DATALOGIC AUTOMATION RFID

DATALOGIC

ems RFID AT WORK™

COBALT UHF SERIES

Ultra High Frequency RFID Controllers/Antennas

OPERATOR'S MANUAL

DATALOGIC AUTOMATION RFID BU HQ
Via S. Vitalino 13, 40012
Lippo di Calderara di Reno,
BO Italy
Tel. +39 051 314 7011

AMERICAS
3000 Earhart Ct., Ste 135
Hebron KY 41048
Inside USA Tel. 1-800-849-5358
Outside USA Tel. 1-859-689-7000

ASIA
Unit 808A, Tower 1,
833 Cheung Sha Wan Road,
Kowloon, Hong Kong, China
Tel. +852 2785 3912

EMEA
Via S. Vitalino 13, 40012
Lippo di Calderara di Reno,
BO Italy
Tel. +39 051 314 7011

Cobalt UHF Series Operator's Manual

For Models: UHF-CNTL-232/485/IND –02 EU
UHF-CNTL-232/485/IND –02 US

28/05/2009

COBALT UHF-SERIES

RFID CONTROLLERS

Ultra High Frequency, Multi Protocol, Passive Radio Frequency Identification Controllers

For Cobalt UHF-Series

RFID Controller Models:

- **UHF-CNTL-232-02**
- **UHF-CNTL-485-02**
- **UHF-CNTL-IND-02**

OPERATOR'S MANUAL

How to Install, Configure and

Operate the Cobalt UHF-Series

RFID Controllers

REGULATORY COMPLIANCE

FCC Compliance

Modifications or changes to this equipment without the expressed written approval of Datalogic could void the authority to use 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 received, including interference which may cause undesired operation.

FCC ID: E36-UHF-CNTL-02

Radio Compliance

ENGLISH

Contact the competent authority responsible for the management of radio frequency devices of your country to verify any possible restrictions or licenses required. Refer to the web site:

http://europa.eu.int/comm/enterprise/rtte/spectr.htm for further information.

ITALIANO

Prendi contatto con l'autorità competente per la gestione degli apparati a radio frequenza del tuo paese, per verificare eventuali restrizioni o licenze. Ulteriori informazioni sono disponibili sul sito:

http://europa.eu.int/comm/enterprise/rtte/spectr.htm.

FRANÇAIS

Contactez l'autorité compétente en la gestion des appareils à radio fréquence de votre pays pour vérifier d'éventuelles restrictions ou licences. Pour tout renseignement vous pouvez vous adresser au site web:

http://europa.eu.int/comm/enterprise/rtte/spectr.htm.

DEUTSCH

Wenden Sie sich an die für Radiofrequenzgeräte zuständige Behörde Ihres Landes, um zu prüfen ob es Einschränkungen gibt, oder eine Lizenz erforderlich ist. Weitere Informationen finden Sie auf der Web Seite:

http://europa.eu.int/comm/enterprise/rtte/spectr.htm.

ESPAÑOL

Contacta la autoridad competente para la gestión de los dispositivos de radio frecuencia de tu país, para verificar cualesquiera restricciones o licencias posibles requerida. Además se puede encontrar mas información en el sitio Web:

http://europa.eu.int/comm/enterprise/rtte/spectr.htm.

Power Supply

This product is intended to be installed by Qualified Personnel only.

This device is intended to be supplied by a UL Listed or CSA Certified Power Unit with «Class 2» or LPS power source.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: GETTING STARTED

1.1 INTRODUCTION

Welcome to the **Cobalt UHF-Series RFID Controllers - Operator's Manual**. This manual will assist you in the installation, configuration and operation of the Cobalt UHF RFID controllers.

The Cobalt UHF-Series is a complete line of feature-rich, passive, ultra high frequency, read/write Radio-Frequency Identification devices that provide RFID data collection and control solutions to shop floor, item-level tracking and material handling applications. Cobalt UHF controllers are designed to be compact, rugged and reliable, in order to meet and exceed the requirements of the industrial automation industry.

The Cobalt UHF is ideal for industrial applications where single or multiple tags must be read at long distance and at high speed.

1.1.1 About this Manual

This manual provides guidelines and instructions for installing and operating the Cobalt UHF-Series RFID Controllers. Included are descriptions of the RFID command set and examples demonstrating how to issue commands to the Cobalt RFID Controller.

Numbers expressed in Hexadecimal notation, are prefaced with "**0x**"**.** For example, the number **ten** in decimal is expressed as **0x0A** in hexadecimal. In case of need, the user should refer to a chart containing Hex values and their corresponding decimal integers.

1.2 Cobalt Controller Overview

1.2.1 Cobalt Controller Features

High performance, industrial RFID controller

Features long range, and high speed read/write rates

Supports RS232, RS485 or Ethernet interface connection

RFID Air Protocol: EPCglobal™ Class 1 Generation 2

Compatible with UHF-G2-525 and UHF-G2-525HT RFID tags from Escort Memory systems; compatible with all Class 1, Gen 2 RFID tags

Supports Escort Memory Systems' ABx Fast™ and CBx™ RFID command protocols

Operates at the internationally recognized ISM frequencies of 865-870 MHz (ETSI approved for European use) and of 902-928 MHz (FCC approved for North America use)

Housed in rugged IP65 rated enclosure

LED status indicators display power status, COM activity and RF activity,

Software programmable, contains flash memory for firmware upgrades and internal configuration storage

Long range antennas capable of reading EPCglobal Class 1 Gen2.

1.2.2 UHF Operating Frequencies Options

The Cobalt UHF-Series Controllers are available in two different operating frequency ranges:

865-870 MHz (ETSI approved for European use)

902-928 MHz (FCC approved for North America use)

Please refer to Appendix B - Models & Accessories for the corresponding Cobalt UHF Controller models.

1.2.3 Connection and Communication Interface Options

There are three different models of the Cobalt HF-Series RFID Controllers. Each model is designed to support a specific communication protocol and interface connection option. The table below lists the three controller models, their respective connection types and supported communication interfaces.

CONTROLLER MODEL	INTERFACE CONNECTION	COMMUNICATION INTERFACE	MAX CABLE LENGTH	MAX SPEED
UHF-CNTL-232-02	RS232	Serial, Point-to-Point, Host/Controller	15m	115 KB
UHF-CNTL-485-02	RS485	Multidrop (Subnet16) Bus Architecture	300m	115 KB
UHF-CNTL-IND-02	Ethernet	TCP/IP, Ethernet/IP, Modbus TCP	100m	100 Mb/s

Table 1-1: Connection and Communication Interface Options

1.2.4 Cobalt Controllers - Interface Connectors

CONTROLLER MODEL	INTERFACE CONNECTOR(S)	
UHF-CNTL-232-02	8-pin, Male M12 Connector for Power and Data	
UHF-CNTL-485-02	5-pin, male M12 Connector for Power and Data	
UHF-CNTL-IND-02 **(2 connectors)**	4-pin, Female M12, D-Code Connector for Ethernet	5-pin, Male M12 Connector for Power

Table 1-2: Cobalt Controllers - Interface Connectors

1.2.5 Package Contents

Unpack your Cobalt Controller hardware and accessories. Inspect each piece carefully, if an item appears to be damaged, notify your EMS' product distributor.

The Cobalt UHF Series RFID Controller product package contains the following components:

DESCRIPTION	QTY
Cobalt UHF-CNTL-xxx-02 RFID Controller	1
UHF-CNTL-xxx-02 Installation Guide	1
Cobalt UHF-Series Configuration Tag	1

Table 1-3: Package Contents

1.3 Cobalt Controller Dimensions

1.3.1 UHF-CNTL-232/485/IND-02 Controller Dimensions

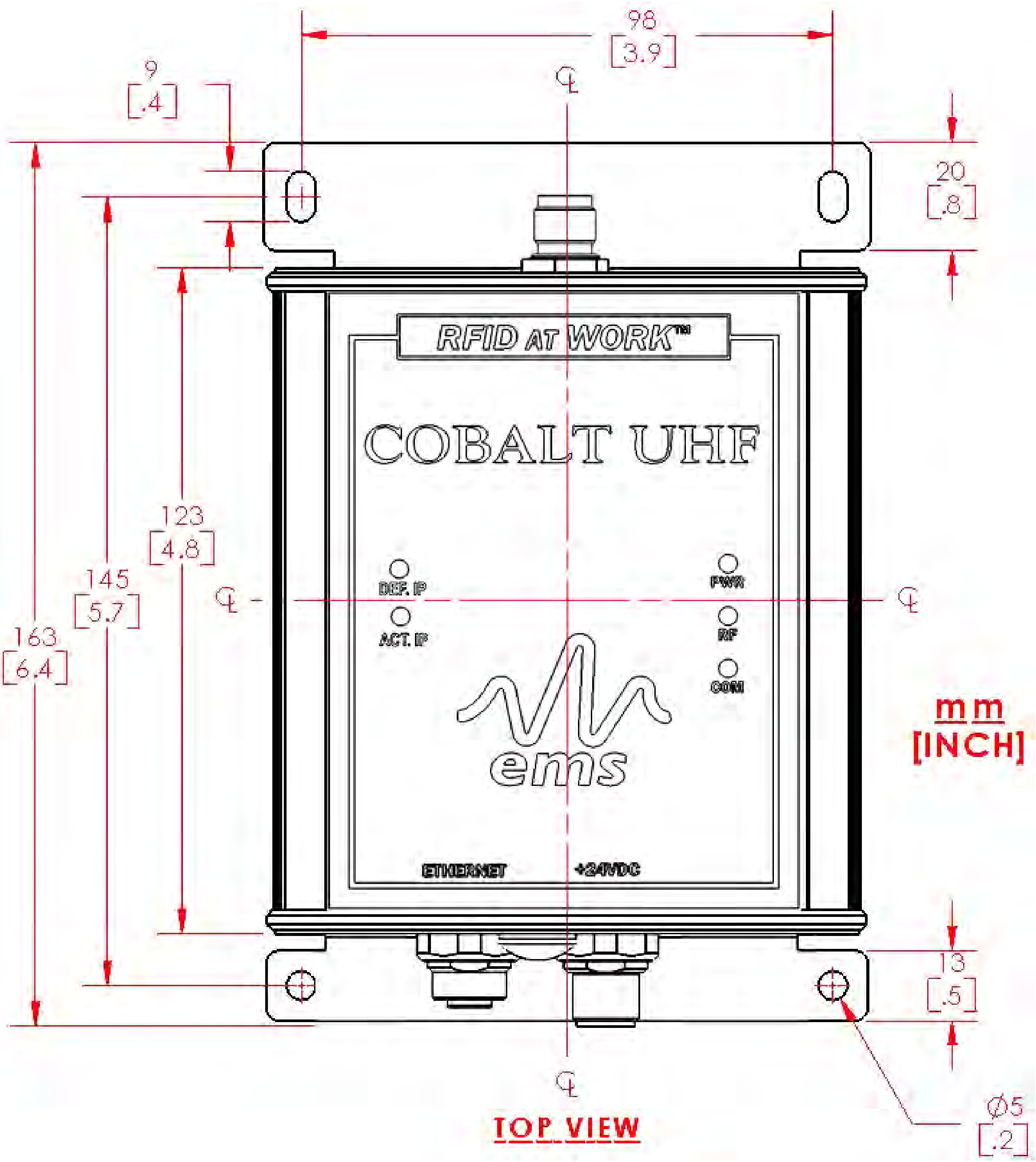


Figure 1-1: Cobalt UHF Controller Dimensions – Top View

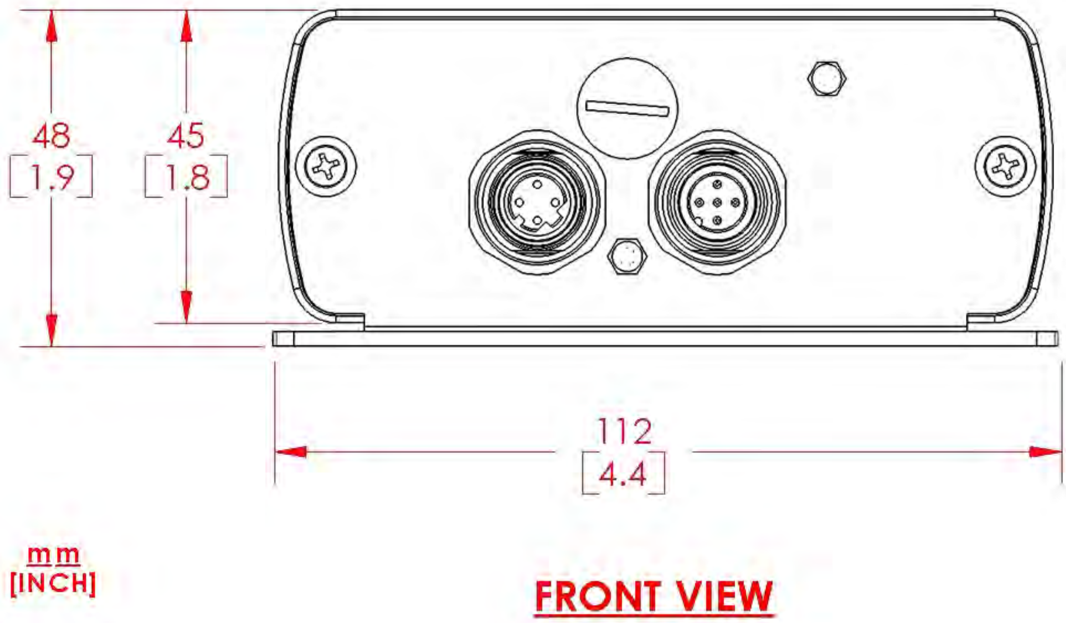


Figure 1-2: Cobalt UHF Controller Dimensions – Front View

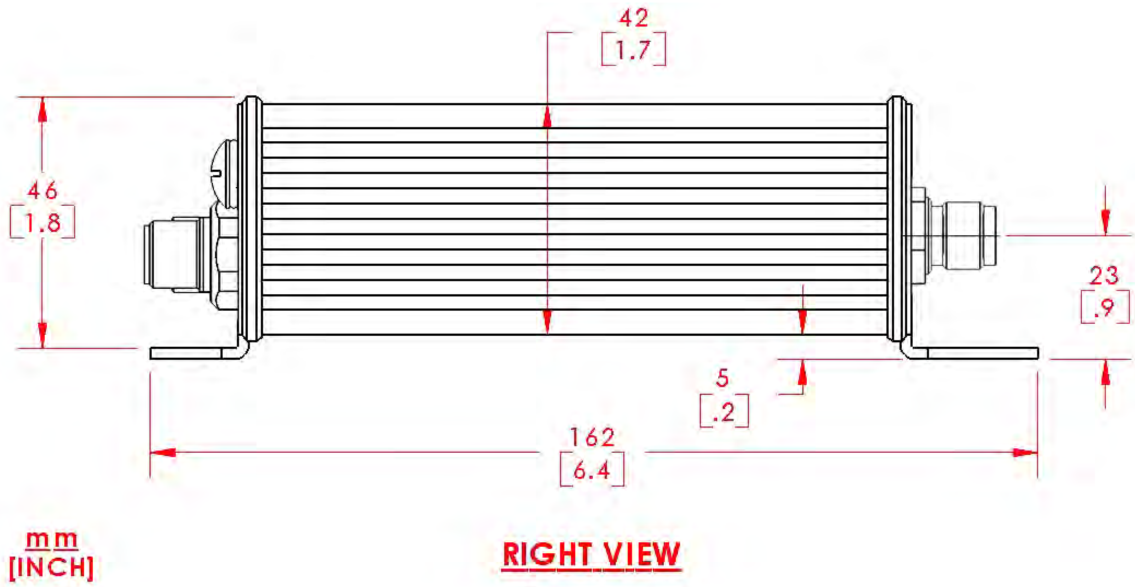


Figure 1-3: Cobalt UHF Controller Dimensions – Right View

1.4 Cobalt UHF RFID Antennas

1.4.1 Cobalt UHF RFID Antennas - Features

Long read range (up to 3 meters with the UHF-G2-525HT tag and depending on installation conditions)

Right-hand circular polarization ensures capturing tag data when tag is at random orientations

3dB Beamwidth, 63° or 65°, providing a large reading zone

Housed in rugged IP67 rated enclosure

Mounting kit for easy installation available

1.4.2 Cobalt UHF RFID Antennas - Models and Sizes

The Cobalt UHF product family includes two RFID antenna models:

UHF-ANT-2626-01-86 for operating frequencies in the 865-870 MHz UHF ranges

UHF-ANT-3030-01-91 for operating frequencies in the 902-928 MHz UHF ranges

Please refer to the table below for antennas' dimensions and part numbers:

ANTENNA MODEL	ANTENNA P/N	UHF FREQ	ANTENNA SIZE
UHF-ANT-2626-01-86	970669001	868MHz	260 x 260mm (*10.2 x 10.2 inch*)
UHF-ANT-3030-01-91	970665003	915MHz	305 x 305mm (*12 x 12 inch*)

Table 1-4: Cobalt UHF RFID Antennas - Models and Sizes

The two Cobalt UHF RFID Antennas are compatible with all Cobalt UHF-Series RFID Controller models (see Appendix B - Models & Accessories).

1.4.3 UHF-ANT-2626-01-86 Antenna Dimensions

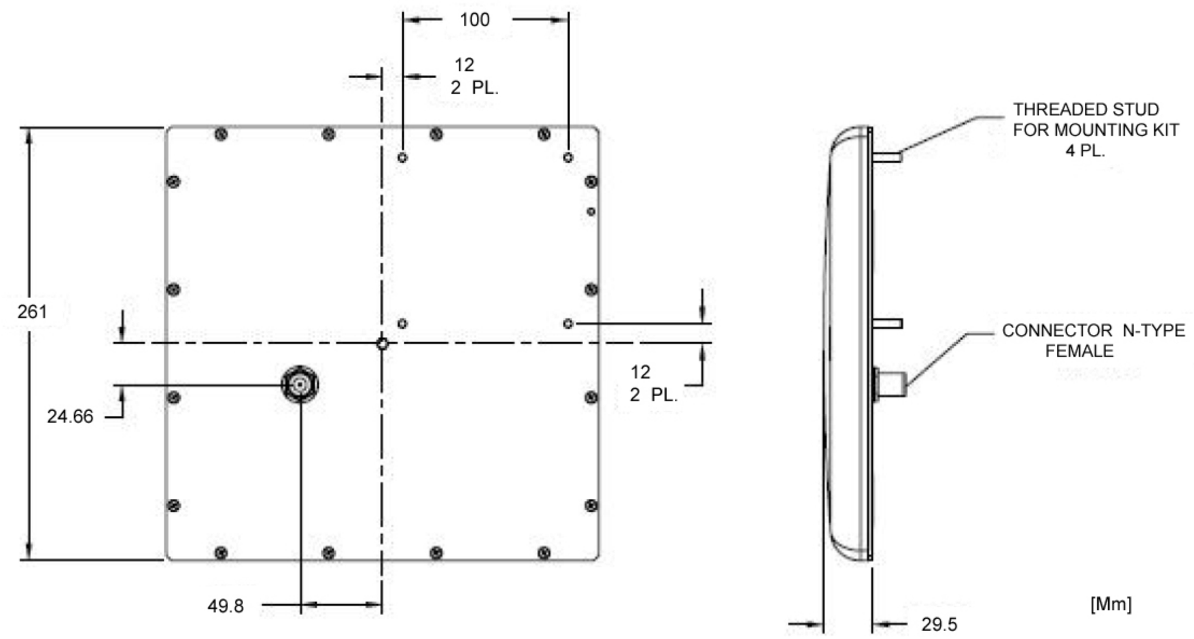


Figure 1-4: UHF-ANT-2626-01-86 Antenna Dimensions

1.4.4 UHF-ANT-3030-01-91 Antenna Dimensions

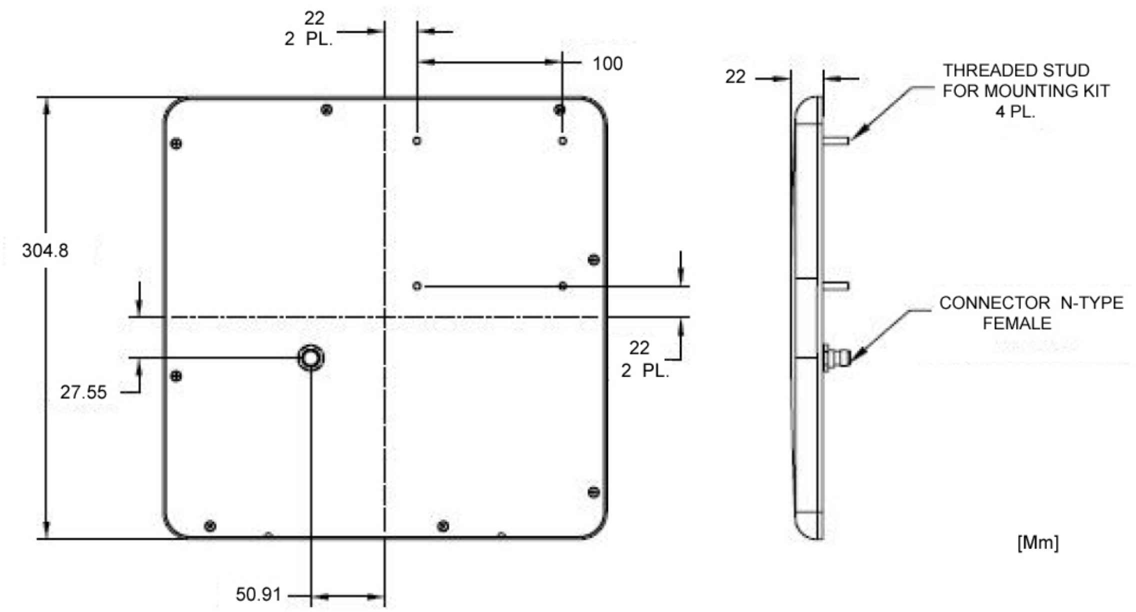


Figure 1-5: UHF-ANT-3030-01-91 Antenna Dimensions

1.4.5 Connecting the Antenna to the Controller

The Cobalt UHF Antennas are connected to the top of the Cobalt UHF-Series RFID Controller's housing through a single coaxial cable.

