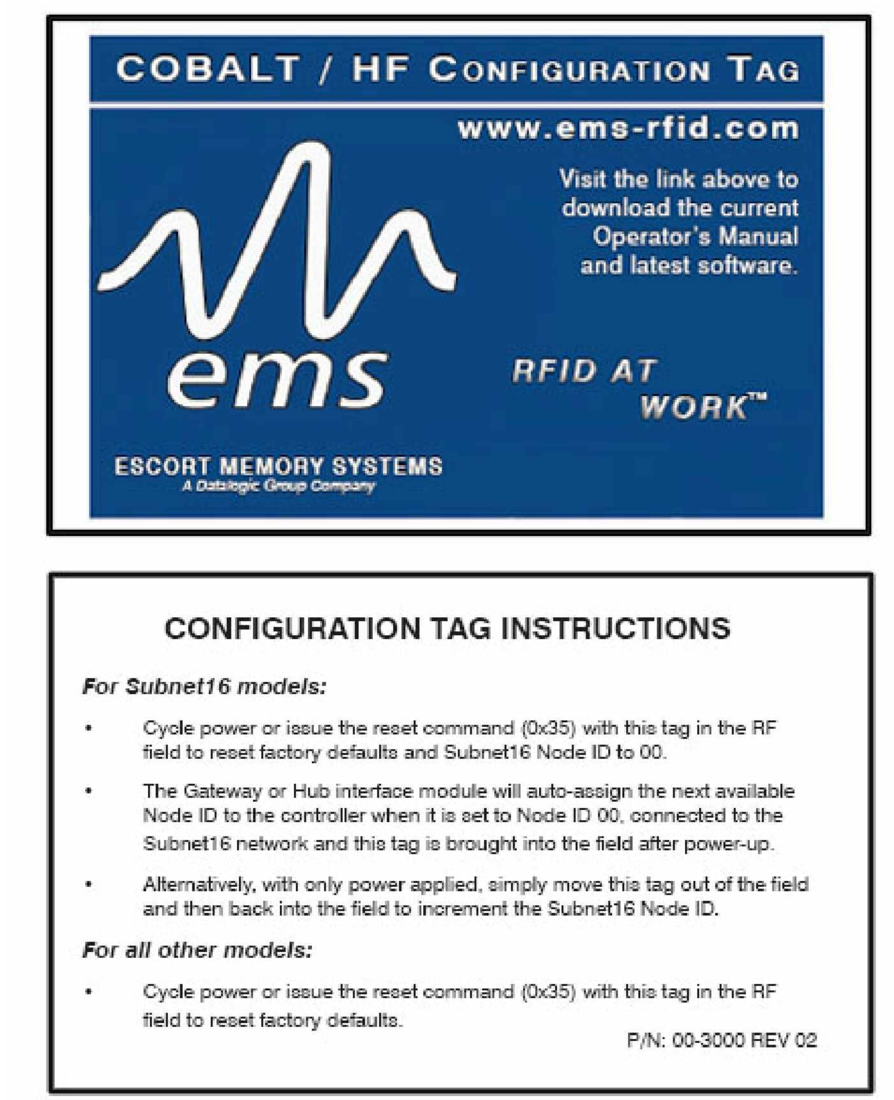


Figure 3-1: Cobalt HF Configuration Tag

In the event that serial communication parameters become improperly assigned, recycle 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 C0405-485, this Configuration Tag can also be used manually to set the device's Node ID. It is recommended to write the product 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 on this tag (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 to Default Settings

The Configuration Tag can be used to reset factory defaults to all versions of the C0405. To restore factory defaults, 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 C0405, remove the Configuration Tag from the RF field. The controller will be reset to the following default settings:

CONFIGURATION PARAMETER	DEFAULT SETTING
Command Protocol	ABx Fast – No Checksum
Tag Type:	ISO 15693 (*I-Code SLi*)
Serial Communications	9600, N, 8, 1, N (*C0405-232 model*)
Node ID	00 (*C0405-485 model*)

Table 3-2: Configuration Tag - Controller Defaults

Setting Node ID Manually (C0405-485 only)

To set the Node ID on C0405-485 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 C0405, remove the Configuration Tag from the RF field. This will set the Node ID value back to the default value of Node ID 00. (Note: see Section 4.1 - LED Functions Overview for LED positions and colors).

- 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 bringing 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 vale assigned to the controller (See Chapter 4 for more information on LED status).

This procedure can be used to cycle through all 16 possible Subnet Nodes. Note that after reaching Subnet Node 16, incrementing the Node ID value once more returns the controller to Node ID 0.

After selecting the desired Node ID value, reset the C0405 with the Configuration Tag out of RF range to allow the unit to reset completely and resume operation under its new Node ID.

Setting Node ID Automatically (C0405-485 only)

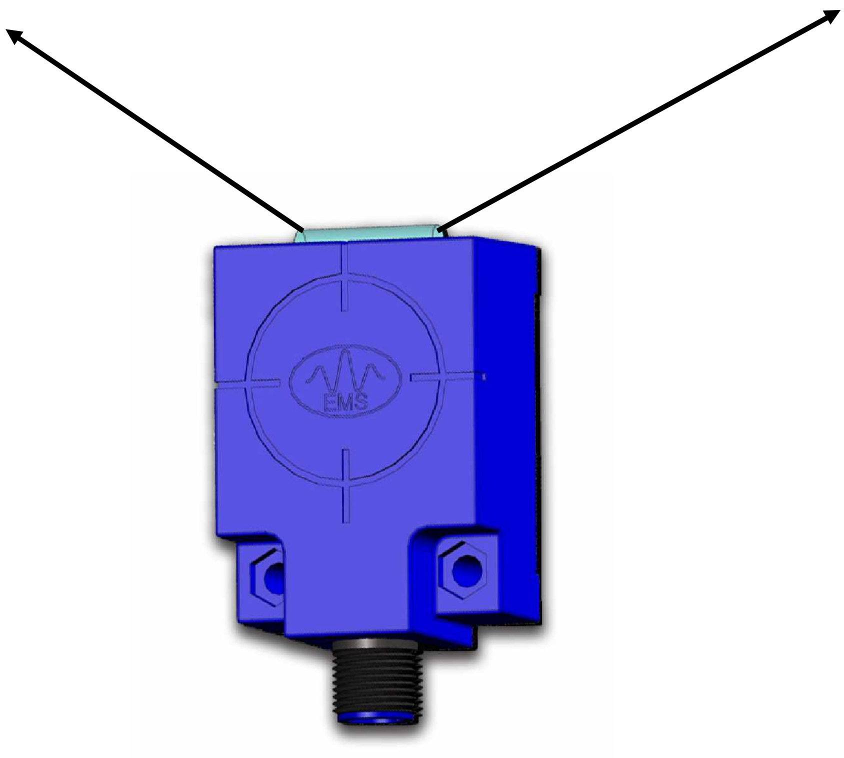
To allow a Subnet16 Gateway or Hub to assign the Subnet Node ID to a C0405-485 automatically, reset the controller to Node ID 00, connect the controller to the network, and apply power to the Subnet16 bus. When the Gateway or Hub comes on line, hold the Configuration Tag in the RF field of the controller 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 theSubnet16 Gateway and/or subnet16 Hub.

CHAPTER 4: LED STATUS

4.1 LED FUNCTIONS OVERVIEW

C0405-Series RFID Controllers have eight LED status 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.

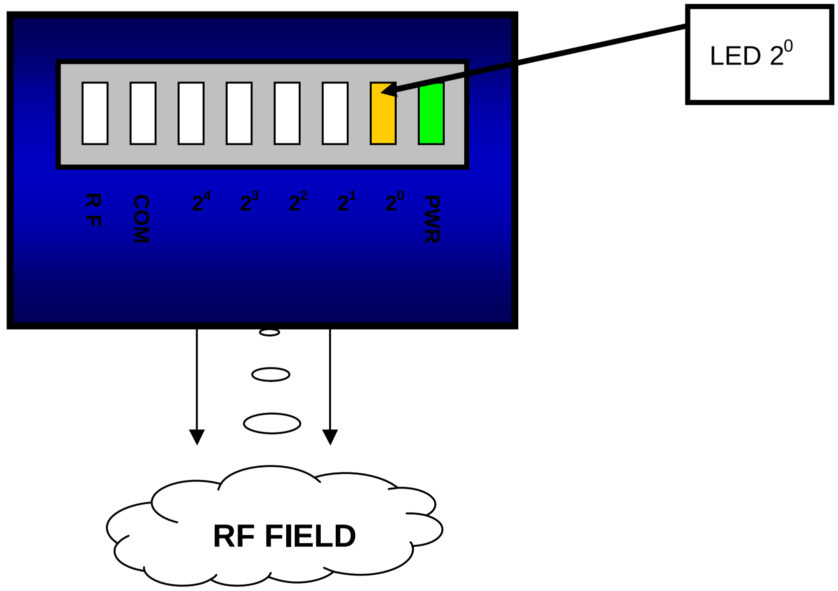
COM LED: Color is green. The COM LED indicates that data is being transmitted between the host and the C0405. On receipt of a command, the COM LED will begin flashing ON and OFF rapidly. After the controller generates the command response, COM LED flashing will halt. When in *Continuous Read* mode, the COM LED will remain ON and will turn OFF briefly only while data is being read or written to a tag.