Figure 1-6: Connecting the Antenna to the Controller

The Cobalt UHF antenna has one **female, N-type connector** located on its rear side.

The Cobalt UHF Controller has one **TNC-Reverse female connector** located on the top of the Controller's housing.

The RF port on the Cobalt UHF controller connects directly to the RF port on the Cobalt UHF antenna via a compatible antenna feeder cable (see *Table 1-6* below for cabling information).

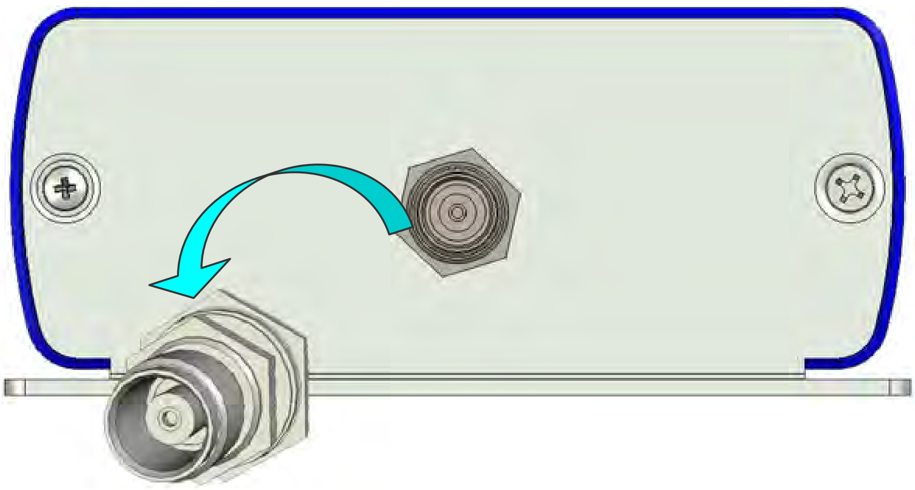


Figure 1-7: TNC-Reverse Female Connector for Antenna Feeding

For cabling part numbers and descriptions, please refer to the table below:

CABLE MODEL	CABLING P/N	DESCRIPTION
UHF-CBL-01	970106002	Coaxial Cable Controller-Antenna, TNC-Reverse Male to N-Type Male, 1 meter
UHF-CBL-03	970106003	Coaxial Cable Controller-Antenna, TNC-Reverse Male to N-Type Male, 3 meters

Table 1-5: Controller-Antenna Cabling Information

Figure 1-8: UHF-CBL-0X - Controller-Antenna Coaxial Cable

To connect the Cobalt UHF controller to the antenna, follow the steps below:

- Attach the TNC-Reverse male plug of the controller-antenna coaxial cable to the TNC- Reverse female connector located on the top of the controller's housing.
- Attach the N-type male plug of the coaxial cable to the N-type female connector located in the rear of the antenna's body.

1.4.6 Optional Mounting Kit for Antenna Installation

Industrial environments where UHF RFID applications are used often entail specific installation requirements.

The Cobalt UHF Antenna can take advantage of an optional mounting set, providing an easy and solid installation (***P/N: 970103035, Mounting Kit for large size UHF Antennas***).

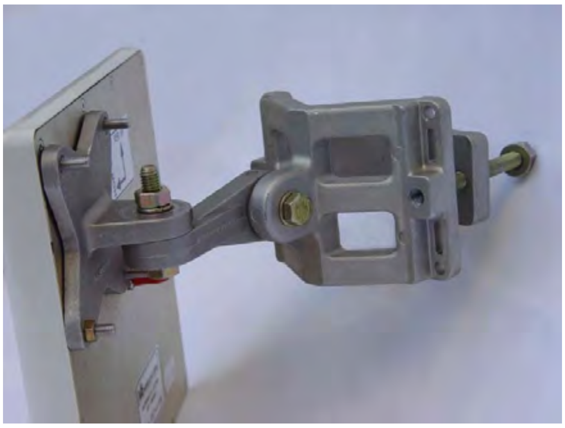


Figure 1-9:Optional Mounting Kit for Antennas

1.5 SUBNET16™ MULTIDROP PROTOCOL

The ***UHF-CNTL-485-02*** model includes support for Escort Memory Systems' ***Subnet16™*** Multidrop RFID networking protocol. Under the Subnet16 protocol, up to 16 UHF-CNTL-485-02 controllers can be connected via a trunk and tap network to a Subnet16 Industrial Gateway (*GWY-01-IND-1*), a Subnet16 TCP/IP Gateway (*GWY-01-TCP-01*) or a Subnet16 Serial Gateway (*GWY-01-232-1)*.

UHF-CNTL-485-02 models can also be connected directly to a Subnet16 Industrial Hub (*HUB-04-IND-01*) or Subnet16 TCP/IP Hub (*HUB-04-TCP-01*). Subnet16 Hubs possess four independent controller ports, four digital inputs and four digital outputs.

Figure 1-10: Subnet16™ Industrial Gateway and Industrial Hub

CHAPTER 2: INSTALLING THE COBALT UHF

2.1 PREPARING FOR INSTALLATION

The Cobalt UHF-Series RFID Controllers support point-to-point serial connections (RS232 and RS485), multi-drop network connections (via Subnet16™ Gateway or Hub) and Ethernet connections (TCP/IP, Ethernet/IP, Modbus TCP).

NOTE: Up to 16 UHF-CNTL-485-02 units can be networked via Subnet16 Gateway interface module and Escort Memory Systems' Subnet16 Multidrop Bus Architecture.

2.1.1 Power Requirements

The Cobalt UHF Controller requires an electrical supply voltage of ***10~30VDC*** (see *Appendix A: Technical Specifications*).
Use a dedicated and regulated power supply connected to a suitable AC power source that is capable of delivering these requirements. Do not apply power until the entire system is wired and checked.
See *Appendix B: Models & Accessories – Power Supplies* for a list of available power supplies.

2.1.2 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 and liquids (for further information, refer to *Section 9.2.2 "UHF Signal Propagation"*). Avoid mounting the Cobalt antenna within 15cm (6 inches) of any metallic object or wet surface.
- If electrical interference is encountered (as indicated by a reduction in read/write performance), relocate the controller/antenna 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.
- Always use adequate electro-static discharge (ESD) prevention measures to dissipate potentially high voltages.
- Refrain from mounting the controller/antenna near sources of EMI (electro-magnetic interference) or near devices that generate high ESD levels.

2.2 Installing the UHF-CNTL-232-02

The ***UHF-CNTL-232-02*** 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 serial interface cable.

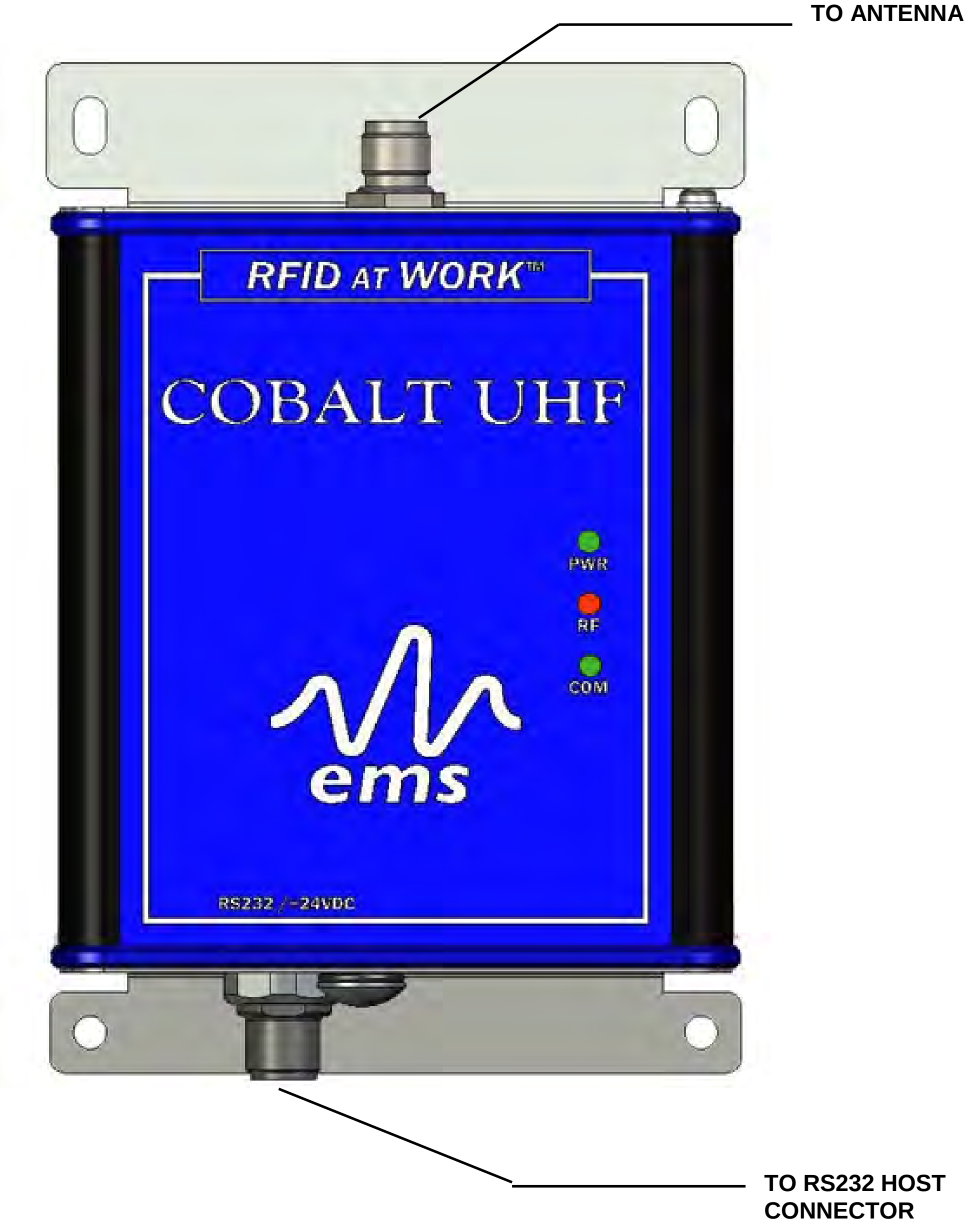


Figure 2-1: UHF-CNTL-232-02 Communication Interfaces

2.2.1 Steps to Install the UHF-CNTL-232-02

1. Select a suitable location for the Cobalt UHF Controller/Antenna.
2. Attach the Cobalt UHF Antenna to the Cobalt UHF Controller, as described in Section 1.4.5 "Connecting the Antenna to the Controller".
3. Fasten the combined controller and antenna to your mounting fixture using two ***M5 (#10)*** diameter screws (*not included*) and secure them with appropriate washers and nuts. Tighten screws to ***1.7 Nm or 15 lbs per inch ± 10%***.
4. Connect the 8-pin, female M12 connector from an RS232-compatible serial interface cable (***EMS P/N: CBL-1478)*** to the 8-pin, male M12 interface connector on the Cobalt UHF-CNTL-232-02.
5. Connect the 9-pin, female D-sub connector on the serial interface cable to a COM port on a host computer. Tighten the cable's two locking thumbscrews.
6. 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.
7. Plug the power supply transformer into a suitable AC power source. Apply power to the controller after all cable connections have been made. The green *PWR (power) LED* will remain ON while the Cobalt is powered.
8. On the host computer, set COM port parameters to the following values:

COM PORT PARAMETER	DEFAULT VALUE
Baud Rate	**9600***
Parity	**None**
Data Bits	**8**
Stop Bits	**1**
Handshaking	**None**

Table 2-1: COM Port Parameter Defaults (UHF-CNTL-232-02)

**Supported baud rates include 9600, 19.2k, 38.4k, 57.6k, and 115.2k.*

9. To verify operations, download the ***Cobalt Dashboard Utility*** from Escort Memory Systems' website (www.ems-rfid.com). The *Cobalt Dashboard Utility* allows users to configure their Cobalt UHF Controllers and send RFID commands for testing purposes. Please refer to Section 3.1 "Configuring the Cobalt via Dashboard Utility" for some generic Cobalt UHF configuration examples.

2.2.2 UHF-CNTL-232-02 Cabling Information

The UHF-CNTL-232-02 has one **8-pin, male M12 RS232 connector** located on the bottom of the Controller's housing.

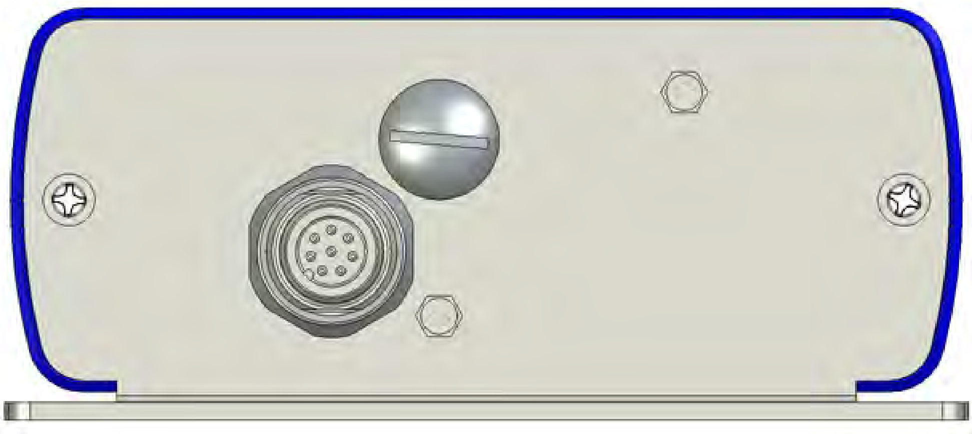
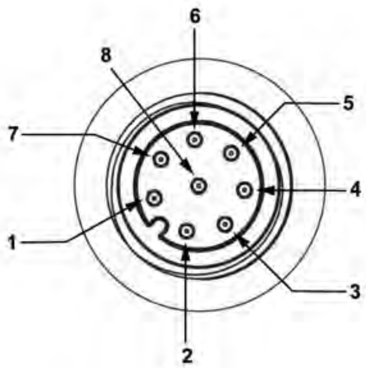


Figure 2-2: UHF-CNTL-232-02 Controller - RS232 Connector



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 2-2: RS232 Connector - Pinout

UHF-CNTL-232-02 CABLING PART NUMBERS

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*).

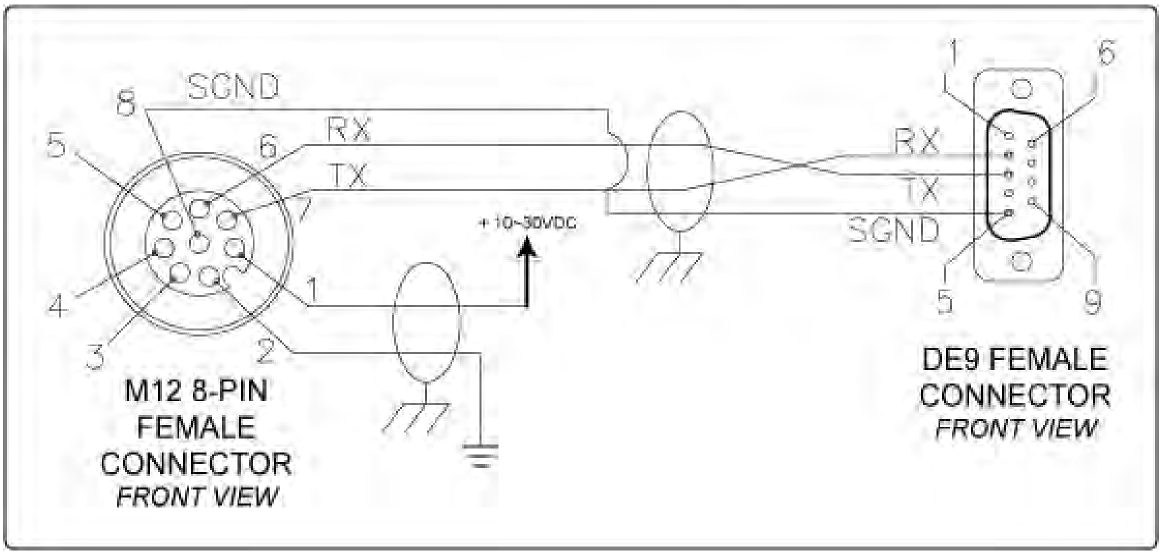


Figure 2-3: RS232 Serial Interface Cable – Schematic

CBL-1493: Field Mountable Connector

Figure 2-4: CBL-1493 Mountable Connector

The ***CBL-1493*** field mountable connector is available for attaching the UHF-CNTL-232-02 model to a host computer via bulk cable. See Appendix B: Cobalt Cables and Accessories for more information regarding cables and connectors for the entire line of Cobalt UHF RFID Controllers.

2.3 Installing the UHF-CNTL-485-02

The UHF-CNTL-485-02 RFID Controller supports RS485 communications and Escort Memory Systems' ***Subnet16™*** multi-drop bus architecture and RFID network protocol.

Through the Subnet16 protocol, up to 16 UHF-CNTL-485-02 units can be connected to one Subnet16 Gateway and four UHF-CNTL-485-02 units can be connected to one Hub interface module. Subnet16 Gateways and Hubs assign each attached controller a unique Node ID number through which communication with a host computer and/or Programmable Logic Controller (PLC) is achieved.

For applications that require multiple UHF-CNTL-485-02 controllers, install and configure each device one at a time.

Figure 2-5: UHF-CNTL-485-02 Communication Interfaces

2.3.1 Steps to Install the UHF-CNTL-485-02

1. Select a suitable location for the Cobalt UHF Controller/Antenna.
2. Attach the Cobalt UHF Antenna to the Cobalt UHF Controller, as described in *Section 1.4.5 "Connecting the Antenna to the Controller".*
3. Fasten the combined controller and antenna to your mounting fixture using two M5 (#10) diameter screws (not included) and secure them with appropriate washers and nuts. Tighten screws to 1.7 Nm or 15 lbs per inch ± 10%.
4. Connect the 5-pin, female end of an EMS approved Subnet16-compatible cable to the 5-pin, male M12 interface connector on the UHF-CNTL-485-02. Connect the opposite end of this cable to a Subnet16 Gateway or Subnet16 Hub network interface module. Connect the Gateway or Hub to your host computer via CAT5E Ethernet cabling.*.
5. The UHF-CNTL-485-02 will require 10~30VDC (see *Appendix A: Technical Specifications*) from the network or interface module to which it is connected.Utilize a regulated power supply for the controller that is capable of delivering these requirements.
6. Turn the power supply ON. The green PWR (power) LED on the unit will illuminate when power is applied to the unit and remain ON while the Cobalt is powered.
7. After installation is complete (see also *Sections 3.3.2* and *3.3.3*), the yellow Node ID LEDs will display the currently assigned Subnet16 Node ID (in binary). Note: the Cobalt's default Node ID is Node 00; in which case none of the yellow Node ID LEDs will be lit.
8. To verify operations, download the Cobalt Dashboard Utility from Escort Memory Systems' website (www.ems-rfid.com). The Cobalt Dashboard Utility allows users to configure their Cobalt UHF Controllers and send RFID commands for testing purposes. Please refer to *Section 3.1 "Configuring the Cobalt via Dashboard Utility"* for some generic Cobalt UHF configuration examples.

* 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 UHF-CNTL-485-02 Cabling Information

The UHF-CNTL-485-02 has one **5-pin, male M12 RS485 connector** located on the bottom of the Controller's housing.

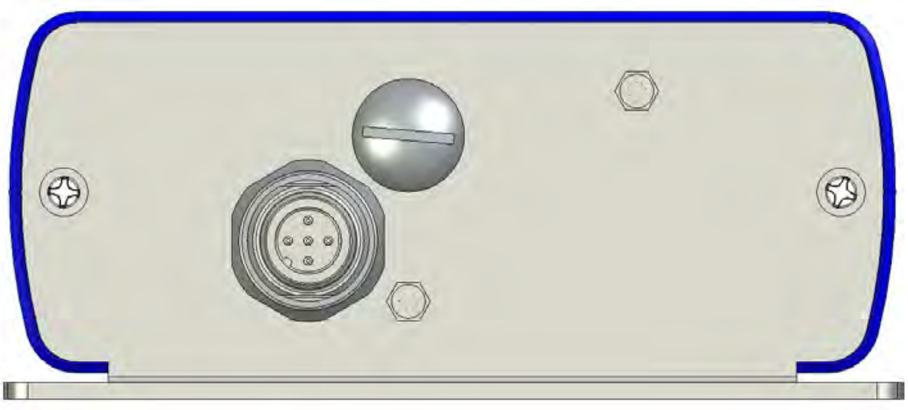
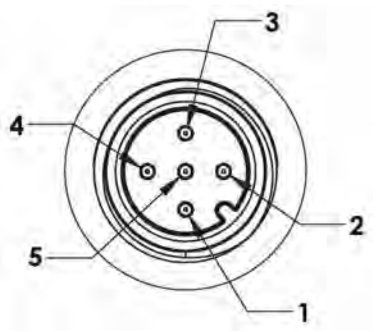


Figure 2-6: UHF-CNTL-485-02 Controller - RS485 Connector



PIN #	DESCRIPTION
1	SIGNAL GND
2	10~30VDC PWR
3	0V (POWER GND)
4	Tx/Rx+
5	Tx/Rx-

Table 2-3: RS485 Connector – Pinout

UHF-CNTL-485-02 Cabling Part Numbers

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)

(*XX = Cable Length in Meters*)

2.4 INSTALLING THE UHF-CNTL-IND-02

The UHF-CNTL-IND-02 RFID Controller supports TCP/IP and Industrial Ethernet communications. The UHF-CNTL-IND-02 can be connected to a LAN or Programmable Logic Controller (PLC) via CAT5E Ethernet cabling or it can be connected directly to a host computer by means of a standard Ethernet crossover cable.

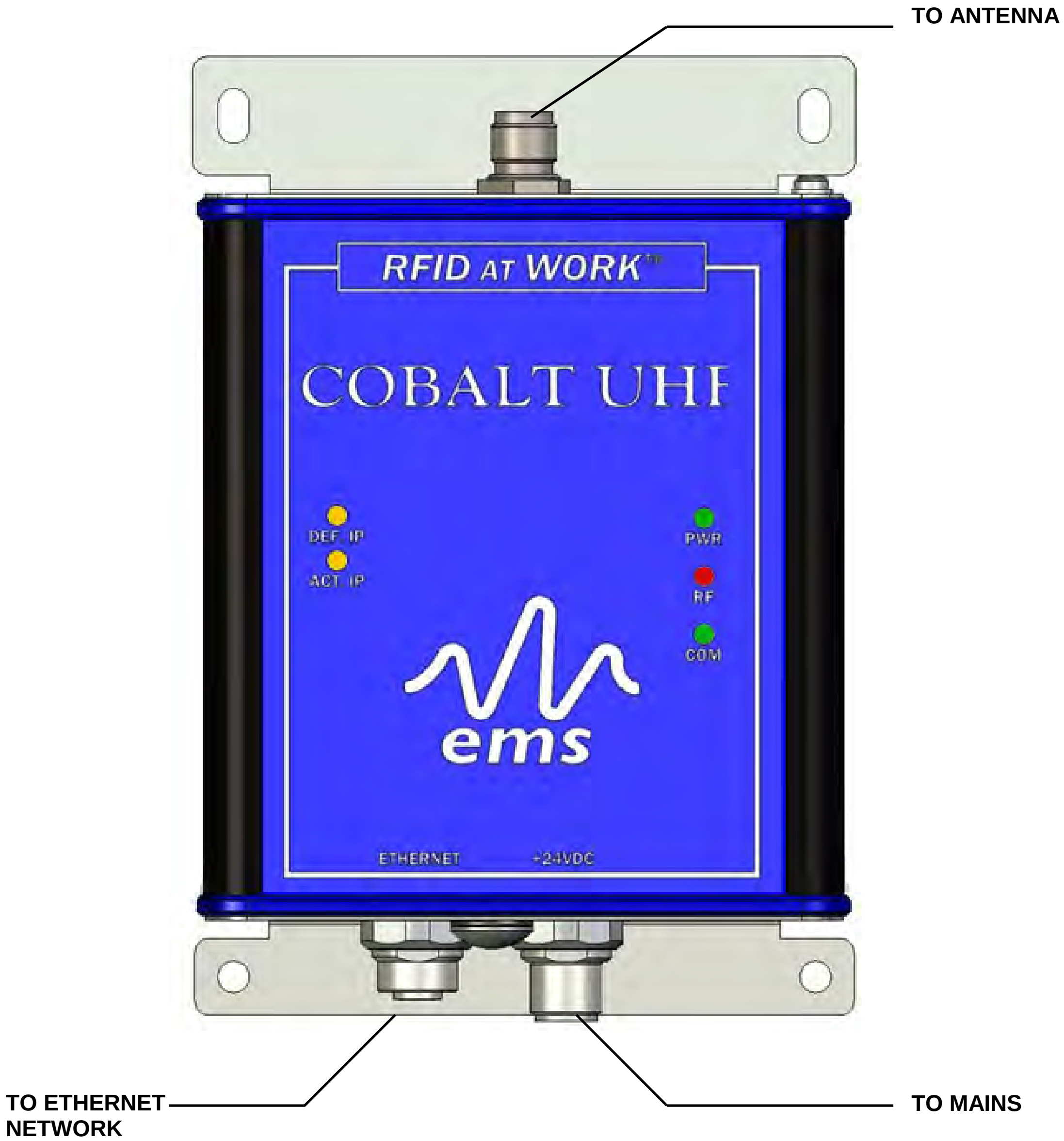


Figure 2-7: UHF-CNTL-IND-02 Communication Interfaces

2.4.1 Steps to Install the UHF-CNTL-IND-02

1. Select a suitable location for the Cobalt UHF Controller/Antenna.
2. Attach the Cobalt UHF Antenna to the Cobalt UHF Controller, as described in *Section 1.4.5 "Connecting the Antenna to the Controller".*
3. Fasten the combined controller and antenna to your mounting fixture using two M5 (#10) diameter screws (not included) and secure them with appropriate washers and nuts. Tighten screws to 1.7 Nm or 15 lbs per inch ± 10%.
4. Connect the three wires from your power supply to pins 1-3 on the 5-pin, female, M12 connector (P/N: CBL-1487).
5. Attach the CBL-1487 connector to the 5-pin, male, M12 connector on the Cobalt Controller.
6. Attach the 4-pin, male, M12, D-Code connector from a CAT 5E (or better) industrial Ethernet cable (P/N: CBL-1515-05) to the 4-pin, female, M12, D-Code connector on the Cobalt Controller.
7. Connect the other RJ45S end of the CBL-1515-05 cable to your application network or LAN. A crossover cable may be required if you are connecting the Cobalt directly to a host computer (rather than to a switch, hub or router).
8. Turn the power supply ON. The green Power LED on the unit will illuminate.
9. After installation is complete, the amber Default IP LED will be lit when the controller is operating using its default IP address. The amber Actual IP LED will be lit when the controller is operating with a user assigned IP address.

UHF-CNTL-IND-02 Default IP Address:

192.168.253.110

10. To verify operations, download the Cobalt Dashboard Utility from Escort Memory Systems' website (www.ems-rfid.com). The Cobalt Dashboard Utility allows users to configure their Cobalt UHF Controllers and send RFID commands for testing purposes. Please refer to *Section 3.1 "Configuring the Cobalt via Dashboard Utility"* for some generic Cobalt UHF configuration examples.

2.4.2 UHF-CNTL-IND-02 Cabling Information

The UHF-CNTL-IND-02 includes:

- a **4-pin, female M12, D-code connector** for Ethernet communication
- a **5-pin, male M12 connector** for power.

These connectors are located on the bottom of the Controller's housing.

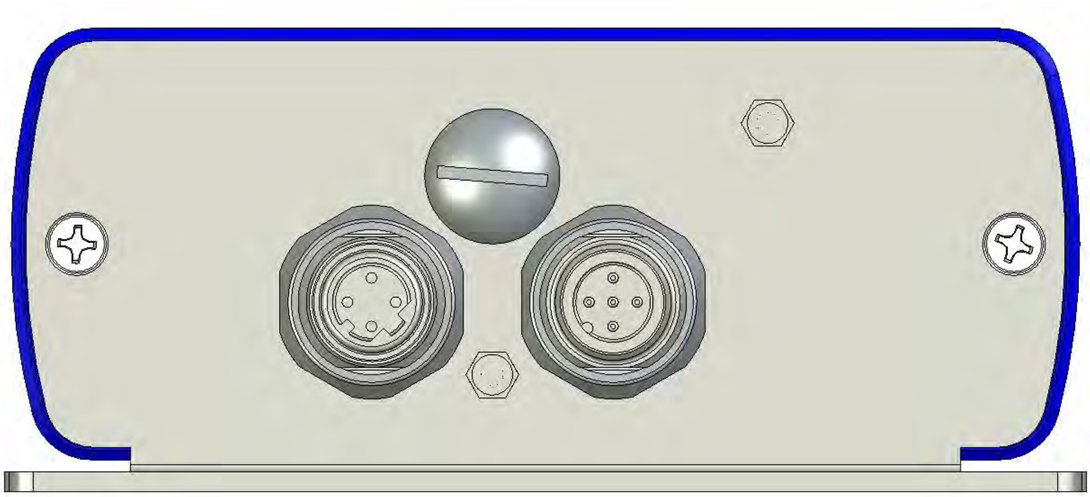
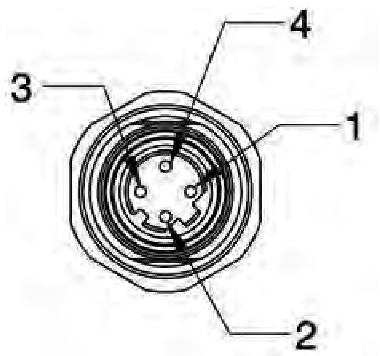
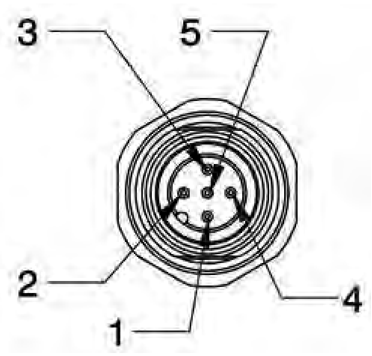


Figure 2-8: UHF-CNTL-IND-02 Controller - Ethernet & Power Connectors



PIN #	DESCRIPTION
1	TX+
2	RX+
3	TX-
4	RX-

Table 2-4: Ethernet Connector - Pinout



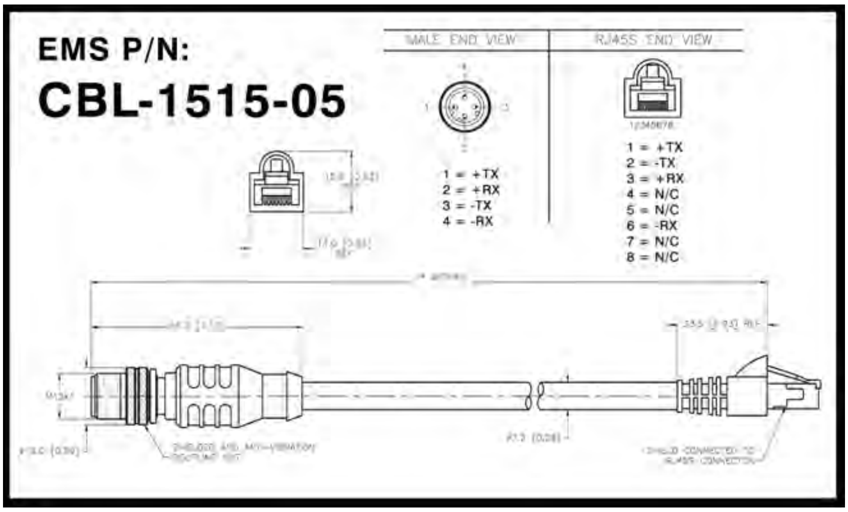
PIN #	DESCRIPTION
1	NOT CONNECTED
2	10~30VDC POWER
3	0VDC (POWER GROUND)
4	NOT CONNECTED
5	NOT CONNECTED

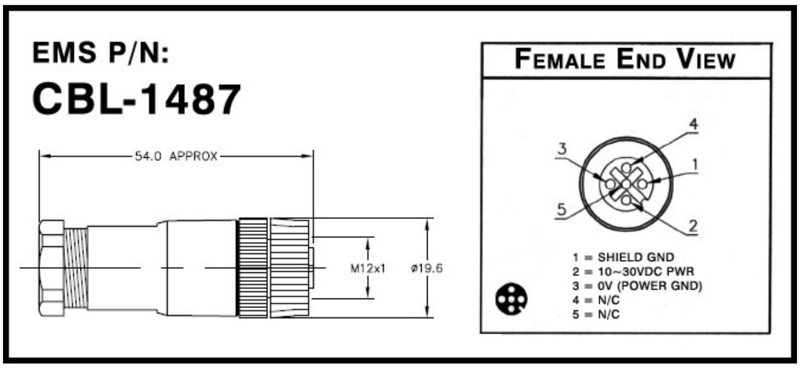
Table 2-5: Power Connector - Pinout

UHF-CNTL-IND-02 Cabling Part Numbers

CBL-1515-05: Cable Assembly (CAT5E, RJ45S to 4-pin, male M12, D- Code, 5m)

CBL-1487: Field Mountable Connector (5-pos, female M12)





CHAPTER 3: CONFIGURING THE COBALT UHF

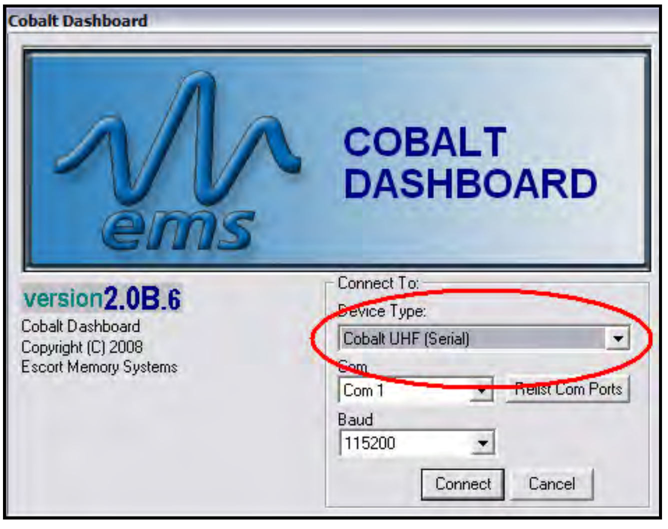
Stored in the Cobalt's flash memory is a group of settings, attributes and parameters known as the "***Controller Configuration***." These parameters are related to the communication protocol and operating mode.
The controller configuration can be modified by using Escort Memory Systems' ***Cobalt Dashboard Utility*** (which can be downloaded from www.ems-rfid.com) or through the use of a ***Cobalt UHF Configuration Tag*** (included with each Cobalt Controller).

3.1 Configuring the Cobalt via Dashboard Utility

The ***Cobalt Dashboard Utility*** is a software application that allows users to view, modify, save and update the configuration settings of their Cobalt controllers.

Download the Cobalt Dashboard from www.ems-rfid.com and follow the instructions included with the software to install and operate the utility and to set the controller's configuration.

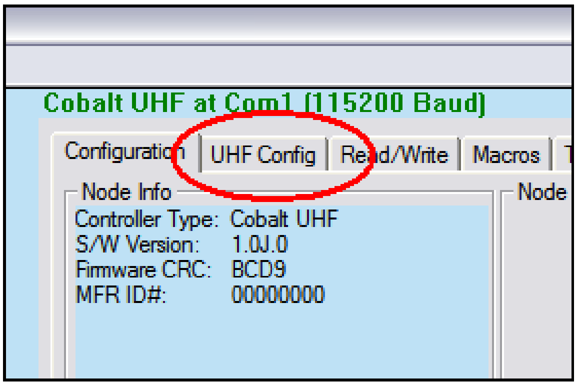
The Cobalt Dashboard configuration utility is a general purpose software that can be used with all the Cobalt family devices, including HF controllers and Gateways. To use it with the UHF Series Controller you need to properly select the model at startup. For example, in this case the Cobalt UHF Serial controller is selected:



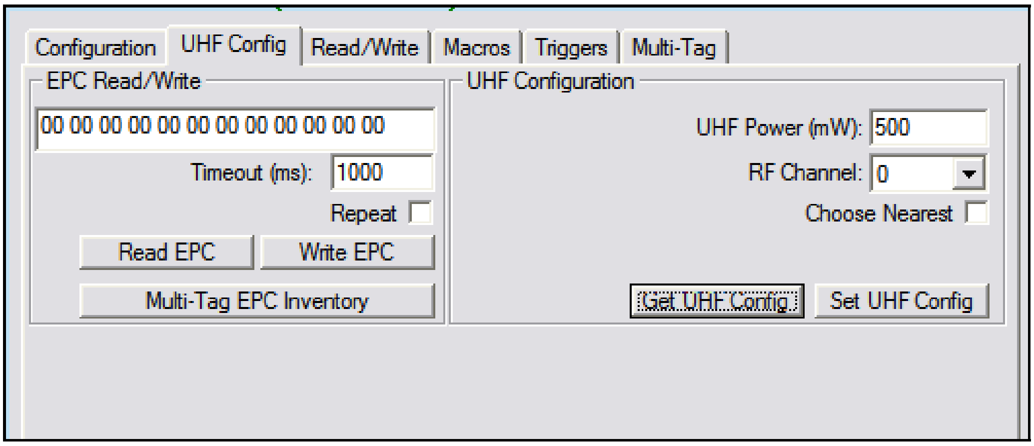
Once the connection is established, you will see the normal startup screen of the Dashboard utility. For more information on the Dashboard please see the manual that you can find on the web site.