Node LEDs: Colors are amber. These five LEDs indicate the serial communications type for C0405-232 and -USB models. For the C0405-485 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 C0405-Series Controller.

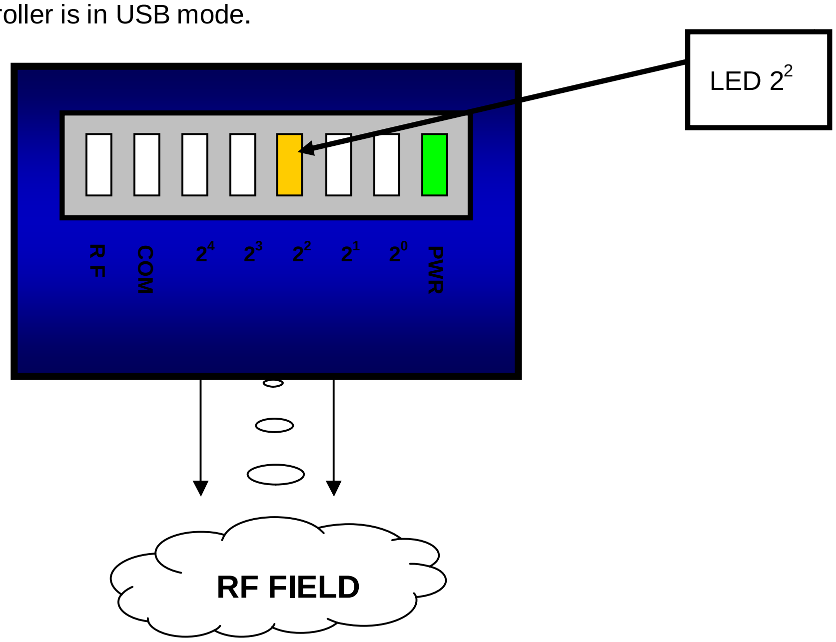
4.1.2 C0405-232 LED Status

On the C0405-232 model, the amber Node $2^{\mathbf{0}}$ LED will stay on indefinitely to indicate that the controller is in RS232 mode.



4.1.3 C0405-USB LED Status

On the C0405-USB model, the amber Node $2^{\mathbf{2}}$ LED will stay on indefinitely to indicate that the controller is in USB mode.



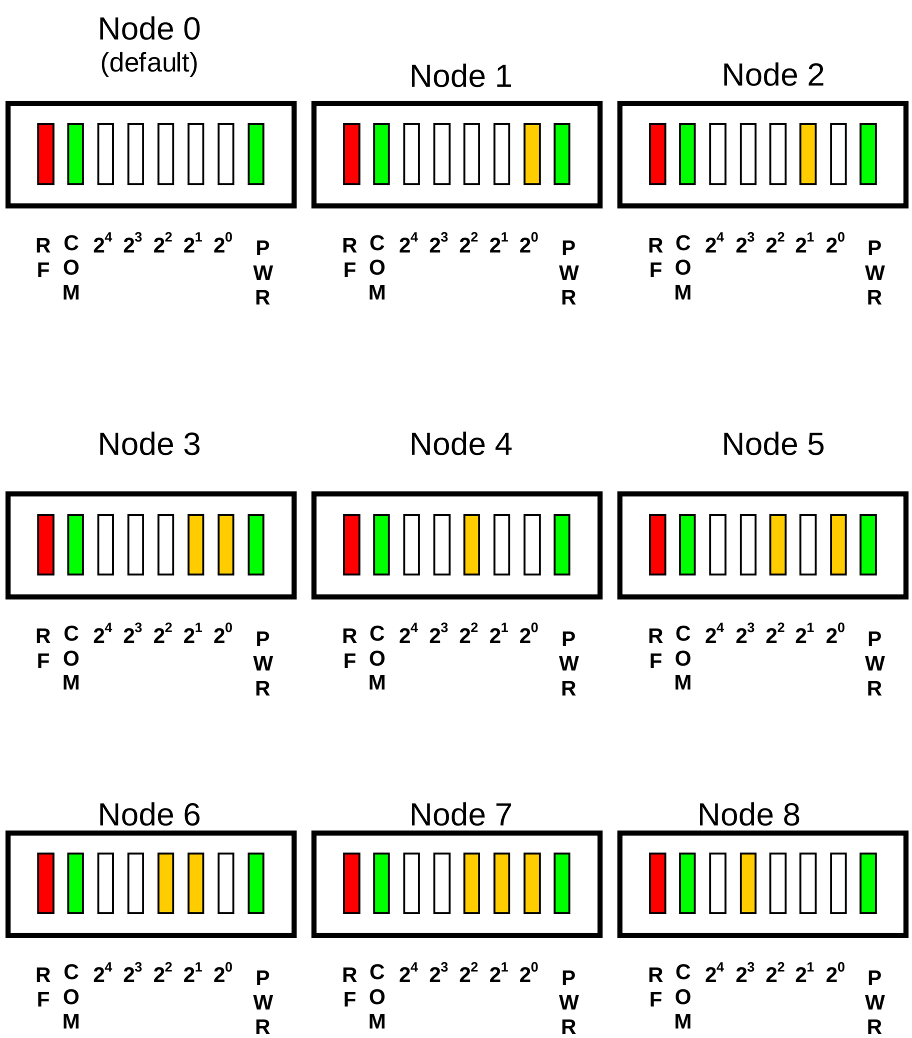
4.1.4 C0405-485 LED Status

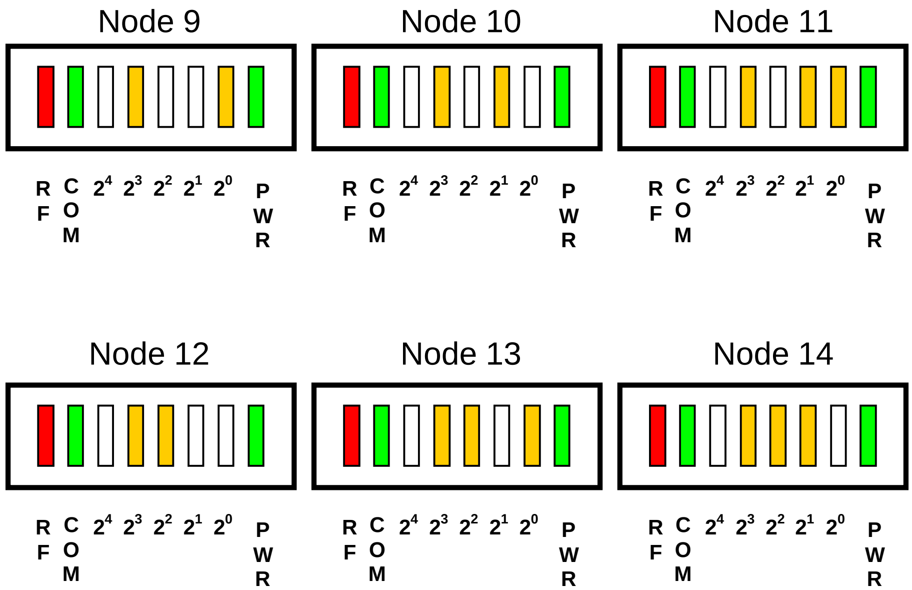
When used in conjunction with a Subnet16 Gateway or Subnet16 Hub, the five amber LEDs on the C0405-485 model indicate (in binary, weighted by powers of two, from right to left) the Node ID value currently assigned (for which there are 16).

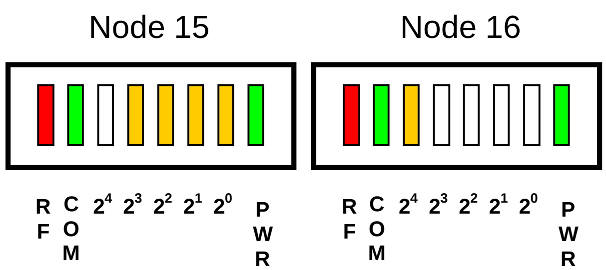
For example, 2^0 (0x01) = Node ID 1, 2^1 (0x02) = Node ID 2, 2^2 (0x04) = Node ID 4, 2^3 (0x08) = Node ID 8, 2^4 (0x10) = Node ID 16.