COBALT UHF CONFIGURATION EXAMPLE: UHF CONFIGURATION TAB

One of the five different tabs shown in the Dashboard's main display is the *UHF Configuration Tab*.



This tab contains two different sections: *EPC Read/Write* and *UHF Configuration Section.* These sections provide configuration details and contains parameter options related to the UHF controller's specific features.



In the *EPC Read/Write* section, for instance, users can read and write the EPC portion of the UHF tags and also do an inventory of the ECP codes of all the tags in the field of the reader. Setting the Repeat option will make the Dashboard continuously sending the same command.

The *UHF Configuration* section allows users to set configuration parameters which are specific to the UHF controller, namely:

- *UHF Power,* representing the RF power in mW emitted during the communication with tags
- *RF Channel,* a 2-bytes value in the range 0-9 representing the RF channel to use (this has a meaning only on the EU frequency reader)

- *Choose Nearest,* Instruct the reader to return only the information of the tag with the stronger signal, which can be assumed is the "nearest" in space, even if in real world condition this might be not always true.

Furthermore, users may retrieve or set the desired UHF configuration settings by clicking on the buttons "*Get UHF Config"* and "*Set UHF Config*".

3.2 Note About the Reader Power

The performance of a UHF reader depends on the ***radiated*** power, not simply on the reader output power that can be set with the above parameter. The radiated power depends on the reader output power, the cable attenuation and the antenna gain. The radiated power limits are set by the different governments (see table below for details).

REGION	REGULATIONS	RADIATED POWER
USA	FCC Part 15	4 W EIRP (36 dBm)
Europe	EN 302 208	2 W ERP (35 dBm)

Table 3-1:Reader Radiated Power Limits

The UHF-CNTL-XXX-02 controllers produce up to 500 mW output power.

Example of a calculation:

Radiated Power = Reader Power + Antenna Gain – Cable Losses

500 mW (27dBm) + 6.85 dBi - 1.5dBm = 32.35 dBm (~1.7 W ERP)

3.3 Configuring The Cobalt via "Configuration Tag"

As noted, the Cobalt UHF controllers are software configurable via the *Cobalt Dashboard Utility*. However, they can also be configured through the use of the ***Cobalt UHF Configuration Tag*** supplied with each unit.

The Configuration Tag can be used to restore the factory default values for all versions of the Cobalt UHF RFID Controller.

3.3.1 Restoring Factory Defaults

1. Place the Configuration Tag in the antenna's RF field.
2. Cycle power to the controller or issue the "*Reset Controller*" command (*Command 0x35*).
   As power returns to the unit, the LEDs will blink.
3. After the LEDs blink, remove the Configuration Tag from the antenna's RF field.
   Factory default values have been restored.

The following factory default values will be restored on the controller:

CONFIGURATION PARAMETER	FACTORY DEFAULT VALUE
Continuous Read Mode	Disabled
Macros and Triggers	Erased
UHF Power **RF channel** **Choose Nearest**	500 mW 0 Disabled
RS232 - Serial Communications **RS485 - Node ID** **IND – TCP/IP Address**	9600, N, 8, 1, N 0 192.168.253.110

Table 3-2: Configuration Tag – Restored Factory Defaults

3.3.2 Manually Assigning Node ID (Cobalt -485 Model Only)

On the UHF-CNTL-485-02, the five amber Node LEDs display (in binary notation) the numerical Node ID value of the controller. For example, if Node LEDs 1, 2 and 8 are ON, the controller has been assigned Node ID 11.

Follow the steps below to assign a Node ID value manually to an UHF-CNTL-485-02.

1. Place the Configuration Tag in the antenna's RF field.
2. Cycle power to the controller or issue the "*Reset Controller*" command (*Command 0x35 for ABx Fast, Command 0x54 for CBx*).
   As power returns to the unit, the LEDs will blink.
3. Remove the Configuration Tag from the antenna's RF field and then immediately place it back within antenna range. Verify that all five amber Node LEDs are OFF (indicating that the controller's Node ID was reset to zero).
4. With all amber Node LEDs OFF, remove the Configuration Tag from the antenna's RF field and then immediately place it back in the antenna's RF field to increment the Node ID value by one (from *Node ID 00 to 01*, in this case). The lone amber Node 1 LED will illuminate to indicate that Node 01 is selected.
5. You may repeat Step 4 until the desired Node ID number is reached. The value is incremented by one each time a Configuration Tag is withdrawn from and re-introduced to the Cobalt HF Antenna's RF field. This procedure can be used to cycle through all 16 possible Node ID values. Note that after reaching Node ID 16, incrementing the value once more returns the selected Node ID number to zero.
6. After setting the desired Node ID, remove the Configuration Tag from the RF field and allow approximately 10 seconds for the unit to reset and resume operation under its new Node ID value.

3.3.3 Automatic Node ID Assignment via Gateway (Cobalt -485 Model Only)

For multi-drop network configurations (where up to 16 Cobalt UHF-CNTL-485-02 controllers are connected via one *Subnet16 Gateway* interface module), a Gateway module can be instructed, through the use of a Configuration Tag, to automatically assign each controller a separate Node ID number (between 1 and 16).

However, before the Gateway can begin allocating Node IDs automatically, each UHF-CNTL-485-02 controller must first be restored to factory default values. In doing so, the Cobalt's Node ID number will be reset to zero.

Note that, by default, the Cobalt UHF-CNTL-485-02 controller ships pre-configured to Node ID 00. Therefore, if your Cobalt is brand new, it should already be set to Node ID 00. If it has previously been assigned another Node ID number, you will likely need to reset its Node ID value to zero (see Section 3.2.1 – Restoring Factory Defaults for instructions on resetting the controller's Node ID to 00).

When automatically assigning a Node ID to a new Cobalt Controller, the Gateway will normally issue the next available Node ID value.

The Gateway can also assign a new controller the same Node ID and configuration settings of a previous Cobalt controller that has since disappeared from the network or has been determined to be offline. Therefore, if a controller becomes damaged and must be quickly replaced, a new Cobalt controller can be installed easily in its place, allowing the Gateway to assign the new controller the same Node ID and controller configuration settings as the recently replaced controller.

ATTENTION: Connect and configure only one RFID controller at a time. Conflicts can occur when multiple controllers set to the same Node ID are simultaneously attached to a multi-drop network. You may, however, leave connected any controller once it has been has successfully assigned a Node ID by the Gateway.

Baud rates for all controllers must be set to 9600

Follow the steps below to assign the Cobalt -485 controller a Node ID automatically via a Subnet16 Gateway.

1. Place a Configuration Tag within the Cobalt Antenna's RF field.
2. Cycle power to the controller or issue the "*Reset Controller*" command (Command 0x35 for ABx Fast, Command 0x54 for CBx).
   As power returns to the unit, the LEDs will blink.
3. After the LEDs blink, remove the Configuration Tag from the antenna's RF field and then immediately place it back within range. Confirm that all five amber Node LEDs are OFF (indicating that the controller's Node ID is set to zero) then remove the tag from RF range.
4. Cycle power once again to the Cobalt (or issue the *Reset Controller* command). While the Cobalt is restarting, place the Configuration Tag back within the antenna's RF field. Allow 10 seconds for the Gateway to recognize and assign the controller an available Node ID number, then remove the Configuration Tag from RF range. Check the five amber Node LEDs to determine the assigned Node ID.

3.3.4 Automatic Node ID Assignment via Hub (Cobalt -485 Model Only)

Subnet16 Hub interface modules, which have four independent RFID controller ports, can automatically assign an attached UHF-CNTL-485-02 controller the corresponding Node ID number of the port to which it is connected.

For example, if a controller is attached to port 1 on the Hub, it will be assigned Node ID 01. If a controller that was previously assigned Node ID 03 is connected to port 2, the Hub will override the controller's internal configuration and automatically change it from Node ID 03 to 02.

Follow the steps below to assign the Node ID automatically to an RFID controller via Subnet16 Hub:

1. Connect an UHF-CNTL-485-02 to controller port 1 on a Subnet16 Hub.
2. Place the Configuration Tag within the antenna's RF field and cycle power to the UHF-CNTL-485-02 controller.
3. When power returns to the unit, the LEDs on the controller will blink. Remove the Configuration Tag from RF range and then immediately place it back within antenna range. Verify that all five amber Node LEDs are OFF (indicating that the controller's Node ID has been reset to zero). Then remove the Configuration Tag from RF range and cycle power to the Hub module.
4. While the Hub is restarting, place the Configuration Tag back into the antenna's RF field. Allow several seconds for the Hub to recognize the controller and assign it the corresponding Node ID number of the controller port to which it is attached. The amber Node LEDs on the Cobalt will display its assigned Node ID (between one and four) in binary format. Remove the Configuration Tag from RF range.

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

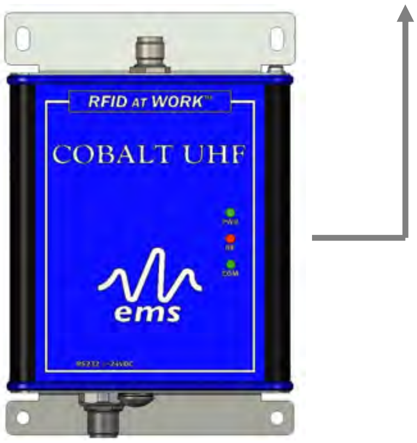
CHAPTER 4: LED STATUS

4.1 LED FUNCTIONS OVERVIEW

4.1.1 LED Behavior for Cobalt UHF-CNTL-232-02

Cobalt UHF-232 RFID Controller has **three** LED indicators conveniently located on the front of the device, that convey visual information to the operator.

LED FUNCTION	PWR Power On	RF Activity	COM Activity
LED COLOR	Green	Red	Green



LEDs Description

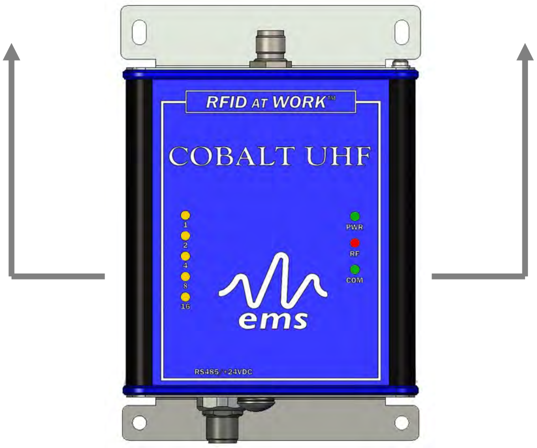
LED COLOR		NAME	LED DESCRIPTION
	RED	RF	The RF LED illuminates when RF power is being transmitted by the antenna.
	GREEN	COM	The COM (communications) LED flashes ON and OFF when data is being transmitted between the antenna and a tag. When in Continuous Read mode, the COM LED will remain ON and will turn OFF briefly only while data is being read from or written to a tag.
	GREEN	PWR	The PWR (power) LED is ON whenever power is applied to the Cobalt.

Table 4-1: UHF-CNTL-232-02 - LEDs Description

4.1.2 LED Behavior for Cobalt UHF-CNTL-485-02

The Cobalt UHF-485 RFID Controller has **eight** LED indicators conveniently located on the front of the device, that convey visual information to the operator.

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



LEDs Description

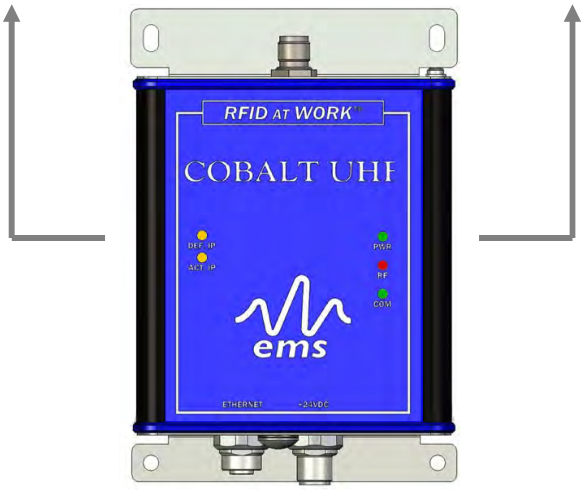
LED COLOR		NAME	LED DESCRIPTION
	RED	**RF**	The RF LED illuminates when RF power is being transmitted by the antenna.
	GREEN	**COM**	The COM (communications) LED flashes ON and OFF when data is being transmitted between the antenna and a tag. When in Continuous Read mode, the COM LED will remain ON and will turn OFF briefly only while data is being read from or written to a tag.
	GREEN	**PWR**	The PWR (power) LED is ON whenever power is applied to the Cobalt.
	AMBER	**16,8,4,2,1 (*Node LEDs*)**	The five amber Node LEDs on the right side indicate the current Subnet 16 address of the unit. In binary from bottom to top, they indicate the current Node ID value assigned to the controller. For example, Node 9 will have: Led 16 OFF, Led 8 ON, Led 2 OFF, Led 1 ON

Table 4-2: UHF-CNTL-485-02 - LEDs Description

4.1.3 LED Behavior for Cobalt UHF-CNTL-IND-02

The Cobalt UHF-IND RFID Controller has **five** LED indicators conveniently located on the front of the device, that convey visual information to the operator.

LED FUNCTION	DEF IP	ACT IP	PWR Power On	RF Activity	COM Activity
LED COLOR	Amber	Amber	Green	Red	Green



LEDs Description

LED COLOR		NAME	LED DESCRIPTION
🔴	RED	RF	The RF LED illuminates when RF power is being transmitted by the antenna.
🟢	GREEN	COM	The COM (communications) LED flashes ON and OFF when data is being transmitted between the antenna and a tag. When in Continuous Read mode, the COM LED will remain ON and will turn OFF briefly only while data is being read from or written to a tag.
🟢	GREEN	PWR	The PWR (power) LED is ON whenever power is applied to the Cobalt.
🟡	AMBER	DEF IP	The DEF IP LED indicate the status of the IP address in the unit. It illuminates when the IP address of the unit is the default one: 192.168.253.110
🟡	AMBER	ACT IP	The ACT IP LED indicate the status of the IP address in the unit. It illuminates when the IP address of the unit is not the default one, but one chosen by the user.

Table 4-3: UHF-CNTL-IND-02 - LEDs Description

CHAPTER 5: COMMAND PROTOCOLS

5.1 COMMAND PROTOCOLS OVERVIEW

In order to execute RFID commands properly, the Cobalt UHF and host computer must be able to communicate using the same language. The language that is used to communicate is referred to as the ***Command Protocol***.

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.

The Cobalt RFID product line by Datalogic supports **three** basic command protocols: ***CBx, ABx Fast*** and ***ABx Standard***. To determine which command protocol to utilize for the different versions of Cobalt UHF Series, please refer to the table below:

PRODUCT	CBX	ABX FAST	ABX STANDARD
UHF-CNTL-232-02		**X**	**X**
UHF-CNTL-IND-02	**X**		
UHF-CNTL-485-02	**X**		

Table 5-1: Command Protocol Matrix

NOTE: RS485-based RFID controllers are used in conjunction with Subnet16 Gateway and Subnet16 Hub interface modules, which use the CBx Command Protocol.

5.2 RFID COMMAND TABLE

This is a list of all the commands supported by the Cobalt UHF Series 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.
0xC2	Read EPC Code	Retrieves the tag's Electronic Product Code Identity
0xC3	Write EPC Code	Used to modify the tag's factory default Electronic Product Code Identity
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
0x51	Set Controller Time	Used to set the time for the controller

COMMAND ID	COMMAND NAME	DESCRIPTION
0x56	Set Controller Trigger	Used to set the parameters for one of the controller's eight triggers
0x57	Get Controller Trigger	Used to retrieve the parameters of one of the controller's eight triggers
0x70	Set Controller Macro	Used to set the parameters for one of the controller's eight macros
0x71	Get Controller Macro	Used to retrieve the parameters of one of the controller's eight macros
0x72	Execute Controller Macro	Instructs the controller to execute one of its eight macros
0xC0	Set UHF Configuration	Used to set (configure or modify) the controller's UHF configuration parameters and settings
0xC1	Get UHF Configuration	Retrieves the controller's UHF configuration parameters
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
0x87	Multi-Tag Get Inventory	Retrieves the tag ID from all RFID tags in range
0xC4	Read EPC Code	Retrieves the Electronic Product Code Identities for all tags in range (multi-tag inventory)

Table 5-2: RFID Command Table

5.2.1 RFID Commands - Note About the UHF-G2-525xx Tag Memory Structure

The memory in Datalogic's EPC Class 1 Gen 2 tag UHF-G2-525xx is organized in **three** areas:

NAME	DESCRIPTION	SIZE
EPC	EPC memory according to the EPCglobal standard	96 bit (12 bytes)
TID	Read Only Unique identifier	64 bits (8 bytes)
USER	User memory	512 bit (64 bytes)

Table 5-3: UHF-G2-525xxx Tag Memory Structure

EPC

EPC is a numbering scheme that allows assignment of a unique identifier to any physical object. It can be regarded as the next generation of Universal Product Code (UPC), which is used on most products today.

EPC enables the means to assign a unique identifier to each item, thus allowing every item to be uniquely identified.

To have more details on the structure of the EPC memory area please consult:

EPC Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID Protocol for Communications at 860 Mhz – 960 Mhz, Version 1.1.0 (December 17, 2005)

In our UHF-G2-525xx tag this memory area is preprogrammed with the TID unique identifier and padded with zeroes. The user can change that but it's important to note that only tags with **different** EPC codes will be discriminated in a multitag reading environment.

TID

This is a read-only area that holds a unique tag identifier number. ***This area can be accessed using the common ABx/CBx Read ID commands***.

USER

This is the normal data area that ***can be accessed using the common ABx/CBx Read and Write commands***.

NOTE: The fastest access memory is the EPC area. For applications where speed is important the use of this memory is recommended.

5.3 ABx Command Protocol Overview

There are two versions of the ABx Command Protocol that are supported by the Cobalt UHF Serial Controller, they are:

- **ABx Fast** (*default*)
- **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 Standard. ABx Fast is the default command protocol used by Cobalt UHF Serial RFID Controller. It can be used with or without a checksum byte.

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

NOTE:
By default, the UHF-CNTL-232-02 is configured to use the *ABx Fast Command Protocol*. ABx Fast (as the name suggests) is the faster and more efficient of the two ABx protocols, offering increased communication speed and error immunity.

5.3.1 ABx Command Packet Structure

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]

5.3.2 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***, 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 Standard	0xAA	0xFF, 0xFF

Table 5-4: 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.

5.3.3 ABx Response Packet Structure

After completing an ABx command, the RFID controller 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.

ATTENTION: This ***Cobalt UHF Series Manual*** does NOT contain descriptions or examples of each supported RFID command common to all the devices in the Cobalt family. For complete details regarding the use of common RFID commands please visit www.ems-rfid.com and download the ***ABx Standard Command Protocol – Reference Manual*** or the ***ABx Fast Command Protocol – Reference Manual.*** Here you will find only the commands that are specific to the UHF controller.

5.4 ABx Fast Command Protocol

The default command protocol used by UHF-CNTL-232-02 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 5.4.3 "Command Packet Elements"* for more on using the checksum parameter.

5.4.1 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 controller, allow the host to first process (remove from memory) any pending response data.