By default, C0405-485 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: HF-Series Configuration Tag*.

Node ID Values for the C0405-485



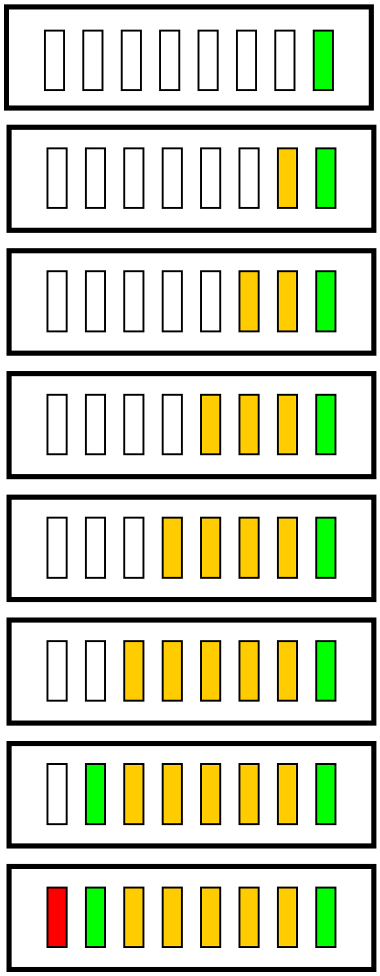




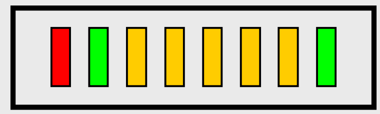
Node ID 00 is the default Node ID for C0405-485 controllers. In this state, the controller will be unable to perform commands until it has been initialized by a Gateway or Hub, at which time it will be assigned a Node ID between 1 and 16.

4.2 SPECIAL LED OPERATION FUNCTIONS

4.2.1 Updating the Controller's Firmware

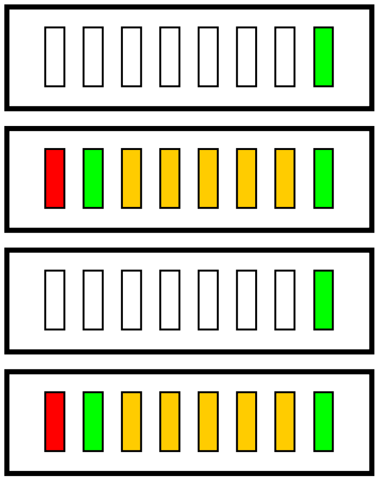


Updating Firmware (Part 1)

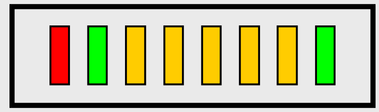


With the PWR LED on the right, the remaining LEDs will illuminate one at a time sequentially from right to left to indicate that new firmware code is being copied to internal memory.

The LEDs will repeat this R to L sequence until the C0405 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 unit 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

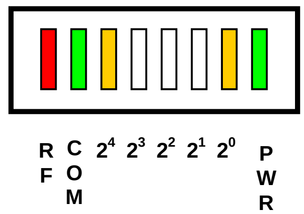
4.3 LED DISPLAYED ERROR CODES

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.

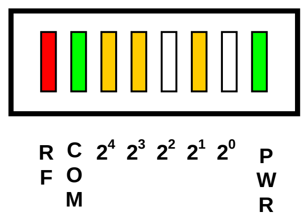
To display the single-byte error code in binary, the two left-most amber Node LEDs (LED 2^4 and LED 2^3) represent the first or most significant digit (MSD) of the error code. The three remaining amber Node LEDs (LED 2^2, LED 2^1 and LED 2^0) are combined to represent the second or least significant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

Examples:

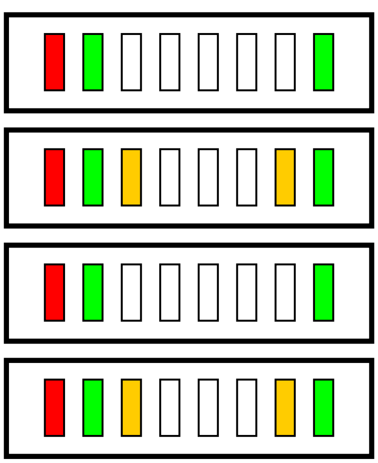
- If the five amber Node LEDs (from L to R) = **ON, OFF, OFF, OFF, ON,** the first digit of the error code is a "***2*** " and the second digit is a "***1,***" meaning that error code **0x21** occurred (*error code 0x21 = command syntax error*).

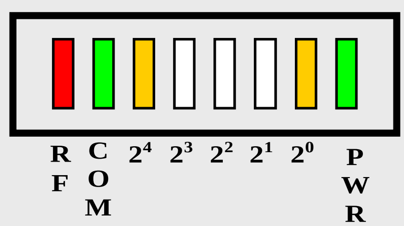


- If the five amber Node LEDs (from L to R) = **ON, ON, OFF, ON, OFF,** the first digit of the error code is a "***3*** " and the second digit is a "***2,***" meaning that error code **0x32** occurred (*error code 0x32 = invalid programming address*).



After an error has occurred, the red RF LED and one or more amber Node LEDs will continue to flash the error code until a valid command is received by the controller. If an unrecoverable error occurs, the LEDs will continuously flash the error code until the C0405 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 C0405.

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.

C0405-Series 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 ISO 14443A standards 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 a C0405-Series controller is suitable.

ISO 14443A compliant tags and controllers incorporate security authentication and use software "keys" during each transfer of data to and from the tag. Both the RFID controller and the tag must use the same security keys to authenticate communication. The C0405 Controller's operating system manages these security features, making their existence transparent to the user. However, it is important to understand the implications associated with ISO 14443 when using another manufacturer's tags. Because of these security "features," an ISO 14443 tag made by one manufacturer may not be readable by a C0405 Controller and an Escort Memory Systems ISO 14443 compliant tag might not be readable by another manufacturer's RFID controller. C0405-Series Controllers support EMS' security keys for use on Mifare ISO 14443A tags.

ISO 15693

ISO 15693 was established at a time when the RFID industry identified that the lack of standards was preventing the market from growing. 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 the C0405-Series Controller 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.

It is important to know that not all 13.56MHz RFID tags are compatible with the C0405 and even tags that are compliant to the ISO 15693 or ISO 14443 standards may not be compatible with RFID controllers compliant to the same standards. This is partially because these ISO standards leave many features open to the discretion and interpretation of the RFID equipment manufacturers to implement or define. 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 this publication, tags that contain the following RFID integrated circuits are compatible with C0405-Series Controllers.

5.2.1 HMS-Series Tags

- Philips Mifare Classic, 1k-byte* + 32-bit ID (ISO 14443A)

***Mifare** 1 kilobyte total IC memory. Of this memory, 736-bytes are available for user data.*

- Philips Mifare Classic, 4k-byte** + 32-bit ID (ISO 14443A)

*****Mifare** 4 kilobytes total IC memory. Of this memory, 3,440-bytes are available for user data.*

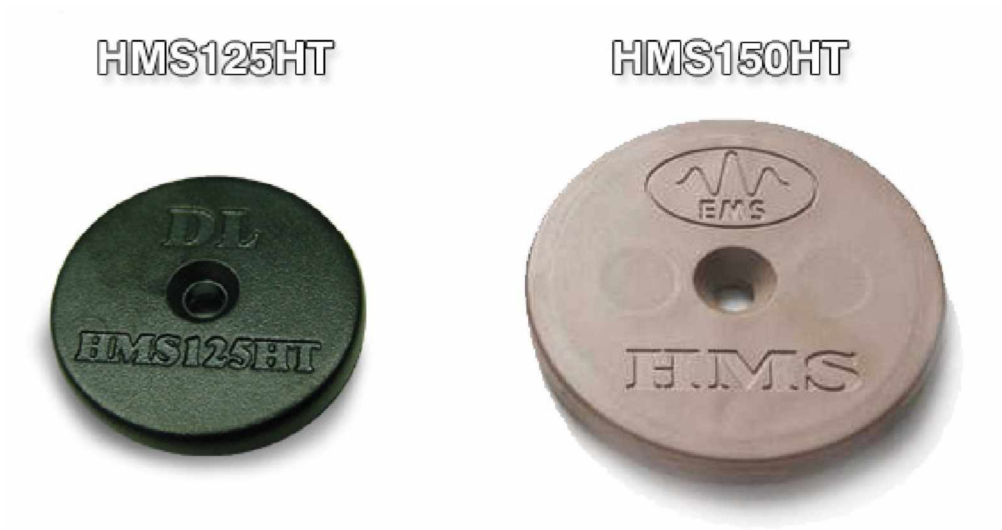


Figure 5-1: HMS125HT and HMS150HT tags

5.2.2 LRP-Series Tags

- Philips I-CODE 1, 48-byte + 64-bit ID
- Philips I-CODE SLi, 112-byte + 64-bit ID (ISO 15693)
- Texas Instruments Tag-it, 32-byte + 64-bit ID (ISO 15693)
- Infineon My-D Vicinity, 1k-byte + 64-bit ID (ISO 15693)