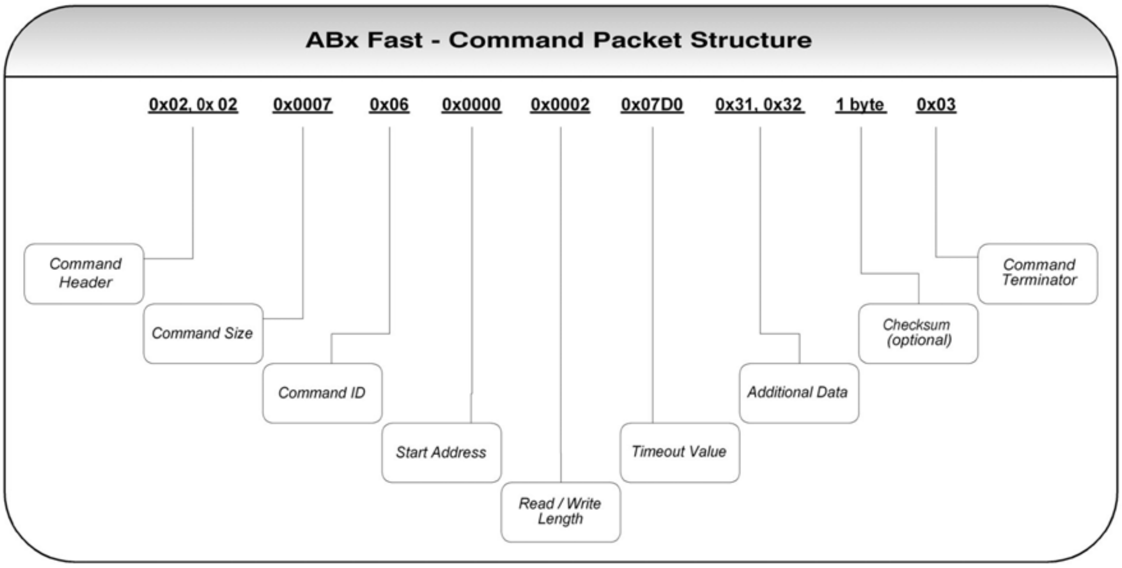


Table 5-5: ABx Fast - Command Packet Structure

5.4.2 ABx Fast - Command Packet Structure

The packet structure of all ABx Fast RFID commands contains certain basic elements, including ***Command Header***, ***Command Size***, ***Command ID*** and ***Command Terminator***. Packet element and parameter availability depends on the command being performed.

COMMAND PACKET ELEMENT	CONTENT	SIZE
COMMAND HEADER: The first two bytes of an ABx Fast command.	0x02, 0x02	2 bytes
COMMAND SIZE: This two-byte integer defines the number of bytes in the packet (*excluding Header, Command Size, 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 integer indicates the location of tag memory where a read or write operation shall begin.	0x0000	2-byte integer
BLOCK SIZE: This two-byte integer represents the number of bytes that are to be read from or written to the RFID tag.	0x0001	2-byte integer
TIMEOUT VALUE: This two-byte integer indicates the maximum length of time for which the controller will attempt to complete the command. Measured in milliseconds, this value can have a range of 0x0001 to 0xFFFE or between 1 and 65,534 msecs.	0x07D0 (*0x07D0 = 2000 x .001 = 2 seconds*)	2-byte integer
ADDITIONAL DATA: This parameter uses one byte 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	1 or more bytes
CHECKSUM: This optional parameter holds a single-byte checksum (only applicable when using *ABx Fast with Checksum*).	Optional	1 byte (*when applicable*)
COMMAND TERMINATOR: The single-byte command packet terminator is always *0x03* for ABx Fast.	0x03	1 byte

Table 5-6: ABx Fast - Command Packet Structure

5.4.3 ABx Fast – Command Packet Elements

Command Size

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

Command Size = number of bytes in these fields

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

Table 5-7: ABx Fast - Command Size Parameter

In the above sample command packet, there are eight bytes of data (located between the *Command Size* parameter and the *Checksum* parameter) that are included in the *Command Size*. Therefore, the *Command Size* for this example is ***0x0008***.

Command ID

The one-byte ***Command ID*** parameter identifies the Hex value of the RFID command to perform. (See the *Section 5.2 - ABx Fast RFID Command Table*.)

Start Address

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

Block Size (Read/Write Length)

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

Timeout Value

Most ABx Fast commands include a two-byte ***Timeout Value***, which is used to limit the length of time that the Cobalt UHF will attempt to complete the specified operation.

The *Timeout Value* is measured in 1-millisecond increments and has a maximum supported value of *0xFFFE* or 65,534 milliseconds (which is slightly longer than one minute).

Setting a long *Timeout Value* does not necessarily mean that a command will take any longer to execute. This value only represents the period of time for which the Cobalt UHF will attempt execution of 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

The ABx Fast Command Protocol supports the inclusion of an **optional *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 *Command Header*, *Checksum* and *Command Terminator* parameters), and then subtracting the total byte sum from 0xFF.

Therefore, when the byte values of each parameter (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*) when using a Checksum.

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

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

Table 5-8: ABx Fast - Checksum Example

Add the byte values from the *Command Size, Command ID, Start Address, Block Size* and *Timeout Value* parameters together and subtract from 0xFF. The resulting value will be the Checksum.

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

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

5.4.4 ABx Fast - Multi-Tag Command Packet Structure

Multi-tag (*anti-collision*) commands are used to communicate with one or more RFID tags, when numerous tags are simultaneously within RF range. ABx Fast Multi-tag commands are formatted as follows:

COMMAND PACKET ELEMENT	CONTENT	SIZE
COMMAND HEADER: The first two bytes of an ABx Fast command.	0x02, 0x02	2 bytes
COMMAND SIZE: This two-byte integer defines the number of bytes in the packet (*excluding Header, Command Size and Terminator*).	0x0007 + (*number of bytes of additional data*)	2-byte integer
COMMAND ID: This single-byte value indicates the RFID command to execute.	0x06 (*Write Data*)	1 byte
Reserved for future use	0x00	1 byte
Reserved for future use	0x00	1 byte
TAG LIMIT: This single byte specifies the maximum # of tags expected in RF range, up to 100; 0x64 = 100 tags expected max (*when applicable*)	0x64	1 byte
START ADDRESS: This two-byte integer indicates the location of tag memory where a read or write operation shall begin.	0x0000	2-byte integer
BLOCK SIZE (**READ/WRITE LENGTH**): This two-byte integer represents the number of bytes that are to be read from or written to the RFID tag.	0x0001	2-byte integer
TIMEOUT VALUE: This two-byte integer indicates the maximum length of time for which the controller will attempt to complete the command. Measured in milliseconds, this value can have a range of 0x0001 to 0xFFFE or between 1 and 65,534 msecs.	0x07D0 (*0x07D0 = 2000 x .001 = 2 seconds*)	2-byte integer
ADDITIONAL DATA: This parameter uses one byte 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	1 or more bytes
COMMAND TERMINATOR: The single-byte command packet terminator is always *0x03* for ABx Fast.	0x03	1 byte

Table 5-9: ABx Fast - Anti-Collision Command Packet Structure

5.4.5 ABx Fast - Multi-Tag Command Packet Elements

Tag Limit

The ***Tag Limit*** parameter holds a one-byte value that indicates the maximum number of tags expected simultaneously in RF range for the given command operation.

This parameter allows users to limit the number of attempted read/write operations the controller will make per execution. Users do not have to wait for the timeout to expire.

The *Tag Limit* value should be set in relation to the maximum number of tags that could possibly be present in the reading field at any one time. Setting the value higher increases the number of tags expected to be read in the antenna's RF field. Lowering the value, however, can speed up tag read operations for a small group of tags. Setting the proper value is therefore a tradeoff between the number of expected tags in the reading field, and the time required to read/write to them. The permitted values range from zero to 100 (*0x00 – 0x64*). The *Tag Limit* parameter resides directly after the "*Anti-collision Mode*" parameter in the command string (when applicable).

Timeout Value

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

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

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

Timeout Value Example

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

Using a *Timeout Value* that is too short may result in diminished read/write range. Setting a long *Timeout Value* does not necessarily mean that the command will take any longer to complete. The value only represents the period of time in which the Cobalt will attempt to complete the particular operation. If all required tags are in RF range when the command is sent, the time necessary to complete the command will be approximately the same whether the *Timeout Value* is 1000ms or 10,000ms.

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

5.4.6 ABx Fast - Response Packet Structure

After performing a command, the Cobalt UHF will generate a host-bound response packet. ABx Fast responses contain a ***Response Header***, ***Response Size***, ***Command Echo***, one or more ***Response Values*** / ***Retrieved Data*** (when applicable), and a ***Response Terminator***.

RESPONSE PACKET ELEMENT	CONTENT	SIZE
RESPONSE HEADER: The first two bytes of an ABx Fast response packet	0x02, 0x02	2 bytes
RESPONSE SIZE: This two-byte integer indicates the total number of bytes in the response packet (*excluding Response Header, Response Size, Checksum and Terminator*).	0x0001 + (*number of bytes of retrieved data*)	2-byte integer
COMMAND ECHO: This single-byte parameter reiterates the Hex value of the command for which the response packet was generated.	0x06	1 byte
RESPONSE VALUES / RETRIEVED DATA: This parameter is used to hold one or more bytes of the 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 5-10: ABx Fast - Response Packet Structure

5.4.7 ABx Fast Protocol: Error Response Packet Structure

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

ERROR RESPONSE ELEMENT	CONTENT
Response Header	0x02, 0x02
Response Size	0x0002
Error Flag	0xFF
Error Code	<1-byte error code>
Checksum	Optional
Response Terminator	0x03

Table 5-11: 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* operation (*Error Code 0x06*).

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

SINGLE-TAG RFID COMMAND 0XC2: READ EPC CODE

COMMAND 0XC2 – DESCRIPTION

The ***Read EPC Command*** instructs the controller to retrieve the EPC memory area of a single tag UHF Class1 Gen2.

COMMAND 0XC2 - ABX FAST EXAMPLE

This example instructs the controller to read the EPC memory from a tag. A *Timeout Value* of 2 seconds (*0x07D0 = 2000 x one-millisecond increments*) is set for the completion of the command.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0003
Command ID	0xC2
Timeout Value	0x07D0
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x000D
Command Echo	0xC2
EPC byte 1	0x05
EPC byte 2	0xAA
EPC bytes 3… to 11	……..
EPC byte 12	0x07
Terminator	0x03

SINGLE-TAG RFID COMMAND 0XC3: WRITE EPC CODE

COMMAND 0XC3 – DESCRIPTION

The ***Write EPC Command*** instructs the controller to write the EPC memory area of a single tag UHF Class1 Gen2.

COMMAND 0XC3 - ABX FAST EXAMPLE

This example instructs the controller to write the specified bytes in the EPC memory of a tag. A *Timeout Value* of 2 seconds (*0x07D0 = 2000 x one-millisecond increments*) is set for the completion of the command.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x000F
Command ID	0xC3
EPC Data Byte Value 1	0x48
EPC Data Byte Value 2	0x45
EPC Data Byte Value 3… to 11	…….
EPC Data Byte Value 12	0x4C
Timeout Value	0x07D0
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0001
Command Echo	0xC3
Terminator	0x03

Multi-Tag RFID Command 0xC4: Read EPC Code

Command 0xC4 – Description

The ***Multi-Tag Read EPC Code*** is used to retrieve the EPC data from all tags within RF range. A final termination packet is sent when the *Timeout Value* expires.

Command 0xC4 - ABx Fast Example

This example instructs the controller to read the EPC data from each tag in range. A *Timeout Value* of 3 seconds *(0x0BB8 = 3000 x 1msec increments)* is set for the completion of the command.

Command from Host

PARAMETER FIELD	CONTENT
Command Header	0x02, 0x02
Command Size	0x0003
Command ID	0xC4
Timeout Value	0x0B, 0xB8
Command Terminator	0x03

Response for Each Tag Read

PARAMETER FIELD	CONTENT
Response Header	0x02, 0x02
Response Size	0x000D
Command Echo	0xC4
EPC Read Data Byte 1	<D01>
EPC Read Data Byte 2	<D02>
. . .	. . .
EPC Read Data Byte 12	<D12>
Response Terminator	0x03

Final Termination Packet

PARAMETER FIELD	CONTENT
Response Header	0x02, 0x02
Response Size	0x0004
Final Termination Packet Identifier	0xFF
Number of Tags Read	<N-tags>
Status	0x0000
Response Terminator	0x03

CONTROLLER SPECIFIC COMMAND 0xC0: SET UHF CONFIGURATION

COMMAND 0xC0 – DESCRIPTION

The ***Set UHF Configuration*** command is used to set (configure or modify) the controller's UHF configuration parameters and settings to the controller's flash memory.

IMPORTANT: it is recommended that users first run *Command 0xC1: Get UHF Configuration* and make note of their current controller configuration values prior to executing this command.

COMMAND 0xC0 - ABx FAST EXAMPLE

This example permits the user to modify or write the indicated configuration settings to the controller's flash memory. The total number of bytes available for this purpose is **nine**.

Command from Host

<table>
<tr><th>PARAMETER FIELD</th><th>CONTENT</th></tr>
<tr><td>Command Header</td><td>0x02, 0x02</td></tr>
<tr><td>Command Size</td><td>0x000A</td></tr>
<tr><td>Command ID</td><td>0xC0</td></tr>
<tr><td>UHF Configuration Bytes 1 & 2
This two-byte integer represents the Reader Output Power (value from 0 to 500 mW).</td><td><2-bytes integer></td></tr>
<tr><td>UHF Configuration Byte 3…to 7</td><td><Reserved> *</td></tr>
<tr><td>UHF Configuration Byte 8
This byte permits the user to select the specific UHF channel through which commands are transmitted. The user can write a value between o and 9 in bits from 4 to 7.</td><td><Partially Reserved>
<table>
<tr><th>BIT</th><th>Description</th></tr>
<tr><td>0</td><td>Reserved*</td></tr>
<tr><td>1</td><td>Reserved*</td></tr>
<tr><td>2</td><td>Reserved*</td></tr>
<tr><td>3</td><td>Reserved*</td></tr>
<tr><td>4</td><td><Channel ID value></td></tr>
<tr><td>5</td><td><Channel ID value></td></tr>
</table></td></tr>
</table>

	6	<Channel ID value>
	7	<Channel ID value>
UHF Configuration Byte 9 This byte permits the user to enable/disable the ***Choose Nearest One*** property. If the Choose Nearest One property is ***disabled***, an error response is generated whenever a single-tag read/write command is executed in a multi-tag environment. If the Choose Nearest One property is ***enabled***, the read/write command is executed on the tag with the stronger signal.	<Partially Reserved>	
	BIT	Description
	0	Reserved*
	1	<Choose Nearest One option>
	2	Reserved*
	3	Reserved*
	4	Reserved*
	5	Reserved*
	6	Reserved*
	7	Reserved*
Command Terminator	0x03	

*Leave the default value retrieved through *Command 0xC1: Get UHF Configuration*

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0001
Command Echo	0xC0
Terminator	0x03

Controller Specific Command 0xC1: Get UHF Configuration

Command 0xC1 – Description

The ***Get UHF Configuration Command*** instructs the controller to retrieve the controller's UHF configuration parameters and settings stored in the unit's flash memory. These are the same values that are set with *Command 0xC0: Set UHF Configuration*.

Command 0xC1 - ABx Fast Example

Through this command, the user queries a Cobalt UHF RFID controller and reads the controller's UHF configuration data from its flash memory.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0001
Command ID	0xC1
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x000B
Command Echo	0xC1
UHF Bytes 1 & 2 This two-byte integer represents the ***Reader Output Power*** (0÷500 mW).	<2-bytes value>
UHF Byte 3	<1-byte value>
EPC bytes 4… to 8	……..
EPC byte 9	<1-byte value>
Terminator	0x03

5.5 CBx Command Protocol

The ***CBx Command Protocol*** is based on a double-byte oriented packet structure where commands always contain a minimum of ***six*** data "words," even when one or more parameters are not applicable to the command. CBx does not support the inclusion of a checksum byte.

The CBx Command Protocol, utilized by Cobalt UHF-CNTL-IND-02 and (when connected to a Gateway or Hub interface module) UHF-CNTL-485-02 models, includes Multidrop Subnet16™ networking support for use with Industrial Ethernet applications.
Moreover, the packet structures described herein are protocol independent and can be implemented the same for all Ethernet protocols (Ethernet/IP, Modbus TCP and Standard TCP/IP protocol).

5.5.1 CBx - Command Procedure

Cobalt UHF-CNTL-485-02 Command Procedure

For the Cobalt UHF-CNTL-485-02, controller-bound commands are initiated by a host computer or Programmable Logic Controller (PLC) and are delivered to the controller by a *Subnet16 Gateway* or *Subnet16 Hub Interface Module* that is connected to the host or PLC by standard Ethernet cabling.

Each Cobalt UHF-CNTL-485-02 connected to a Multi-drop Subnet16 network is assigned an individual Node ID number between 1 and 16.

When a controller-bound command is issued, the instructions are retrieved by the interface module (Gateway or Hub) and distributed to the correct RFID controller by specifying the "***Node ID***" number of the particular controller.

Cobalt UHF-CNTL-IND-02 Command Procedure

For the Cobalt UHF-CNTL-IND-02, commands are initiated by a host computer or Programmable Logic Controller (PLC) and are retrieved by the controller via Ethernet connection.

Commands are directed to the Cobalt by specifying, in the command packet, the "***Node ID***" number of the Cobalt Controller. For the Cobalt UHF-CNTL-IND-02, the Node ID will always be 01 (*0x01*).

ATTENTION: This ***Cobalt UHF Series Manual*** does NOT contain descriptions or examples of each supported RFID command common to all the devices in the Cobalt family. For complete details regarding the use of common RFID commands please visit www.ems-rfid.com and download the ***CBx Command Protocol – Reference Manual.*** Here you will find only the commands that are specific to the UHF controller.

5.5.2 CBx - Command Packet Structure

As noted, CBx commands contain a minimum of six words. Below is the structure of a standard CBx command packet.

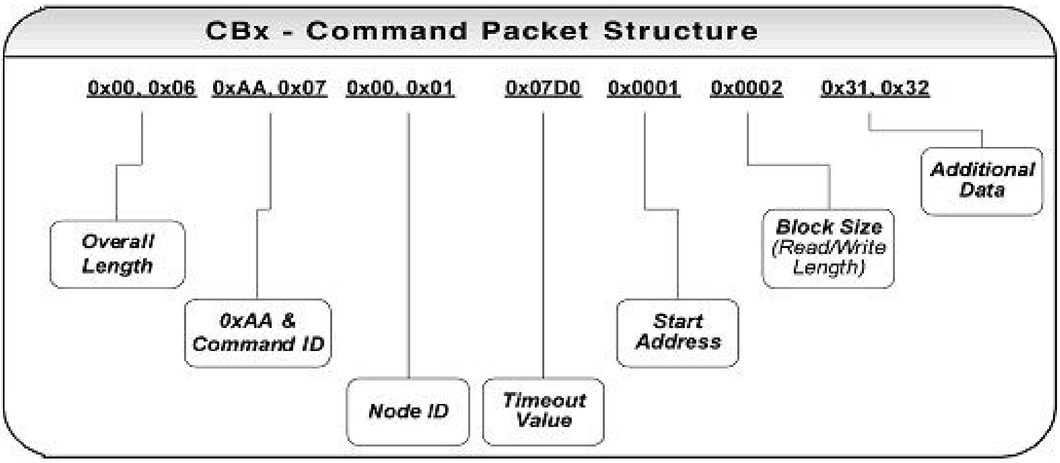


Table 5-12: CBx Command Packet Structure

CBx Command Packet Structure

(MSB = *Most Significant Byte*, LSB = *Least Significant Byte*)

WORD #	COMMAND PACKET ELEMENT	MSB	LSB
01	**Overall Length:** 2-byte integer indicating the number of 16-bit "***words***" in the command packet. Note: this value will always be at least **6**, as each command has a minimum of 12-bytes (or 6 words). Overall Length will increase when additional data words are used in the command (for fills, writes, etc.).	0x00	0x06 + (number of additional data words, if any)
02	**0xAA** in MSB **Command ID**: single-byte value in LSB indicates command to perform	0xAA	<Command ID>
03	**0x00** in MSB **Node ID:** LSB value indicates the Node ID number of the device to which the command is intended. Note: this value must be *0x20* (*Node ID 32*) when the command is directed to a Gateway or Hub, and must be *0x01* (*Node ID 01*) when the command is directed to a Cobalt IND controller.	0x00	<Node ID>

04	**Timeout Value:** 2-byte integer representing the length of time allowed for the completion of the command (when applicable). Measured in one-millisecond increments, the *Timeout Value* can have a value of 0x0001 to 0xFFFE (*1 - 65,534 milliseconds*).	<Timeout MSB>	<Timeout LSB>
05	**Start Address:** 2-byte integer indicating the location of tag memory where a read or write operation will begin (when applicable)	<Start MSB>	<Start LSB>
06	**Block Size:** 2-byte integer indicating the number of bytes that are to be read from or written to a tag during the operation (when applicable)	<Size MSB>	<Size LSB>
07	**Additional Data:** (bytes 1 & 2) used to hold 2-bytes of data used for writes and fills (when applicable)	<D1>	<D2>
08	**Additional Data:** (bytes 3 & 4) used to hold an additional 2-bytes of data for writes (when applicable)	<D3>	<D4>

Table 5-13: CBx Command Packet Structure

5.5.3 CBx Response Packet Structure

After executing a command, the controller will generate a host-bound response message. The response message will contain *EITHER* the results of the attempted command or an error code indicating the reason the operation could not be completed successfully. Below is the structure of a standard CBx response packet.