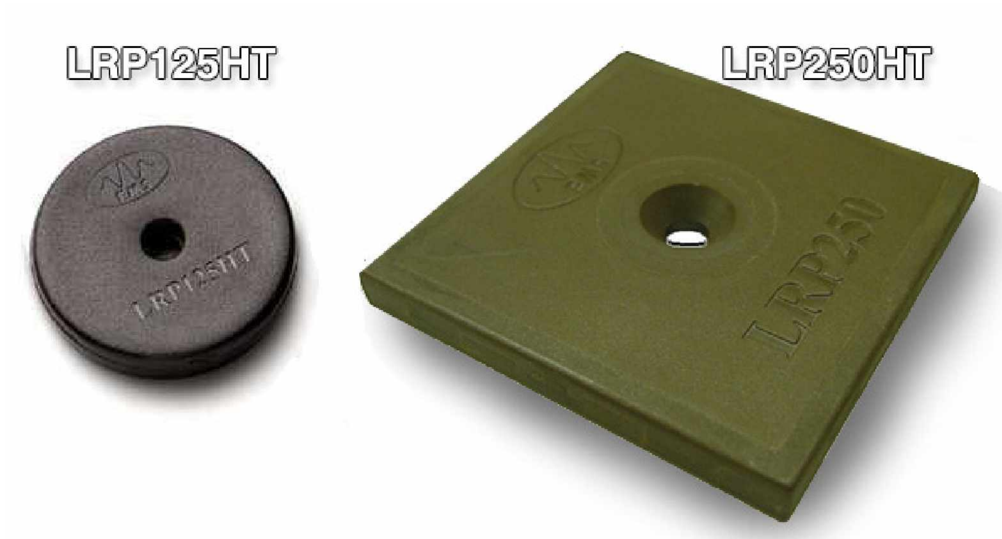


Figure 5-2: LRP-Series Tags

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 reader/writer 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.

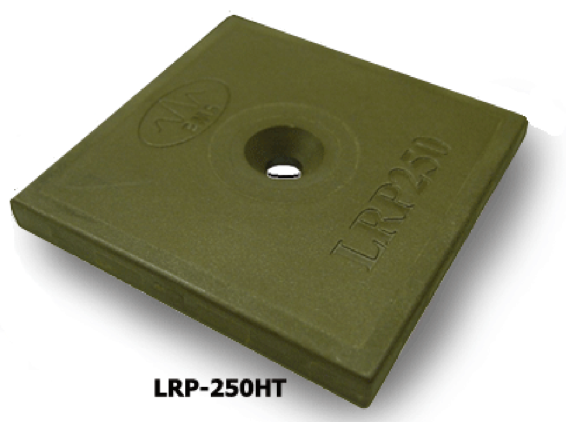
5.3.1 Printed Circuit Board RFID Tags

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, a certain number of bytes may be allocated for storage of security data. For more information regarding a specific RFID tag's memory allocation, please refer to the IC manufacturer's published datasheets.

Escort Memory Systems has taken great care to simplify tag memory addressing. The mapping from logical address to physical address is handled by the C0405-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

Is it a Byte or a Bit?

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

It should first be understood that 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

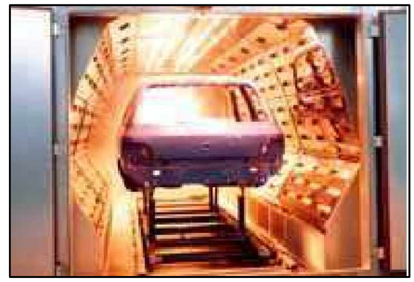
In the above example, instead of using 5-bytes of data to store the ASCII bytes representing characters 5, 2, 8, 8, and 2 (ASCII bytes: 0x35, 0x32, 0x38, 0x38, 0x32) by simply writing two Hex bytes (0xCE and 0x92), 60% less tag memory is used to store the same information.

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).

OPTIMIZING TAG MEMORY - EXAMPLE



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.

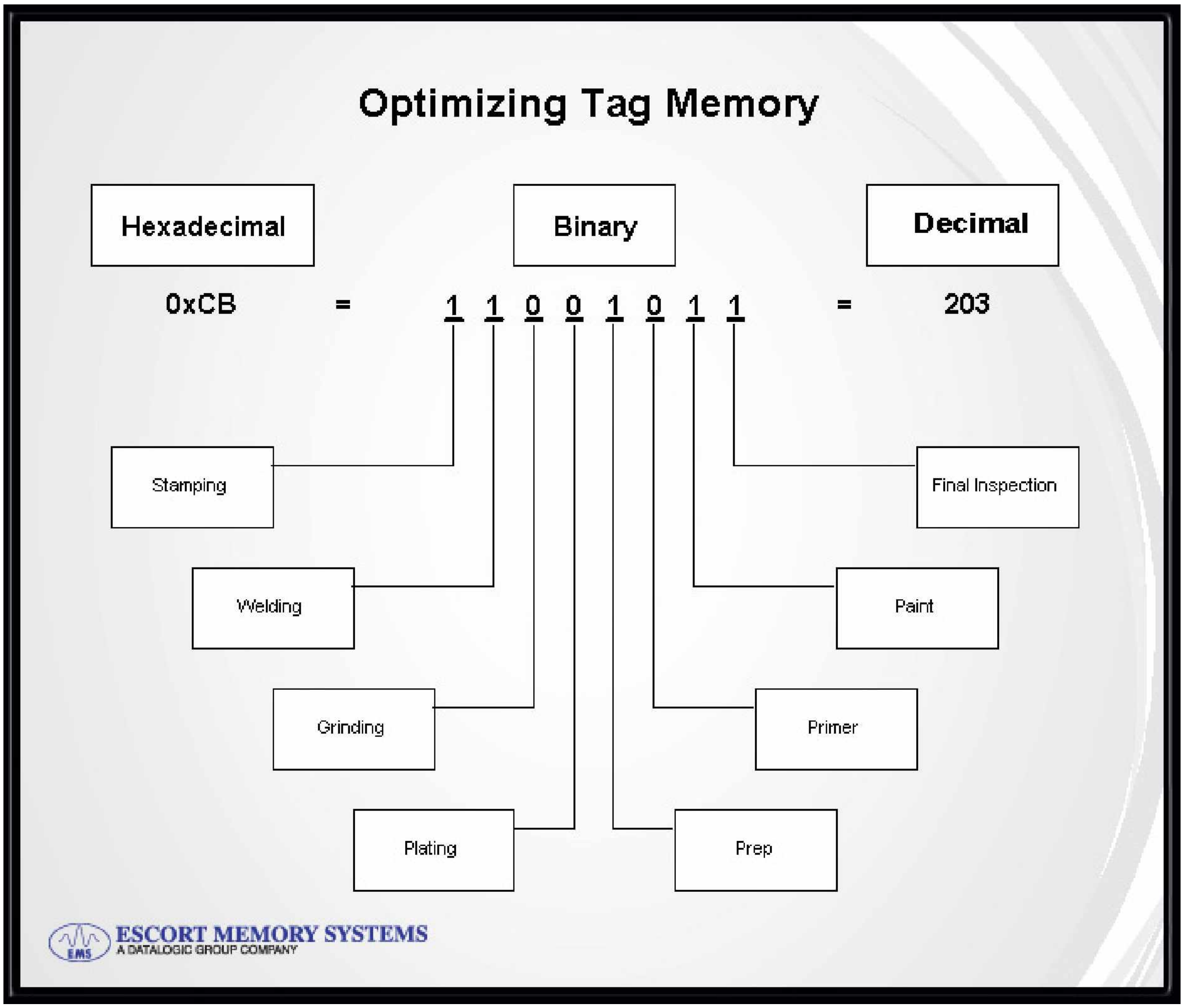


Figure 5-3: Optimizing Tag Memory

CHAPTER 6: COMMAND PROTOCOLS

6.1 ABX COMMAND PROTOCOL 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 C0405 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 three primary variations. The three versions of the ABx Command Protocol that are supported by the C0405-Series RFID Controller are:

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

The ***ABx Fast Command Protocol*** has a single-byte based packet structure that permits the execution of RFID commands while requiring the transfer of fewer total bytes than ABx ASCII and ABx Standard. ABx Fast is the default command protocol used by C0405 RFID Controllers. It can be used with or without a checksum byte.

The ***ABx ASCII Command Protocol*** also has a single-byte based packet structure that supports the execution of RFID commands using the seven-bit ASCII character set. By preventing data from interrupting communications when an ASCII control character is received, ABx ASCII can be useful in applications where flow control is required. This protocol can also be used with or without a checksum.

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 C0405 is configured to use the *ABx Fast Command Protocol*. ABx Fast (as the name suggests) is the faster and more efficient of the three ABx protocols, offering increased communication speed and error immunity.

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

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

See the table below for further clarification.

ABx Protocols - Headers and Terminators

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

Table 6-1: ABx Protocols - Headers and Terminators

When a command is issued by the host, the RFID controller stores the incoming data packet in a buffer while it scans the data for a start character (0x02, 0x02 or 0xAA). When a start character is found, it checks for the proper terminator (0x03 or 0xFF, 0xFF). Having identified a potentially valid command string, the controller will verify the format of the data and either perform the requested function or generate an error message.

6.1.3 ABx Response Structures

After completing an ABx command, the C0405 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 C0405-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* for more 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 that all commands generate a response from the controller. Before sending a second or additional command to a C0405, allow the host to first process (remove from memory) any pending response data.

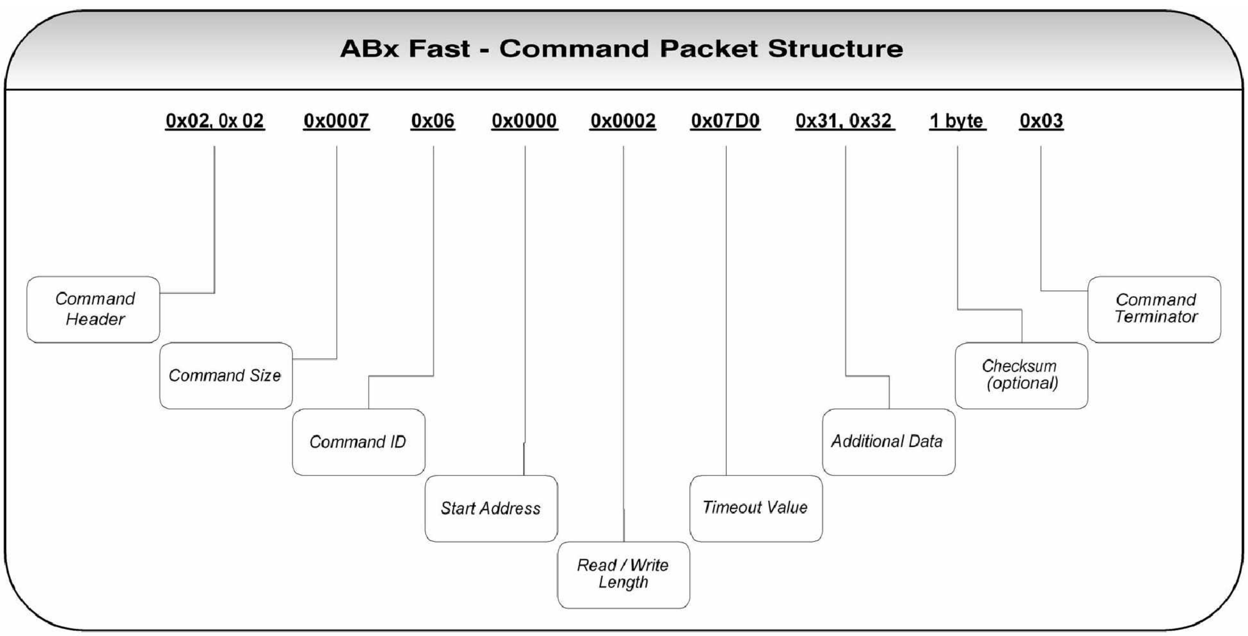


Figure 6-1: ABx Fast - Command Packet Structure

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.

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: 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 C0405, 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), 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	***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

The two-byte ***Read/Write Length*** 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 length 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.

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

COMMAND 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**

6.3 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.

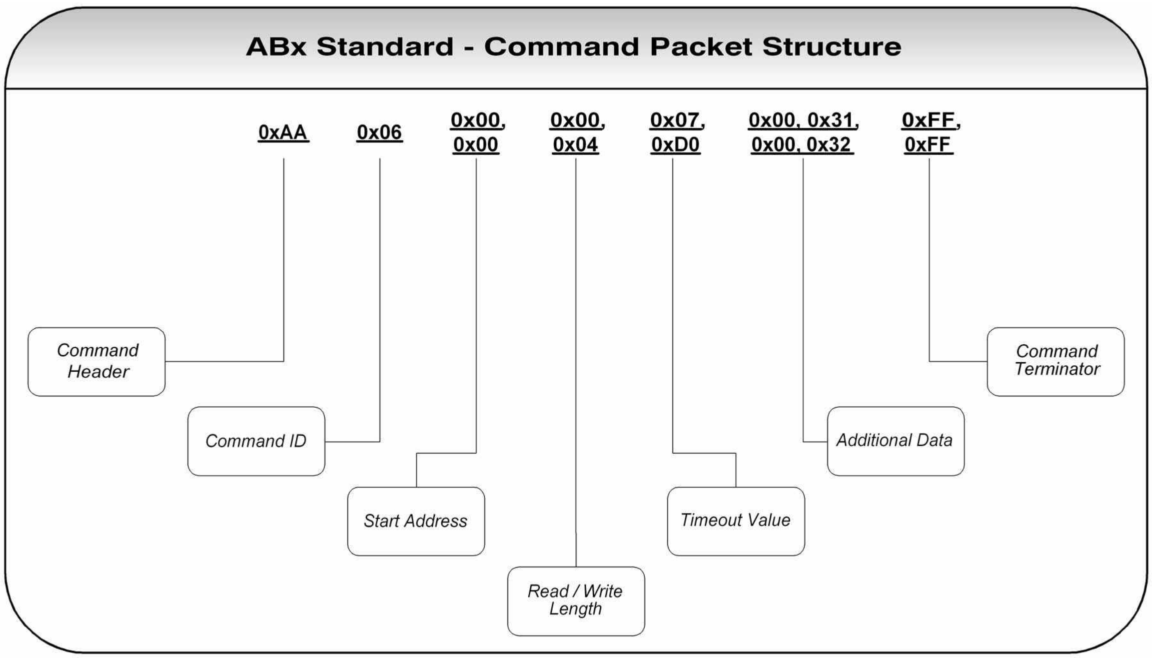


Figure 6-2: ABx Standard - Command Packet Structure

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: 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)
TERMINATOR: Double-byte command packet terminator	0xFF, 0xFF	2

Table 6-4: 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)
TERMINATOR: Double-byte command packet terminator	0xFF, 0xFF	2

Table 6-5: 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
Header and Command ID (MSB/LSB)	0xAA, 0x08 (Tag Search)
Timeout Value	0x07D0
Terminator	0xFF, 0xFF

Response from Controller

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

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 C0405-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 C0405-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

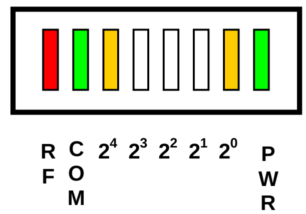
7.3 ERROR CODES

If the C0405 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).