CBx Response Packet Structure

WORD #	RESPONSE PACKET ELEMENT	MSB	LSB
01	**Overall Length:** 2-byte integer indicating the number of "***words***" in the response packet. This value will always be at least ***6 words***.	0x00	0x06 + (number of additional data words retrieved, if any)
02	**0xAA** in MSB **Command Echo:** single-byte LSB value identifies the command that was performed.	0xAA	<Command Echo>

03	**Instance Counter:** in MSB (*see description on following page*) **Node ID Echo:** Value in LSB identifies the Node ID of the device that performed the command and/or generated the response (will always be *0x20* for *Gateway/Hub,* and *0x01* for *Cobalt IND*)	<Instance Counter>	<Node ID Echo>
04	**Month and Day Timestamp**	<Month>	<Day>
05	**Hour and Minute Timestamp**	<Hour>	<Minute>
06	**Second Timestamp** in MSB **Additional Data Length:** Value in LSB indicates the number of additional bytes retrieved (when applicable)	<Second>	<Additional Data Length>
07	**Retrieved Data:** (bytes 1 & 2) used to hold 2-bytes of retrieved data (when applicable)	<B1>	<B2>
08	**Retrieved Data:** (bytes 3 & 4) used to hold an additional 2-bytes of retrieved data (when applicable)	<B3>	<B4>

Table 5-14: CBx Response Packet Structure

INSTANCE COUNTER

The **Instance Counter** is a one-byte value used to track the number of responses generated by each Node ID. *Instance Counter* values are stored in the internal RAM of the Gateway/Hub and are incremented by one following each response. If, for example, the controller at Node 01 has generated 10 responses, the *Instance Counter* value for Node 01 in the Gateway/Hub will read 10 (*0x0A*). When power is cycled to the Gateway/Hub, the *Instance Counter* values for all nodes (and for the Gateway/Hub itself) will be reset to zero (*0x00*).

NOTE: UHF-CNTL-IND-02 Controllers are capable of storing their own *Instance Counter* values. Likewise, when power is cycled to either device, their *Instance Counter* values will be reset to zero.

5.5.4 CBx Multi-Tag Command Packet Structure

CBx Multi-tag Commands instruct a specified controller to read from or write to several tags at once when multiple tags are simultaneously within RF range. It is also possible to single-out and read from or write to one tag (identified by its unique tag ID number) when multiple tags are present in the RF field simultaneously.

Below is the structure of a basic CBx multi-tag command packet.

CBx Multi-tag Command Packet Structure

WORD #	COMMAND PACKET ELEMENT	MSB	LSB
01	**Overall Length**: 2-byte integer value indicating the number of "***words***" in the command packet.	0x00	0x08 + (number of any additional data words)
02	**0xAA** in MSB **Command ID**: LSB value indicates command to perform	0xAA	<Command ID>
03	**0x00** in MSB **Node ID**: LSB value indicates the Node ID number of the controller to which the command is intended (*must be 0x01 for – Cobalt IND models*)	0x00	0x01
04	**Timeout Value**: 2-byte integer represents the maximum length of time allowed for the completion of the command, measured in one-millisecond increments, where *0x0BB8 = 3000 x .001 = 3 seconds.* The *Timeout Value* can have a value of 0x0001 to 0xFFFE (*1 - 65,534 milliseconds*).	0x0B	0xB8
05	**Start Address**: 2-byte integer indicating the location of tag memory where a read or write operation will begin (when applicable).	<Start MSB>	<Start LSB>
06	**Block Size**: 2-byte integer indicating the number of bytes that are to be read from or written to an RFID tag during the operation (when applicable).	<Size MSB>	<Size LSB>
07	**Reserved for future use**	0x00	0x00
08	**Tag Limit**: Single-byte MSB value for the maximum # of tags expected in RF range, up to 100 (*see description in Section 1.3.4*). **0x00** in LSB	0x64 (100 tags max Tag Limit)	0x00

09	**Additional Data Byte Values 1 & 2**: holds 2 bytes of data used for fills, writes, etc. (when applicable)	<D1>	<D2>
10	**Additional Data Byte Values 3 & 4**: holds an extra 2-bytes for write operations if needed (when applicable)	<D3>	<D4>

Table 5-15: CBx Multi-Tag Command Packet Structure

5.5.5 CBx Multi-Tag Command Packet Elements

Tag Limit

The ***Tag Limit*** parameter holds a one-byte value that indicates the maximum number of tags expected simultaneously in RF range for the given command operation. This parameter allows users to limit the number of attempted read/write operations the controller will make per execution (users do not have to wait for the Timeout to expire).

The *Tag Limit* value should be set in relation to the maximum number of tags that could possibly be present in the reading field at any one time. Setting a high value increases the number of tags that are expected in the antenna's RF field. Setting a low value can speed up multi-tag operations when only a small number of tags could be present at any given moment.

Setting the proper value is therefore a tradeoff between the number of expected tags in the reading field, and the time required to read/write to them. The permitted values range from zero to 100 (0x00 – 0x64).

The *Tag Limit* parameter resides directly after the "*Anti-collision Mode*" parameter in the command string (when applicable).

Timeout Value

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

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

The value is expressed in one-millisecond increments, with a maximum value of 0xFFFE (65,534 milliseconds) or approximately 60 seconds. It is recommended that users allow at least **100ms** per tag for multi-tag read operations and **150ms** per tag for multi-tag writes.

Using a *Timeout Value* that is too short may cause the controller to inadvertently "time out" before the data has been successfully read from or written to all tags in RF range. For time critical applications, the optimal *Timeout Value* should be obtained through rigorous performance testing.

5.5.6 CBx Multi-Tag Response Packet Structures

When executing multi-tag commands designed to retrieve information from several tags at once (for example *CBx Command 0x92: Multi-Tag Read ID and Data All)*, the RFID controller will generate separate host-bound response packets for each tag that has been read. Below is the structure of a basic CBx multi-tag response packet generated by the controller at Node 01.

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

WORD #	RESPONSE PACKET ELEMENT	MSB	LSB
01	**Overall Length**: 2-byte integer indicates the number of "***words***" in the response packet.	0x00	0x06 + (number of additional words retrieved)
02	**0xAA** in MSB **Command Echo**: single-byte value identifies the command that was performed in LSB	0xAA	<Command Echo>
03	**Instance Counter**: 1-byte MSB value indicates number of responses generated by the Node ID identified in the LSB. **Node ID Echo**: 1-byte value indicates the Node ID of the RFID controller that performed the command.	<IC>	0x01
04	**Month and Day Timestamp**	<Month>	<Day>
05	**Hour and Minute Timestamp**	<Hour>	<Minute>
06	**Second Timestamp** in MSB **Additional Data Length**: single-byte LSB value indicates the number of additional bytes retrieved, includes both *Tag ID* and *Read Data* bytes (when applicable)	<Second>	<N-bytes>
07	**Tag ID bytes 1 and 2**: holds the first two bytes of the Tag ID number	<ID byte 1>	<ID byte 2>
08	**Tag ID bytes 3 and 4**	<ID byte 3>	<ID byte 4>
09	**Tag ID bytes 5 and 6**	<ID byte 5>	<ID byte 6>
10	**Tag ID bytes 7 and 8**	<ID byte 7>	<ID byte 8>
11	**Read Data bytes 1 and 2**: holds 2 bytes of retrieved data from tag read operations	<D01>	<D02>
…	…	…	…
18	**Read Data bytes 15 and 16**	<D15>	<D16>

Table 5-16: CBx Multi-Tag Response Packet Structure

5.5.7 CBx Multi-Tag Response Final Termination Packet Structure

After the RFID controller has issued response packets for each tag identified and/or read, a final termination packet is generated. Below is the structure of a standard CBx multi-tag response final termination packet generated by the controller at Node 01.

CBx Multi-tag Response Final Termination Packet Structure

WORD #	PACKET ELEMENT	MSB	LSB
01	**Overall Length**: 2-byte integer indicates the number of "***words***" in the packet.	0x00	0x07
02	**0xAA** in MSB, **0xFF** in LSB	0xAA	0xFF
03	**Instance Counter**: 1-byte value indicates the number of responses generated by the Node ID identified in the LSB (this value is not to be confused with the number of tags read during a single operation) **Node ID Echo**: 1-byte value indicates the Node ID of the controller that performed the command.	<IC>	0x01
04	**Month and Day Timestamp**	<Month>	<Day>
05	**Hour and Minute Timestamp**	<Hour>	<Minute>
06	**Second Timestamp** in MSB **Additional Data Length:** Single-byte LSB value indicates the number of additional bytes retrieved (value will usually = 2, for *Number of Tags Read/Written* and *Status*)	<Second>	0x02
07	**Number of Tags Read/Written** in MSB, identifies the number of tags read from or written to during the operation **Status** in LSB (0x00 = operation completed successfully, 0x07 = Read Tag ID failed / Tag Not Found)	<N-tags>	0x00

Table 5-17: CBx Multi-Tag Response Final Termination Packet Structure

5.5.8 CBx Protocol: Error Response Packet Structure

A one-byte ***Error Code*** will be returned in the MSB of the **seventh** data word of an error response packet (followed by *0x00* in the LSB).

ERROR RESPONSE ELEMENT	MSB	LSB
Overall Length: 2-byte value indicating the number of "*words*" in the Response Packet. This value will always be at least *7* words (6 + 1 for the error code).	0x00	0x07
Error Flag: 0xFF in the MSB indicates that an error occurred. **Error Information Byte**: 0xFF in the LSB indicates that a controller-based error occurred. Any value other than 0xFF indicates that a Gateway or Hub-based error occurred (and indicates the command that was attempted when the error occurred).	0xFF	0xFF
Instance Counter: This 1-byte value tallies the number of responses from a given Node ID. **Node ID Echo**: 1-byte value in LSB indicates the Node ID of the controller that experienced or generated the error. (*Cobalt -IND = 01*)	<IC>	0x01
Month and Day Timestamp	<Month>	<Day>
Hour and Minute Timestamp	<Hour>	<Minute>
Seconds Timestamp in MSB **Additional Data Length** in LSB (*1 byte for "Error Code"*)	<Seconds>	0x01
Error Code: 1-byte Error Code in MSB **0x00** in LSB	<Error Code>	0x00

Table 5-18: CBx - Error Response Packet Structure

CBx Single-Tag RFID Command 0xC2: Read EPC Code

Command 0xC2 - Description

The ***Read EPC Command*** instructs the controller to retrieve the EPC memory area of a single tag UHF Class1 Gen2.

Command 0xC2 - CBx Example

This example instructs the controller to read the EPC memory from a tag. A *Timeout Value* of 2 seconds (*0x07D0 = 2000 x one-millisecond increments*) is set for the completion of the command.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x06
0xAA in MSB **Command ID** in LSB (*0xC2*)	0xAA	0xC2
0x00 in MSB **Node ID** in LSB	0x00	0x01
Timeout Value	0x07	0xD0
Not Used (*0x00, 0x00*)*	0x00	0x00
Not Used (*0x00, 0x00*)*	0x00	0x00

*__NOTE__: even when one or more command parameters are not used in a particular command, the parameter's two bytes must still be accounted for in the Overall Length. Include all "zeroes" for these bytes (0x00, 0x00).

Response from Controller (Tag Found)

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x0C
0xAA in MSB, **Command Echo** in LSB	0xAA	0xC2
Instance Counter in MSB, **Node ID Echo** in LSB	<IC>	0x01
Month and Day Timestamp: (*March 19th*)	0x03	0x13
Hour and Minute Timestamp: (*10:11: AM*)	0x0A	0x0B
Seconds Timestamp in MSB: (*:36 seconds*) **Additional Data Length** in LSB: (*0x0C*)	0x24	0x0C
EPC (*bytes 1 & 2*)	0xE0	0x04
EPC (*bytes 3 & 4*)	0x01	0x00
EPC (*bytes 5 & 6*)	0x00	0x2E
EPC (*bytes 7 & 8*)	0xEB	0x34
EPC (*bytes 9 & 10*)	0x11	0x35
EPC (*bytes 11 & 12*)	0x16	0xAD

Response from Controller (Tag Not Found)

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x07
Error Flag in MSB = 0xFF **Error Information Byte** in LSB 0xFF in the LSB indicates that a controller-based error occurred. Any value other than 0xFF indicates that a Gateway or Hub-based error occurred (and identifies the command that was attempted when the error occurred).	0xFF	0xFF
Instance Counter in MSB, **Node ID Echo** in LSB	<IC>	0x01
Month and Day Timestamp: (*March 19th*)	0x03	0x13
Hour and Minute Timestamp: (*10:11: AM*)	0x0A	0x0B
Seconds Timestamp in MSB: (*:36 seconds*) **Additional Data Length** in LSB: (*0x01*)	0x24	0x01
Error Code in MSB (*0x07 = "Tag Not Found"*) **0x00** in LSB	0x07	0x00

CBx Single-Tag RFID Command 0xC3: Write EPC Code

Command 0xC3 - Description

The ***Write EPC*** Command instructs the controller to write the EPC memory area of a single tag UHF Class1 Gen2.

Command 0xC3 - CBX Example

This example instructs the controller to write the specified bytes in the EPC memory of a tag. A *Timeout Value* of 2 seconds (*0x07D0 = 2000 x one-millisecond increments*) is set for the completion of the command.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x0A
0xAA in MSB **Command ID** in LSB (*0x06*)	0xAA	0xC3
0x00 in MSB **Node ID** in LSB	0x00	0x01
Timeout Value (*measured in ms*)	0x07	0xD0
EPC Write Data (*bytes 1 and 2*)	0x48	0x45
EPC Write Data (*bytes 3 and 4*)	0x4C	0x4C
EPC Write Data (*bytes 5 and 6*)	0x58	0x45
EPC Write Data (*bytes 7 and 8*)	0xAB	0x6F
EPC Write Data (*bytes 9 and 10*)	0x4E	0x45
EPC Write Data (*byte 11 and 12*)	0x4F	0x00

Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06
0xAA in MSB **Command Echo** in LSB	0xAA	0xC3
Instance Counter in MSB **Node ID Echo** in LSB	<IC>	0x01
Month and **Day** Timestamp: (*March 19th*)	0x03	0x13
Hour and **Minute** Timestamp: (*10:11: AM*)	0x0A	0x0B
Seconds Timestamp in MSB (*:36 seconds*) **0x00** in LSB	0x24	0x00

MULTI-TAG RFID COMMAND 0XC4: READ EPC CODE

COMMAND 0XC4 - DESCRIPTION

The ***Multi-Tag Read EPC Code*** is used to retrieve the EPC data from all tags within RF range. A final termination packet is sent when the *Timeout Value* expires.

COMMAND 0XC4 - CBX EXAMPLE

This example instructs the controller to read the EPC data from each tag in range. A *Timeout Value* of 3 seconds *(0x0BB8 = 3000 x 1msec increments)* is set for the completion of the command.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command *(in words)*	0x00	0x06
0xAA in MSB, **Command ID** in LSB	0xAA	0xC4
0x00 in MSB **Node ID** in LSB	0x00	0x01
Timeout Value	0x0B	0xB8
Tag Limit in MSB, **0x00** in LSB	0x64	0x00
Not Used (*0x00, 0x00*)*	0x00	0x00

Response for Each Tag Found

PARAMETER FIELD	MSB	LSB
Overall Length of Response *(in words)*	0X00	0X0C
0xAA in MSB, **Command Echo** in LSB	0XAA	0XC4
Instance Counter in MSB **Node ID Echo** in LSB	<IC>	0X01
Month and **Day** Timestamp: (*March 19th*)	0x03	0x13
Hour and **Minute** Timestamp: (*10:11: AM*)	0x0A	0x0B

Seconds Timestamp in MSB (*:36 seconds*) **Additional Data Length** in LSB (*number of additional bytes returned*)	0X24	0X0C
EPC ID (*bytes 1 and 2*)	<ID1>	<ID2>
EPC ID (*bytes 3 and 4*)	<ID3>	<ID4>
EPC ID (*bytes 5 and 6*)	<ID5>	<ID6>
EPC ID (*bytes 7 and 8*)	<ID7>	<ID8>
EPC ID (*bytes 9 and 10*)	<ID9>	<ID10>
EPC ID (*bytes 11 and 12*)	<ID11>	<ID12>

Final Response Packet

PARAMETER FIELD	MSB	LSB
Overall Length of Response *(in words)*	0X00	0X07
0xAA in MSB, **0xFF** in LSB	0XAA	0XFF
Instance Counter in MSB **Node ID Echo** in LSB	<IC>	0X01
Month and **Day** Timestamp: (*March 19^{th}*)	0x03	0x13
Hour and **Minute** Timestamp: (*10:11: AM*)	0x0A	0x0B
Seconds Timestamp in MSB (*:36 seconds*) **Additional Data Length** in LSB (*2 bytes: "Number of Tags" and "Status"*)	0X24	0X02
Number of Tags Found in MSB **Status** in LSB	<NUMBER OF TAGS FOUND>	<0X00 = OPERATION COMPLETED SUCCESSFULLY, 0X07 = READ TAG ID FAILED / TAG NOT FOUND>

CONTROLLER SPECIFIC COMMAND 0xC0: SET UHF CONFIGURATION

COMMAND 0xC0 – DESCRIPTION

The ***Set UHF Configuration*** command is used to set (configure or modify) the controller's UHF configuration parameters and settings to the controller's flash memory.

IMPORTANT: it is recommended that users first run *Command 0xC1: Get UHF Configuration* and make note of their current controller configuration values prior to executing this command.

COMMAND 0xC0 - CBx EXAMPLE

This example permits the user to modify or write the indicated configuration settings to the controller's flash memory. The total number of bytes available for this purpose is **nine**.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (in words)	0x00	0x08
0xAA in MSB **Command ID** in LSB: (*0x43*)	0xAA	0xC0
0x00 in MSB, **Node ID** in LSB	0x00	0x01
UHF Configuration Byte 1 in MSB **UHF Configuration Byte 2** in LSB These two-bytes represent the ***Reader Output Power*** (value from 0 to 500 mW).	<Byte 1>	<Byte 2>
UHF Configuration Byte 3 in MSB **UHF Configuration Byte 4** in LSB	<Reserved> *	<Reserved> *
UHF Configuration Byte 5 in MSB **UHF Configuration Byte 6** in LSB	<Reserved> *	<Reserved> *

<table>
<tr>
<td>
UHF Configuration Byte 7 in MSB
UHF Configuration Byte 8 in LSB

Byte 8 in LSB is partially reserved (see table below). This byte permits the user to select the specific UHF channel through which commands are transmitted. The user can write a value between o and 9 in bits from 4 to 7

UHF Config. Byte 8 - Table
<table>
<tr><th>BIT</th><th>Description</th></tr>
<tr><td>0</td><td>Reserved*</td></tr>
<tr><td>1</td><td>Reserved*</td></tr>
<tr><td>2</td><td>Reserved*</td></tr>
<tr><td>3</td><td>Reserved*</td></tr>
<tr><td>4</td><td><Channel ID value></td></tr>
<tr><td>5</td><td><Channel ID value></td></tr>
<tr><td>6</td><td><Channel ID value></td></tr>
<tr><td>7</td><td><Channel ID value></td></tr>
</table>
</td>
<td><Reserved> *</td>
<td><Partially Reserved></td>
</tr>
<tr>
<td>
UHF Configuration Byte 9 in MSB
0x00 in LSB (not used)

Byte 9 in MSB is partially reserved (see table below).This byte permits the user to enable/disable the Choose Nearest One property.