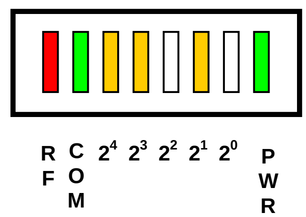
To display the single-byte error code in binary, the two left-most amber Node LEDs (LED 2^4 and LED 2^3) represent the first or most significant digit (MSD) of the error code. The three remaining amber Node LEDs (LED 2^2, LED 2^1 and LED 2^0) are combined to represent the second or least significant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

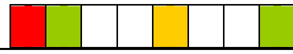
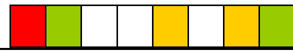
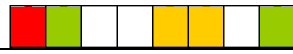
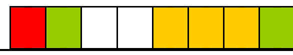
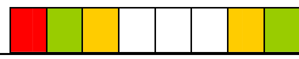
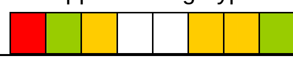
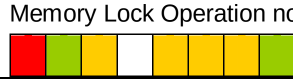
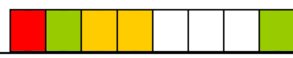
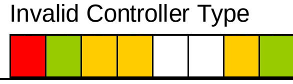
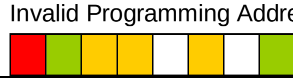
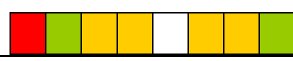
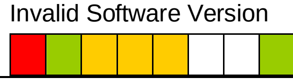
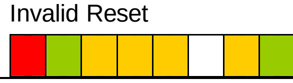
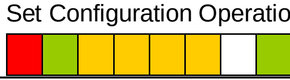
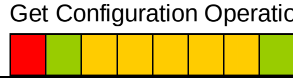
ERROR CODE	DESCRIPTION
0x04	Fill Operation not Completed 
0x05	Read Operation not Completed 
0x06	Write Operation not Completed 
0x07	Read Tag ID Operation not Completed (Tag not Found) 
0x21	Command Syntax Error 
0x23	Unsupported Tag Type / Unsupported RF Command 
0x27	Memory Lock Operation not Complete (memory may be 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: C0405-232-01 and C0405-485-01	2.4W (100mA @ 24VDC)
Power Consumption: C0405-USB-01	1W (200mA @ 5VDC from USB bus)

COMMUNICATION

Communication Interfaces	Point-to-Point: *RS232, USB* Multi-drop, Subnet16, MUX32: *RS485*
RFID Interface	Cobalt C0405-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	40mm x 56mm x 25mm (1.6in x 2.2in x 1in)
Weight	47g (1.7 oz)
Enclosure	Polycarbonate

ENVIRONMENTAL

Operating Temperature	-20° to 50°C (-4° to 122°F),
Storage Temperature	-40° to 85°C (-40° to 185°)
Humidity	100%
Protection Class	IP67
Shock Resistance	IEC 68-2-27 Test EA 30g, 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.

C0405-SERIES RFID CONTROLLER DIMENSIONS

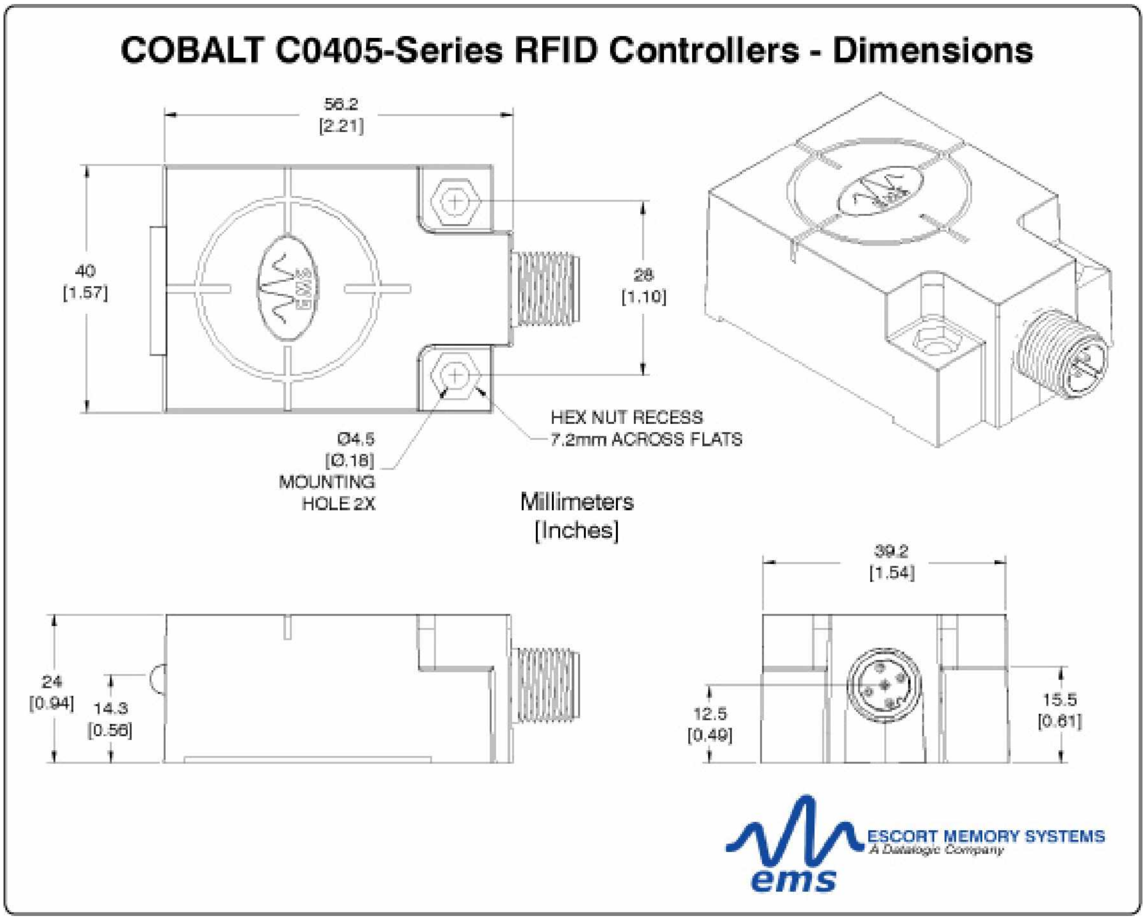


Figure A–0-1: C0405-Series RFID Controller Dimensions

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 C0405-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

C0405-Series RFID Controllers

There are three models of the C0405-Series RFID Controller:

- **C0405-232-01**
- **C0405-485-01**
- **C0405-USB-01**

Each C0405 unit ships with the following accessories:

EMS P/N	QTY	DESCRIPTION
00-3000	1	Configuration Tag for C0405 I-CODE SLI,
20-1940	2	Screws, (M4, 20 PPH SS 18-8\302)
20-5918	2	Hex Nuts, (M4 SS 18-8\302)
20-3910	2	Washers, Flat (M4, 12MM OD, 4.3MMID)
14-3137	1	Mounting Bracket for the C0405, NORYL, Black GTX830

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

SOFTWARE & DEMONSTRATION KITS

Software Applications

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

Cobalt HF Dashboard Utility (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

An easy to use GUI-driven utility that provides rapid development and implementation of custom RFID command macros.

Demonstration Kits

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 and power supply).

00-1217

C0405-USB-01 Demo Kit (includes one C0405-USB-01 controller, one CBL-1525 USB interface cable, one LRP108I tag, one LRP125VS tag and one T7036 tag).

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).

00-1219

Gateway C0405-485 Demo Kit (includes one GWY-01-TCP-01 TCP Gateway interface module, three C0405-485-01 controllers, one HMS150 tag, one LRP125S tag, interface cables, carrying case, display board and power supply).

CABLE AND NETWORK ACCESSORIES

EMS P/N *XX = LENGTH IN METERS*	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

Bulk RS232 Cable Belden Cable P/N: 9941

Bulk RS422 cable Belden Cable P/N: 3109A

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.

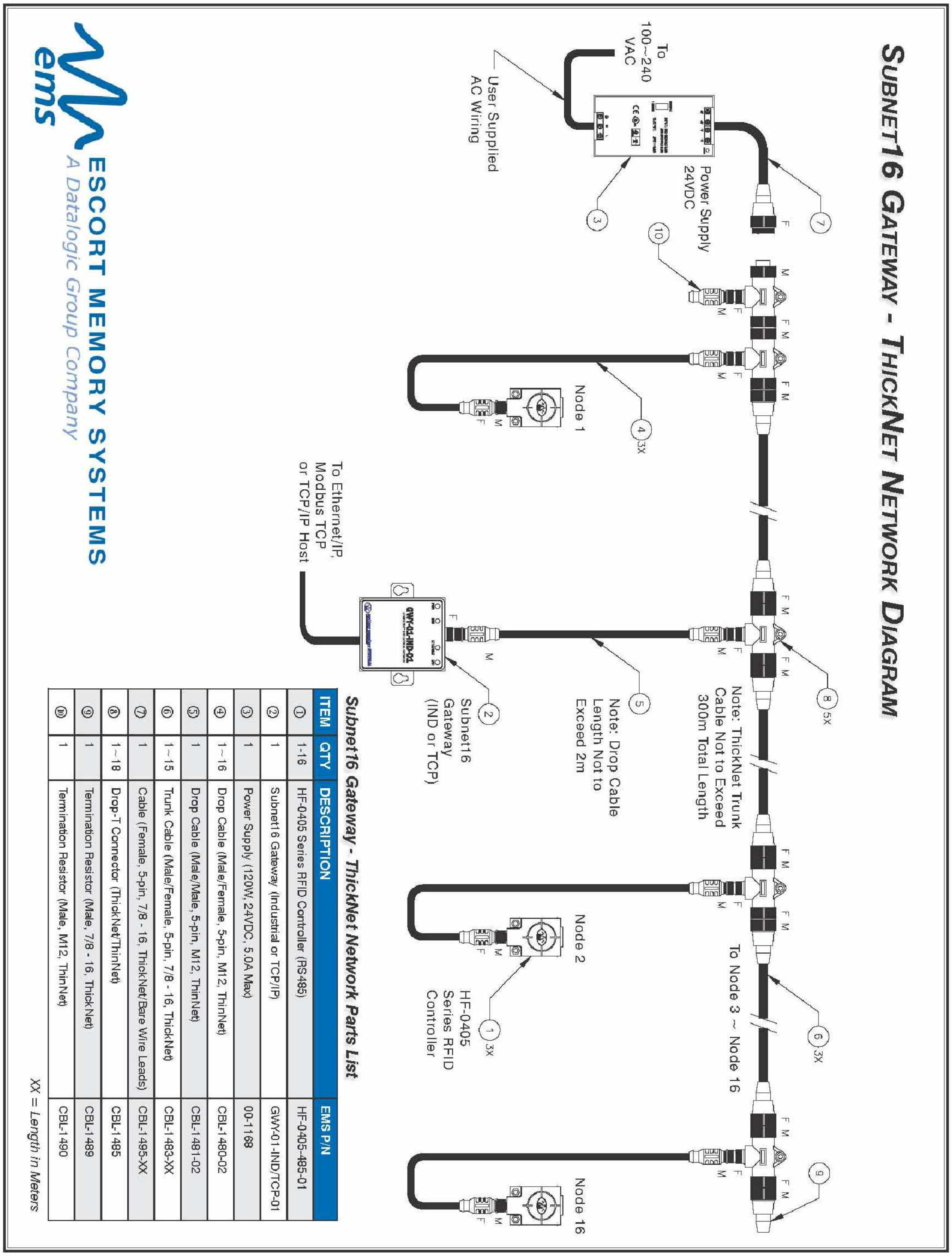
Escort Memory Systems' RFID Tags

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 C0405-Series product line.

APPENDIX C: NETWORK DIAGRAMS

- Subnet16 Gateway - ThickNet Network Diagram
- Subnet16 Gateway - ThinNet Network Diagram
- Subnet16 Hub – Network Diagram

7.6.1 Subnet16 Gateway – ThickNet Network Diagram

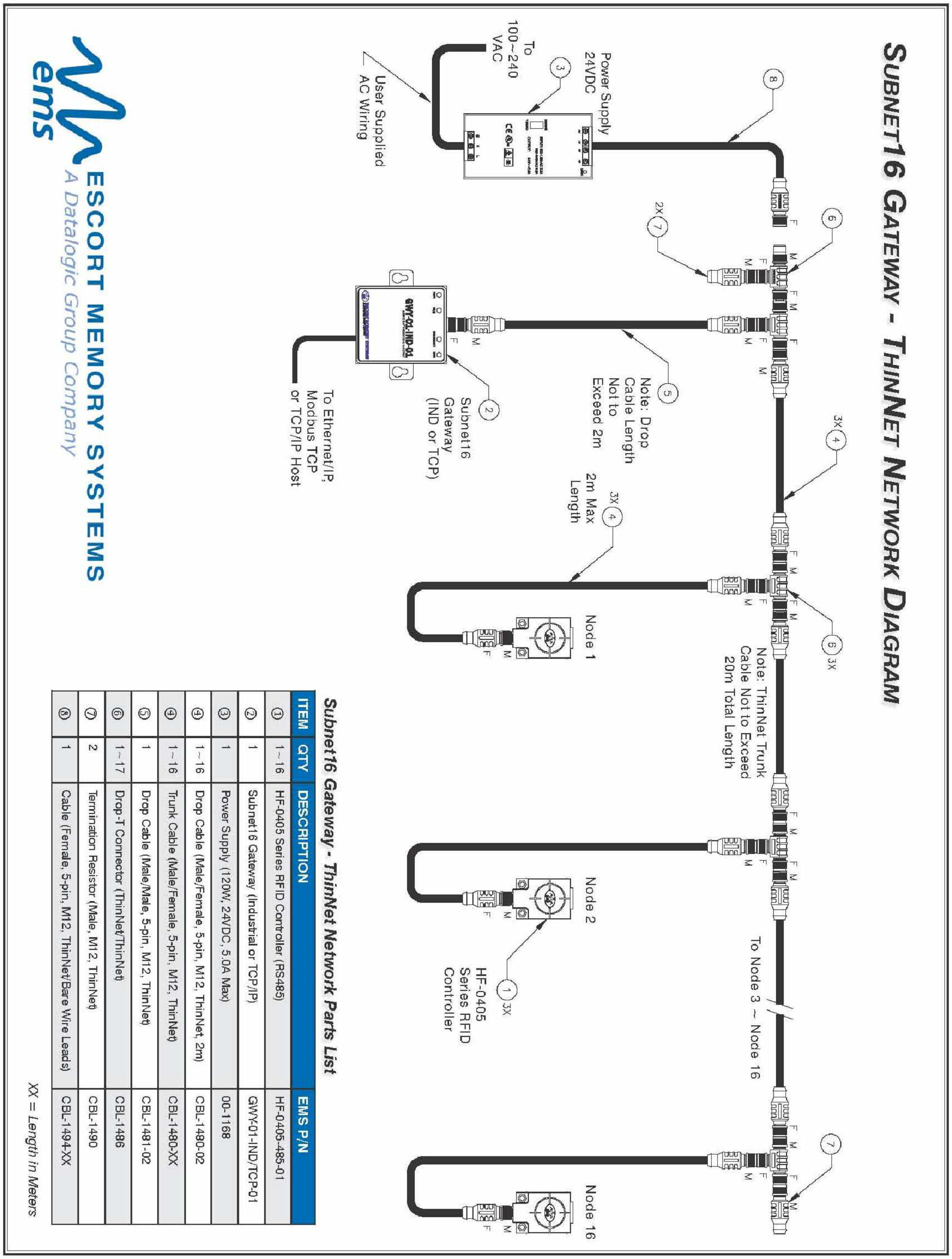


Subnet16 Gateway - ThickNet Network Parts List

ITEM	QTY	DESCRIPTION	EMS P/N
①	1-16	HF-0405 Series RFID Controller (RS485)	HF-0405-485-01
②	1	Subnet16 Gateway (Industrial or TCP/IP)	GWY-01-IND/TCP-01
③	1	Power Supply (120W, 24VDC, 5.0A Max)	00-1168
④	1~16	Drop Cable (Male/Female, 5-pin, M12, ThinNet)	CBL-1480-02
⑤	1	Drop Cable (Male/Male, 5-pin, M12, ThinNet)	CBL-1481-02
⑥	1~15	Trunk Cable (Male/Female, 5-pin, 7/8 - 16, ThickNet)	CBL-1483-XX
⑦	1	Cable (Female, 5-pin, 7/8 - 16, ThickNet/Bare Wire Leads)	CBL-1495-XX
⑧	1~18	Drop-T Connector (ThickNet/ThinNet)	CBL-1485
⑨	1	Termination Resistor (Male, 7/8 - 16, ThickNet)	CBL-1489
⑩	1	Termination Resistor (Male, M12, ThinNet)	CBL-1490