If the Choose Nearest One property is disabled, an error response is generated whenever a single-tag read/write command is executed in a multi-tag environment.

If the Choose Nearest One property is enabled, the read/write command is executed on the tag with the strongest signal.

UHF Config. Byte 9 - Table
<table>
<tr><th>BIT</th><th>Description</th></tr>
<tr><td>0</td><td>Reserved*</td></tr>
<tr><td>1</td><td><Choose Nearest One option></td></tr>
<tr><td>2</td><td>Reserved*</td></tr>
<tr><td>3</td><td>Reserved*</td></tr>
<tr><td>4</td><td>Reserved*</td></tr>
<tr><td>5</td><td>Reserved*</td></tr>
<tr><td>6</td><td>Reserved*</td></tr>
<tr><td>7</td><td>Reserved*</td></tr>
</table>
</td>
<td><Partially Reserved></td>
<td>0x00</td>
</tr>
</table>

*Leave the default value retrieved through *Command 0xC1: Get UHF Configuration*

Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06
0xAA in MSB **Command Echo** in LSB	0xAA	0xC0
Instance Counter in MSB **Node ID Echo** in LSB	<IC>	0x01
Month and **Day** Timestamp: (*March 19th*)	0x03	0x13
Hour and **Minute** Timestamp: (*10:11: AM*)	0x0A	0x0B
Seconds Timestamp in MSB (*:36 seconds*) **0x00** in LSB	0x24	0x00

CONTROLLER SPECIFIC COMMAND 0xC1: GET UHF CONFIGURATION

COMMAND 0xC1 – DESCRIPTION

The ***Get UHF Configuration Command*** instructs the controller to retrieve the controller's UHF configuration parameters and settings stored in the unit's flash memory. These are the same values that are set with *Command 0xC0: Set UHF Configuration*.

COMMAND 0xC1 - CBx EXAMPLE

Through this command, the user queries a Cobalt UHF RFID controller and reads the controller's UHF configuration data from its flash memory.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x06
0xAA in MSB **Command ID** in LSB	0xAA	0xC1
0x00 in MSB **Node ID** in LSB	0x00	0x01
Not Used (*default: 0x00, 0x00*)	0x00	0x00
Not Used (*default: 0x00, 0x00*)	0x00	0x00
Not Used (*default: 0x00, 0x00*)	0x00	0x00

Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x0B
0xAA in MSB, **Command Echo** in LSB	0xAA	0xC1
Instance Counter in MSB, **Node ID Echo** in LSB	<IC>	0x01
Month and Day Timestamp: (*March 19th*)	0x03	0x13
Hour and Minute Timestamp: (*10:11: AM*)	0x0A	0x0B
Seconds Timestamp in MSB: (*:36 seconds*) **Additional Data Length** in LSB: (*0x0A*)	0x24	0x0A

UHF Configuration Bytes 1 & 2 These two bytes represent the ***Reader Output Power*** (0÷500 mW).	<Byte 1>	<Byte 2>
UHF Configuration Bytes 3 & 4	<Byte 3>	<Byte 4>
UHF Configuration Bytes 5 & 6	<Byte 5>	<Byte 6>
UHF Configuration Bytes 7 & 8	<Byte 7>	<Byte 8>
UHF Configuration Bytes 9 & 10	<Byte 9>	0x00

5.6 Error Code Table

ERROR CODE	ERROR	DESCRIPTION
0x04	FILL TAG FAILED	Fill Tag operation failed
0x05	READ DATA FAILED	Read Data operation failed
0x06	WRITE DATA FAILED	Write Data operation failed
0x07	TAG NOT FOUND, TAG SEARCH FAILED	Read Tag ID operation failed, Tag Search operation failed
0x21	INVALID SYNTAX	Command Contained a syntax error
0x30	INTERNAL CONTROLLER ERROR	Generic internal controller error
0x31	INVALID CONTROLLER TYPE	Invalid controller type (when setting configuration)
0x32	INVALID PROGRAMMING ADDRESS	Invalid tag programming address specified
0x35	INVALID RESET	Invalid hardware reset
0x36	SET CONFIGURATION ERROR	Configuration not written
0x37	GET CONFIGURATION ERROR	Configuration not read
0x83	COMMAND INVALID OPCODE	Invalid Command ID specified in the command.
0x84	COMMAND INVALID PARAMETER	A parameter specified in the command was invalid.
0x85	COMMAND INVALID CONTROLLER ID	An invalid Node ID was specified in the command, or no controller was detected/present at the specified Node.
0x86	COMMAND INACTIVE CONTROLLER ID	The Node ID specified in the command is currently inactive.
0x87	SUBNET DEVICE SELECT FAILED	Internal Subnet Error – the specified Subnet device failed.
0x88	SUBNET DEVICE FAILED TO ACKNOWLEDGE	Internal Subnet Error - the specified Subnet device failed to respond to the Cobalt's polling.

0x89	SUBNET RESPONSE MALFORMED	Internal Subnet Error – a controller returned a malformed response.
0x8A	SUBNET RESPONSE TIMEOUT	Internal Subnet Error – a controller was unable to generate a response before timeout was reached.
0x8B	SUBNET RESPONSE INVALID CHECKSUM	Internal Subnet Error – a controller generated a response that has an invalid checksum.
0x8C	SUBNET DEVICE CONFLICT DETECTED	Internal Subnet Error – a Node ID conflict has been detected
0x8D	BUFFER OVERFLOW	Internal Error – buffer limit was exceeded
0x8E	FLASH FAILURE	Internal Error – flash memory failure
0x92	SUBNET16 ONLY COMMAND	A Subnet16-only command was issued when in MUX32 mode.
0x93	NODE MISMATCH ERROR	The Node specified in the command did not match the Node to which the command was sent
0x94	CRC ERROR	Internal Communications Error
0x95	PROTOCOL ERROR	Internal Communications Error

Table 5-19: Error Code Table

CHAPTER 6: ETHERNET/IP INTERFACE

The Cobalt U***HF-CNTL-IND-02*** model is designed to support many common Industrial Ethernet protocols and can be implemented in a wide variety of existing host / PLC applications. One such popular Ethernet protocol is ***Ethernet/IP*** (**EIP**).

This chapter focuses on the process of setting up the Cobalt Industrial RFID Controller to communicate (via Ethernet/IP) with a ControlLogix Programmable Logic Controller (PLC).

Also in this chapter are descriptions of EMS' ***HTML Server*** and ***OnDemand Utilities***, as well as systematic instructions to help configure the Cobalt Industrial RFID Controller for Ethernet/IP environments.

NOTE: This manual assumes that users are already familiar with Ethernet/IP, industrial Ethernet communications protocols and programmable logic controller technologies. For specific information regarding the protocol used by your particular RFID application, please refer to the appropriate documentation from your host / PLC program provider.

IMPORTANT:

- Users of the *Cobalt Dashboard* utility should exit the application before attempting communications between the Industrial Cobalt and an EtherNet/IP host Programmable Logic Controller (PLC).
- When installing the UHF-CNTL-IND-02 for communication over EtherNet/IP, the ODVA Guidelines for EtherNet/IP Media System installation should be followed (refer to www.odva.org, ODVA **PUB00148R0** (Pub 148), EtherNet/IP Media Planning and Installation Manual, 2006 ODVA).
- Follow ODVA recommendations for switching and wiring Ethernet/IP.
- If the Ethernet/IP network enables I/O Messaging for remote I/O, etc., or if other UDP traffic is present, then the Gateway must be protected by a switch that incorporates IGMP Snooping or a VLAN.

6.1 ETHERNET/IP CONFIGURATION OVERVIEW

Based upon on the standard TCP/IP protocol suite, EtherNet/IP is a high-level application layer protocol for industrial automation applications that uses traditional Ethernet hardware and software to define an application layer protocol that structures the task of configuring, accessing and controlling industrial automation devices.

Ethernet/IP classifies Ethernet nodes as predefined device types with specific behaviors. The set of device types and the EIP application layer protocol is based on the Common Industrial Protocol (CIP) layer used in ControlNet. Building on these two widely used protocol suites, Ethernet/IP provides a seamlessly integrated system from the RFID Subnet network to the Host and enterprise networks.

The Cobalt is designed to communicate as an EtherNet/IP client device, which will receive and execute RFID commands issued by the host / PLC (acting as EtherNet/IP Server).

Sections 6.3 through 6.7 contain instructions that will help you accomplish the following:

Assign the Cobalt an IP address via *HTML Server*

Configure the Cobalt's Subnet Node via *OnDemand Utilities*

Create "*Controller Tags*" in the PLC

Verify PLC and Cobalt Subnet Node connectivity

6.2 HTML Server & OnDemand PLC Support

Below is a partial list of the programmable logic controllers that are supported by EMS' *HTML Server* and *OnDemand Utilities*.

ControlLogix – OnDemand supports all current versions

RA's PLC5E releases:

Series C, Revision N.1

Series D, Revision E.1

Series E, Revision D.1

PLC5 "Sidecar" Module Series B, Revision A with EIP support

SLC5/05 releases:

Series A with firmware revision OS501, FRN5

All Series B and Series C PLC Controllers

6.3 HTML Server and OnDemand Utilities

Embedded in the Cobalt *UHF-CNTL-IND-02* is an ***HTML Server,*** which provides a Website-like interface and a suite of configuration tools.

Through the use of the Cobalt's *HTML Server*, users can access, modify and save changes to the unit's Industrial Ethernet configuration, IP address, and *OnDemand* mode settings.

The *OnDemand Utilities* will be used later in this chapter to link the Cobalt to specific *Controller Tags* as defined in Rockwell Automation's (*RA*) ControlLogix PLC.

ATTENTION: Disable any firewall services affecting or running locally on the host computer. Firewalls can potentially block communications between the Cobalt and the host and/or PLC.

ADDITIONAL INFORMATION: In ControlLogix, a "***Controller Tag***" is a small block of internal memory that is used to hold outgoing (*command*) and incoming (*response*) data. Within each controller tag, information is stored in two-byte segments, known as registers or "*words*."

OnDemand is Escort Memory Systems' approach to adding *Change of State* messaging to ControlLogix and legacy support for *RA PLC5E* and *RA SCL5/05* programmable logic controllers.

6.4 IP CONFIGURATION VIA *HTML SERVER*

To configure the Cobalt for Ethernet communications, begin by assigning the controller a locally compatible IP address.

Through a standard Web browser, you can utilize the Cobalt's *HTML Server* to access an embedded suite of controller configuration tools, called the "***OnDemand Utilities***." Among its features is the ability to modify and save changes to the controller's IP address, which is stored internally on the Cobalt.

Cobalt Industrial Ethernet RFID Controller - Default IP Address:

192.168.253.110

SETTING THE IP ADDRESS OF THE COBALT

To set the Cobalt's IP address using the *HTML Server,* follow the steps below:

1. Open a Web browser on the PC.
2. In the URL address field, enter the Cobalt's IP address (*192.168.253.110 = factory default*).
3. Press ***ENTER***.

   The *HTML Server - Main Page* will be displayed.

HTML SERVER – MAIN PAGE

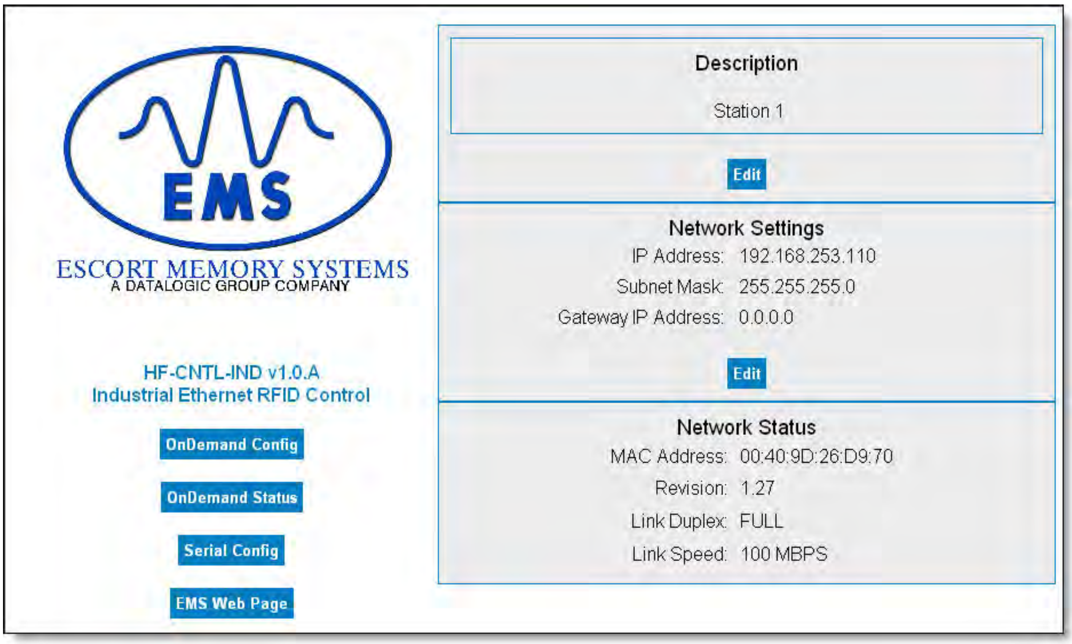
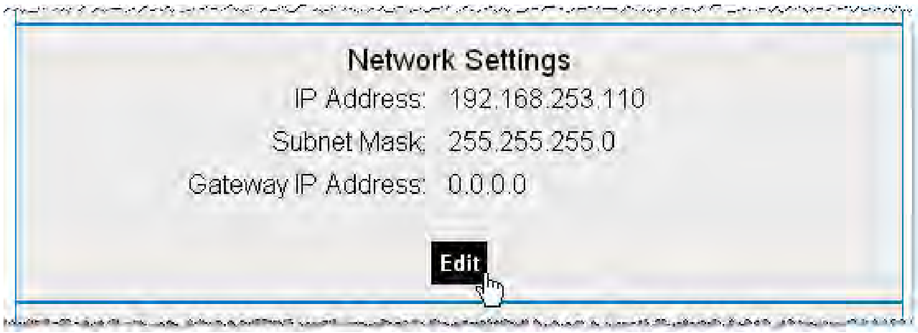


Figure 6-1: The HTML Server - Main Page

The ***HTML Server - Main Page*** lists the IP address and network settings currently stored on the Cobalt.

4. Click the button labeled "***EDIT***", located below "***Network Settings.***"



The *IP Configuration Page* will be displayed.

IP CONFIGURATION PAGE

The *IP Configuration Page* is used to modify and save changes to the IP Address, Subnet Mask and (Network) Gateway IP Address.

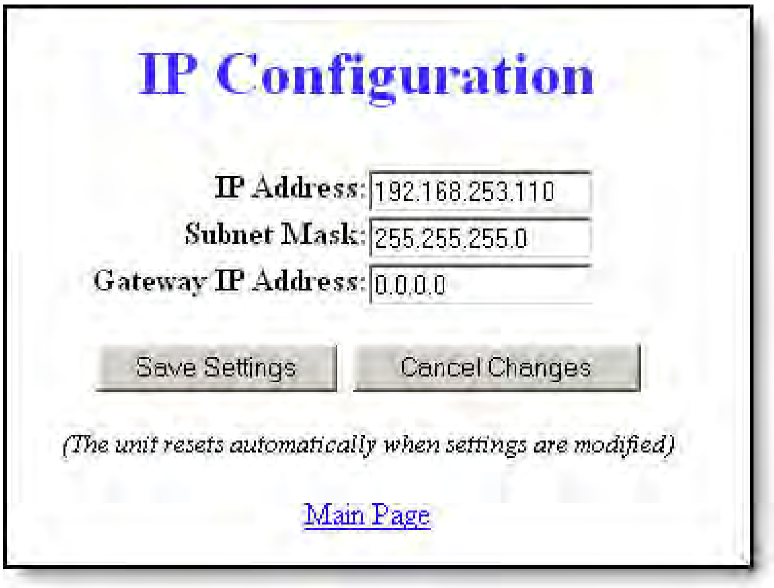


Figure 6-2: The IP Configuration Page

5. In the fields provided, enter your new IP configuration values for the Cobalt.
6. Click the "***Save Settings***" button to store your new IP configuration, then cycle power to the UHF-CNTL to store the changes in the main memory. The Ethernet module will reset and your IP changes will be implemented.
7. After the Cobalt has restarted, verify the new IP configuration by opening a Web browser and manually entering the Cobalt's new IP address in the URL field. If successful, you should arrive back at the *HTML Server – Main Page*.

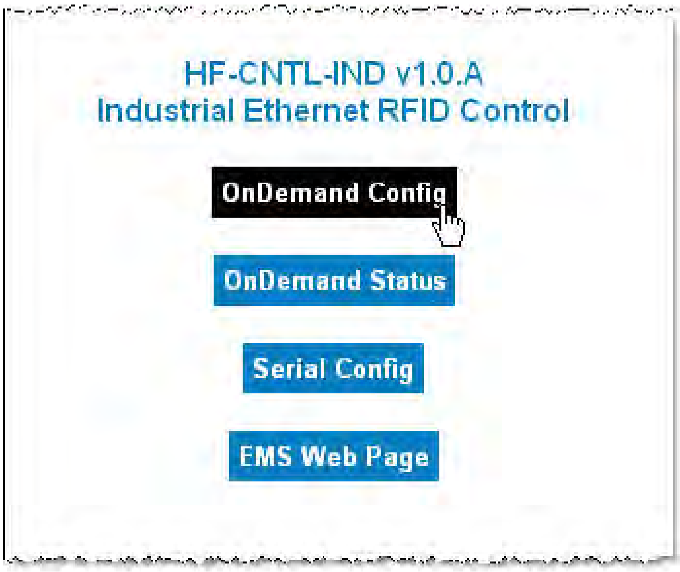
6.5 OnDemand Configuration for EtherNet/IP

Now that you have configured the Cobalt's IP address, you will need to use the embedded *HTML Server* to access the Cobalt's ***OnDemand Configuration Page***. Through the use of the *OnDemand Configuration Page,* the Cobalt can be configured to communicate with a *ControlLogix* PLC.

To configure the Cobalt's *OnDemand Configuration* settings, follow the steps below:

1. Open a Web browser on the host and enter the Cobalt's new IP address in the URL field. The *HTML Server – Main Page* will be displayed.

2. At the *HTML Server – Main Page*, click the button labeled "***OnDemand Config***."



The *OnDemand Configuration Page* will be displayed.

OnDemand Configuration Page

The ***OnDemand Configuration Page*** allows you to modify the settings of the Cobalt's Node.