XX = Length in Meters

7.6.2 Subnet16 Gateway – ThinNet Network Diagram

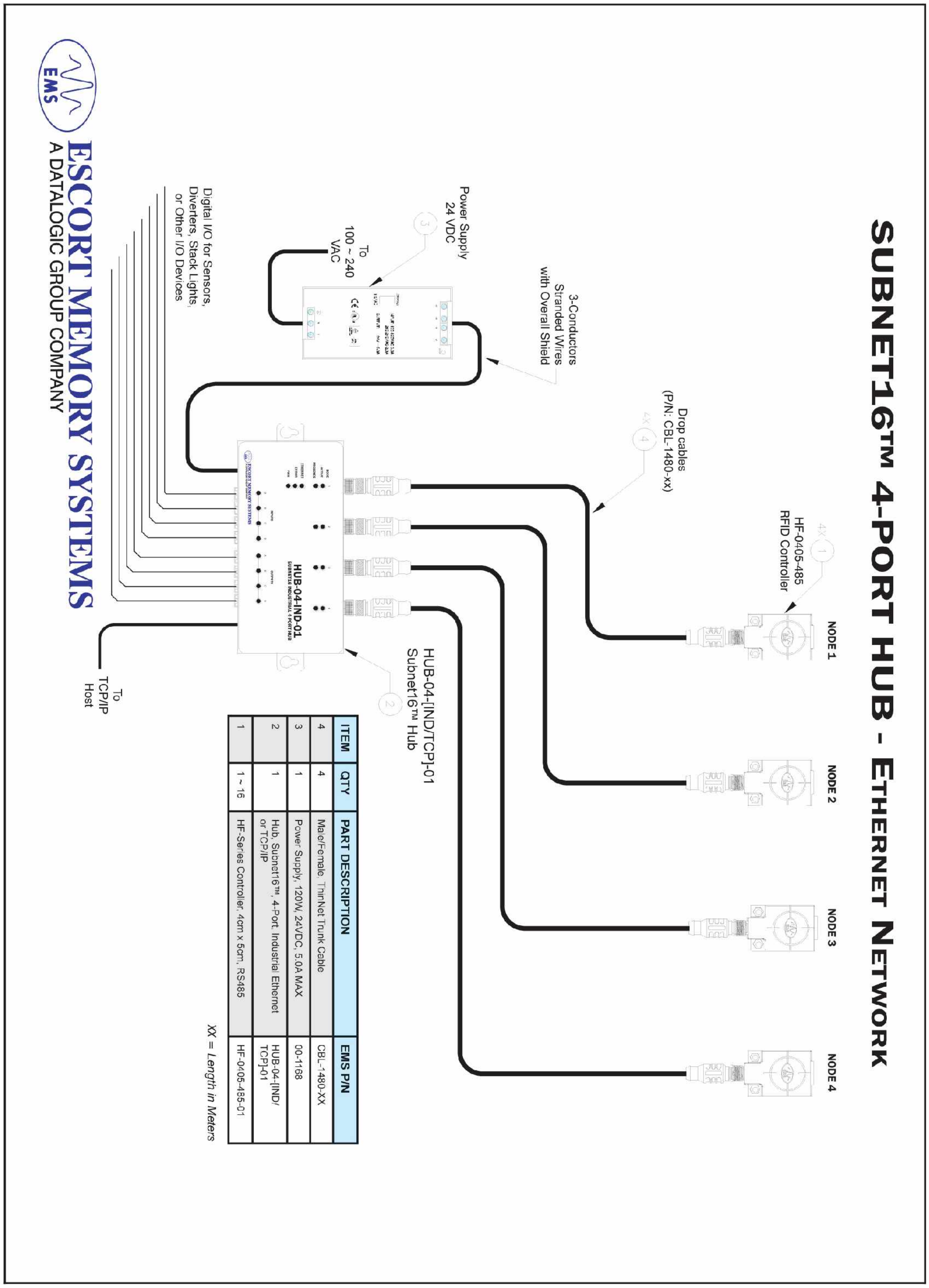


Subnet16 Gateway - ThinNet Network Parts List

ITEM	QTY	DESCRIPTION	EMS P/N
1	1~16	HF-0405 Series RFID Controller (RS485)	HF-0405-485-01
2	1	Subnet16 Gateway (Industrial or TCP/IP)	GWY-01-IND/TCP-01
3	1	Power Supply (120W, 24VDC, 5.0A Max)	00-1168
4	1~16	Drop Cable (Male/Female, 5-pin, M12, ThinNet, 2m)	CBL-1480-02
4	1~16	Trunk Cable (Male/Female, 5-pin, M12, ThinNet)	CBL-1480-XX
5	1	Drop Cable (Male/Male, 5-pin, M12, ThinNet)	CBL-1481-02
6	1~17	Drop-T Connector (ThinNet/ThinNet)	CBL-1486
7	2	Termination Resistor (Male, M12, ThinNet)	CBL-1490
8	1	Cable (Female, 5-pin, M12, ThinNet/Bare Wire Leads)	CBL-1494-XX

XX = Length in Meters

7.6.3 Subnet16 Hub – Network Diagram



ITEM	QTY	PART DESCRIPTION	EMS P/N
4	4	Male/Female ThinNet Trunk Cable	CBL-1480-XX
3	1	Power Supply, 120W, 24VDC, 5.0A MAX	00-1168
2	1	Hub, Subnet16™, 4-Port, Industrial Ethernet or TCP/IP	HUB-04-[IND/TCP]-01
1	1 ~ 16	HF-Series Controller, 4cm x 5cm, RS485	HF-0405-485-01

XX = Length in Meters

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	^

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

APPENDIX E: RFID TERMINOLOGY

TERM	DEFINITION
Antenna	The antenna is the part of the RFID controller that radiates RF energy to, and receives energy from an RFID tag.
ASCII	*American Standard Code for Information Interchange*. A computer code consisting of 128 alphanumeric and control characters, each encoded with 7 bits, used for the exchange of information between computing devices.
ASCII Protocol	A protocol used to send ASCII character commands to the controller. It is possible to use a standard terminal emulator program to send ASCII commands.
Baud	The rate at which a data channel transfers bits of information. Baud is measured in Bits Per Second (bps).
Binary	A numbering system in which numbers are expressed as combinations of digits 0 and 1, based on powers of 2. In computing these can be represented electrically as 'on' or 'off'.
Byte	Eight bits of data.
Capture Field/Area/Zone	The region of the electromagnetic field, generated by the antenna, in which transponders will operate. Also called the "RF Field" in this manual.
Checksum	An addition to the contents of a block of data. Data can then be checked before and after transmission to determine whether any data has been corrupted or lost.
Continuous Read	A mode of operation, in which the controller is instructed to repeatedly attempt to read any tag within RF range.
EPC	Electronic Product Code
Handshaking	A mechanism for the regulation of the flow of data between devices. For example, handshaking can be used to prevent a controller from temporarily overwhelming the host with Command Response data.
Hexadecimal (**Hex**)	A method of numerically representing data based on the number 16. Hex notation uses the numbers 0 to 9 and letters A to F (where the decimal number 10 is represented in hexadecimal as 'A'). In this manual Hex values are preceded by **0x**, as in "*address 0xFF*" (it is also considered correct to append Hex values with a lower case **h**, as in *"interrupt 20h*").
Host	The computer or PLC that issues commands to and receives responses from the RFID controller.

TERM	DEFINITION
Interface	An electrical or physical standard for the interconnection of devices.
ISM	Industry, Science & Medical
LED	Light Emitting Diode
LSB	Least Significant Byte. Also referred to as the Low Byte or second byte in a 2-byte "word."
MSB	Most Significant Byte. Also referred to as the High Byte or first byte in a 2-byte "word."
Multidrop	Multiple devices at various locations connected in parallel (or acting similar to parallel devices). RS-485 supports Multidrop RFID controller configurations.
MUX	Multiplexer
Noise	Unwanted ambient electrical signals found in the operating environment of RFID equipment.
Orientation	The alignment of a transponder with respect to the RFID controller's antenna.
Parity	A technique used to detect data transmission errors by adding an extra bit to each character. This bit is set to 1 or 0 to make the total number of bits ODD or EVEN, depending on the type of parity in use.
Passive Tags	An RFID transponder that does not contain an internal power source (such as a battery). It is powered by electromagnetic signals generated from an RFID antenna.
PCB	Printed Circuit Board
PLC	Programmable Logic Controller (synonymous with Host).
Protocol	A set of rules governing the flow of information in a communications system.
Range (RF)	The distance between the antenna and a tag or transponder in an RFID system at which signals can be properly received.
Read	The action of obtaining information contained in a tag.
Reader	A device containing digital electronics that can extract information from a transponder and pass that data on to a host computer.
Read Only	A type of RFID tag that has been locked with certain information written into it (usually during manufacturing) and thereafter can only be read.

TERM	DEFINITION
Read/Write	A type of RFID tag that allows a controller to retrieve or modify existing data or write new data to its memory.
Reader/Writer	An RFID device that can act as both reader and writer to a tag. (Synonymous with RFID controller).
Response	The string of data sent from the RFID controller to the host after a command has been issued.
RF	Radio Frequency
RFID	Radio Frequency Identification
RFID Tag	See Transponder
RS232	A common physical interface standard specified by the EIA for the interconnection of devices. The standard allows for single device to be connected, point-to-point, at recommended distances up to 15 meters.
RS485	An enhanced version of RS422, which permits multiple devices to be attached to a twisted pair wire bus at recommended distances up to 400 meters.
Rx	Receive
Tag	See Transponder
Transponder	An electronic *TRANSmitter* / *resPONDER* which is attached to an object to be identified and, when appropriate RF signals are received, transmits information as radio signals to an RFID controller (synonymous with tag).
Tx	Transmit
Write	The transfer of data to a tag.
Write Length	The number of contiguous bytes of tag memory that will be written.

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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