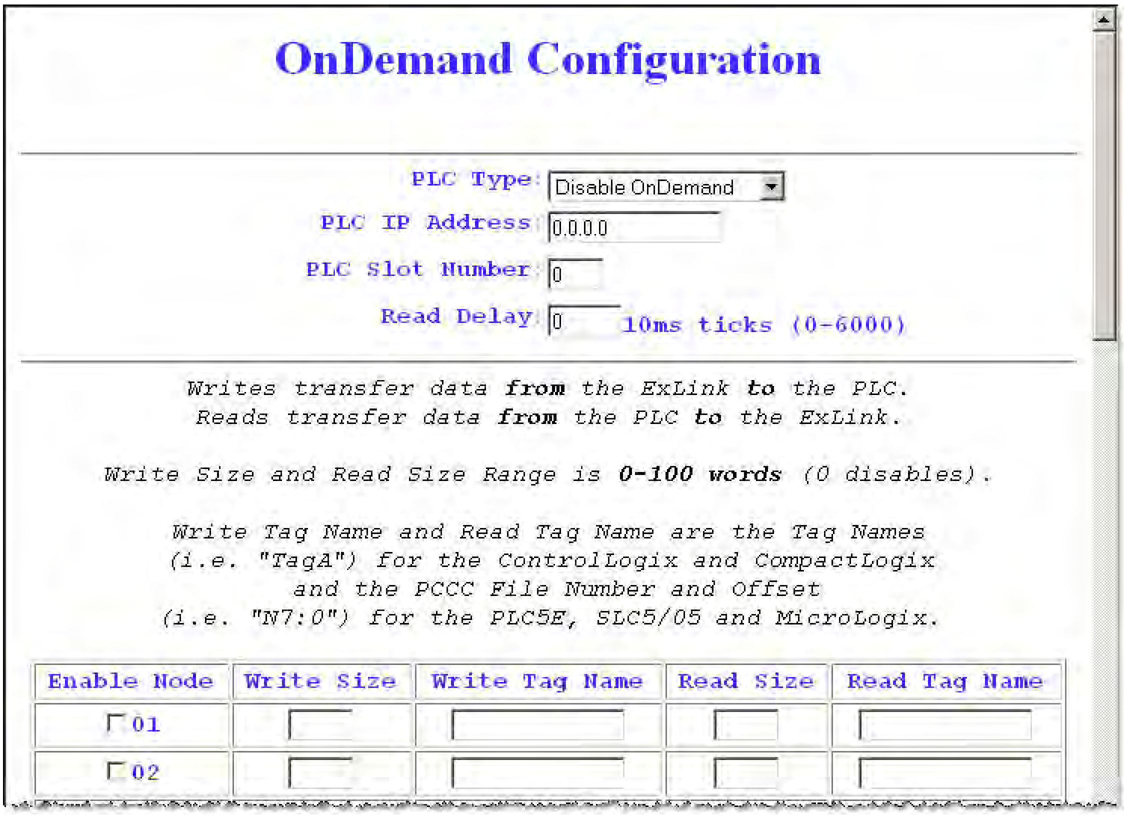
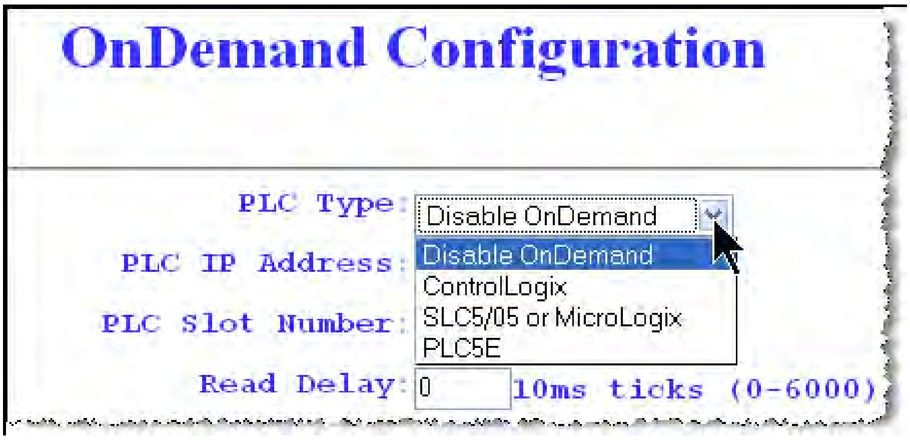


Figure 6-3: The OnDemand Configuration Page

3. In the upper portion of the *OnDemand Configuration Page*, select a ***PLC Type*** from the drop-down menu.



4. Enter the PLC's IP address.
5. For the ***PLC Slot Number,*** enter a value between 0 and 255. The PLC Slot Number indicates the location in your PLC rack where the controller module is installed (normally slot 0 for ControlLogix).

6. In the ***Read Delay*** field, enter a value between 0 and 6000. This number specifies (in 10ms "ticks") how frequently the Cobalt will poll the PLC for the presence of new data. (*Note: a value of 6000 = 60 seconds; zero = disable*).

7. In the column labeled "***Enable Node,***" place a check in the box for **Node 01.** Other Nodes listed on this page are not supported by the Cobalt –IND.

Enable Node	Write Size	Write Tag Name	Read Size	Read Tag Name
☑ 01	100	EMS_WRITE1	100	EMS_READ1

8. **Write Size:** Enter a value between 1 and 100 (or 0 to disable) for the ***Write Size.*** The Write Size represents the maximum number of 2-byte "words" that the Cobalt will attempt to write to PLC memory during a single write cycle. *(Note: to accommodate message handshaking overhead, the actual data size required by the PLC is three words larger than the value specified in this field).*

9. **Write Tag Name:** For *ControlLogix* systems, specify a ***Write Tag Name*** that is 40 characters or less (for example *EMS_WRITE1,* for Node 01). The Write Tag Name is a user defined description or title for the area of memory in the PLC where host-bound data will be written for the Cobalt. (*Note: the Write Tag Name is not to be confused with writing to an RFID transponder, which is often referred to as "writing to a tag").*

OR

Write Tag Name: For *PLC5E, SLC5/05 and MicroLogix* systems, enter the ***PCCC File Number and Offset*** (for example *N7:0*) in the *Write Tag Name* field. Together these values identify the location in the PLC's Status File where host-bound data will be written for the Cobalt.

10. **Read Size:** Enter a value between 1 and 100 (or 0 to disable) for the ***Read Size.*** The Read Size represents the maximum number of 2-byte "words" that the Cobalt will attempt to retrieve from PLC memory during a single read cycle. *(Note: to accommodate message handshaking overhead, the actual data size required by the PLC is three words larger than the value specified in this field).*

11. **Read Tag Name:** For *ControlLogix* systems, specify a ***Read Tag Name*** that is 40 characters or less (for example *EMS_READ1,* for Node 01). The Read Tag Name is a user defined description or title for the area of memory in the PLC from which the Cobalt will retrieve data.

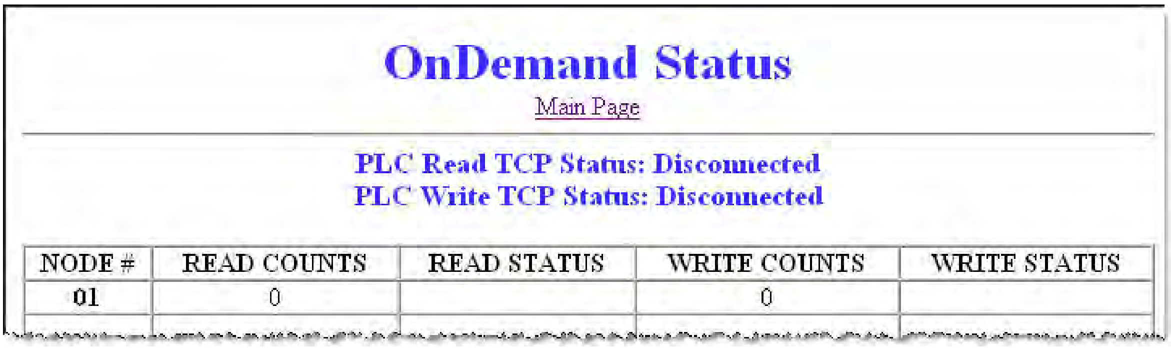
    OR

    Read Tag Name: For *PLC5E, SLC5/05 and MicroLogix* systems enter the ***PCCC File Number and Offset*** in the *Read Tag Name* field. Together these values indicate the location in the PLC's Status File from which the Cobalt will retrieve data.

12. After entering the proper information for Node 01, click the ***Save Settings*** button located at the bottom of the page.

The *OnDemand Status Page* will be displayed.

13. At the *OnDemand Status Page*, click the link labeled "***Main Page***" to return to the *HTML Server – Main Page*.



6.6 Configuring PLC Controller Tags

After you have configured the Cobalt's Node via the *OnDemand Configuration Page*, open your PLC program (i.e. RSLogix 5000) and, if you have not already done so, define two ***Controller Tags*** (a ***Write Tag*** and a ***Read Tag***).

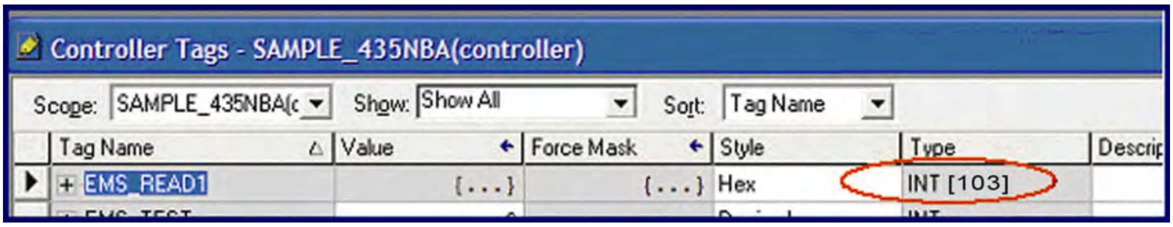
Controller Tag Naming

Controller Tags need to be assigned a name and size. Be sure to use the same ***Write Tag Name*** and ***Read Tag Name*** that you specified in the *OnDemand Node Configuration* (i.e., EMS_WRITE1 and EMS_READ1).

Controller Tag Size

Due to handshaking overhead, *Controller Tags* must have the size capacity to store an integer array equal to your previously specified ***Write/Read Size + three words***.

So for example, if the *Read Size* you specified earlier was 100 words, the corresponding *Read Tag* in the PLC must be able to store an array of 103 integers.



- The **Write Tag** holds messages and response data generated by the Cobalt that is bound for the host or PLC.
- The **Read Tag** holds RFID commands and instructions intended for the Cobalt.

(**NOTE**: the Cobalt should already be linked to the proper Write Tag and Read Tag via the *OnDemand Utilities - OnDemand Configuration Page)*.

After creating and defining a *Write Tag* and a *Read Tag* for the Cobalt, return to the Cobalt's *HTML Server – Main Page* to continue.

6.7 CHECKING ONDEMAND STATUS

Now that you have configured the Cobalt's Node and defined corresponding *Write* and *Read Tags* in the PLC, the last step is to check the communication status between the Cobalt and the PLC.

Return to the Cobalt's *HTML Server - Main Page* and click the link labeled "***OnDemand Status***." The *OnDemand Status Page* will be displayed.

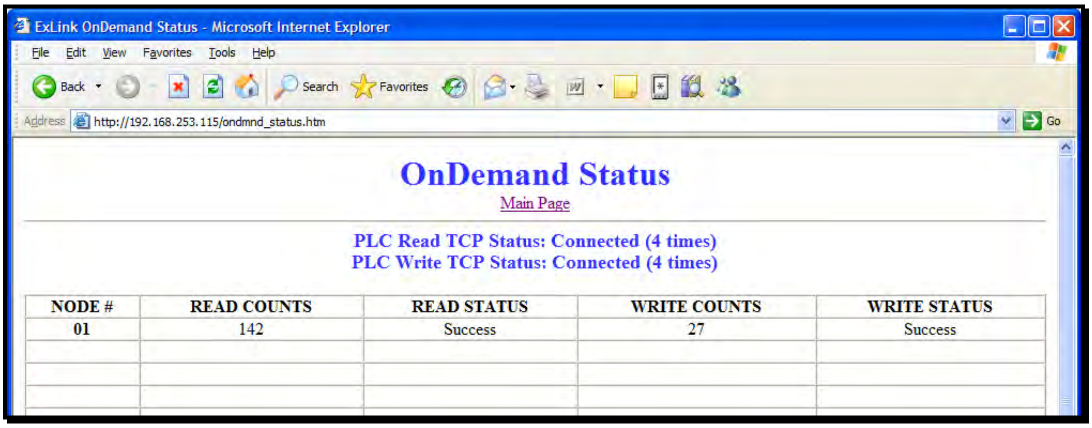


Figure 6-4: The OnDemand Status Page

The *OnDemand Status Page* provides statistical information regarding the connection status of the Cobalt. This information can be used to verify that read and write connections between the Cobalt and the PLC have been established successfully.

- ***Read Counts***: this value indicates the number of times the Cobalt has checked the PLC for new data.
- ***Write Counts***: this value indicates the number of times the Cobalt has provided data to the PLC.

Note that under Ethernet/IP, the host (and/or PLC) acts as the server. However, additional messaging instructions are not required on the part of the host because the Cobalt will automatically poll the Read Tag in the PLC at the interval specified by the ***Read Delay*** value set via the *OnDemand Configuration Utility*.

There is no delay parameter when writing data to the PLC, as the Cobalt delivers all PLC-bound data immediately after it is generated.

If you configured a low *Read Delay* value, the *Read Counts* on the *OnDemand Status Page* will accumulate rapidly. This occurs because a low *Read Delay* value instructs the Cobalt to poll the PLC for new data more frequently.

ATTENTION:

If the Cobalt and PLC do not successfully establish a connection, cycle power to the Cobalt and verify that Ethernet/IP services are running properly on the PLC. If that does not resolve the issue, restart Ethernet/IP services on the PLC and the 1756-ENBT module.

6.8 Verifying Data Exchange with RSLogix 5000

At this point, communication between the Cobalt and the PLC should be properly configured and a connection established. You can verify the exchange of information between devices using RSLogix 5000.

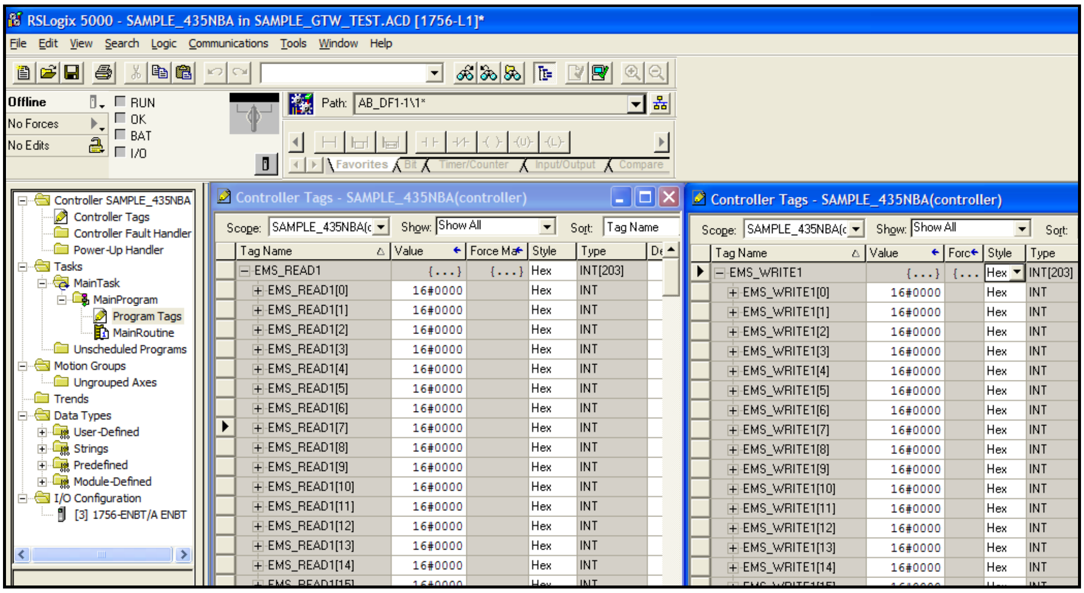


Figure 6-5: RSLogix 5000

6.8.1 Ethernet/IP Handshaking

To ensure that messages to and from the Cobalt are properly delivered and received, a handshaking mechanism has been implemented that uses a pair of dedicated words in the exchange. The first two words in each *Controller Tag* are dedicated to handshaking.

When new information is generated, the producing device (*Data Producer*) will increment a counter in one of the *Controller Tags*. After identifying the new data, the consuming device (*Data Consumer*) will copy that same counter value to a different Controller Tag location, which lets the Data Producer know that the information has been processed by the Data Consumer.

WRITE TAG (where responses are written by the Cobalt)

EMS_Write1 [0] = (2) the Cobalt copies counter here to ACK

EMS_Write1 [1] = (3) the Cobalt increments this counter to signal response available

EMS_Write1 [2] = Data Size

EMS_Write1 [3-102] = Data

READ TAG (where commands are retrieved by the Cobalt)

EMS_Read1 [0] = (4) PLC copies the counter here to ACK the response

EMS_Read1 [1] = (1) PLC increments this counter after writing a command

EMS_Read1 [2] = Data Size

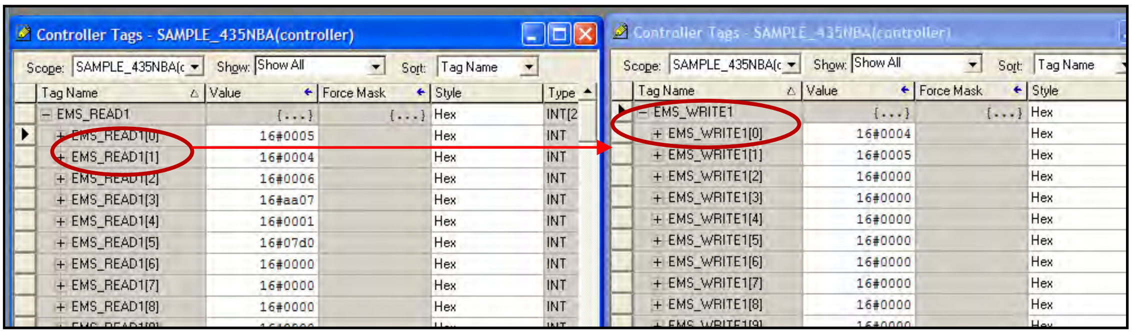
EMS_Read1 [3-102] = Data

6.8.2 Ethernet/IP Handshaking Example

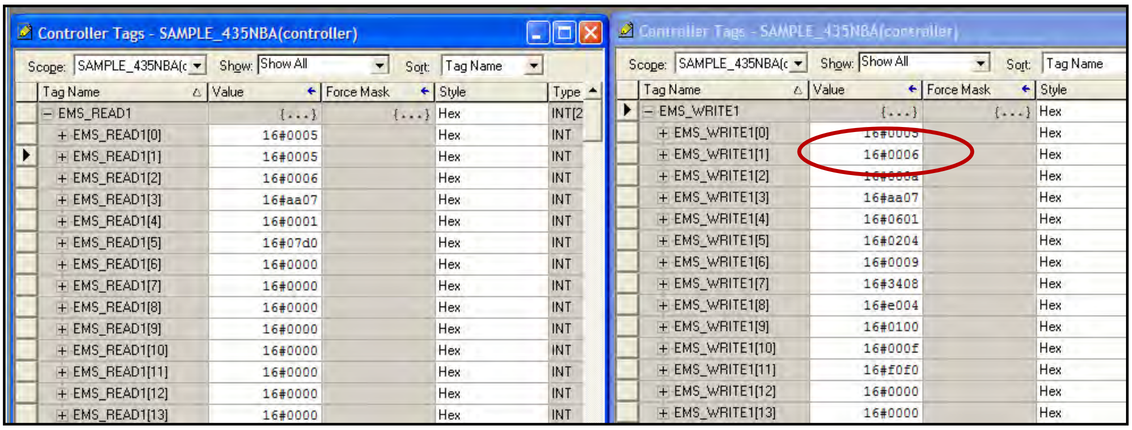
In the example below, **EMS_READ1** is the name of the Read Tag and **EMS_WRITE1** is the name of the Write Tag.

NOTE: **[0]** indicates the first word, **[1]** indicates the second word in a controller tag.

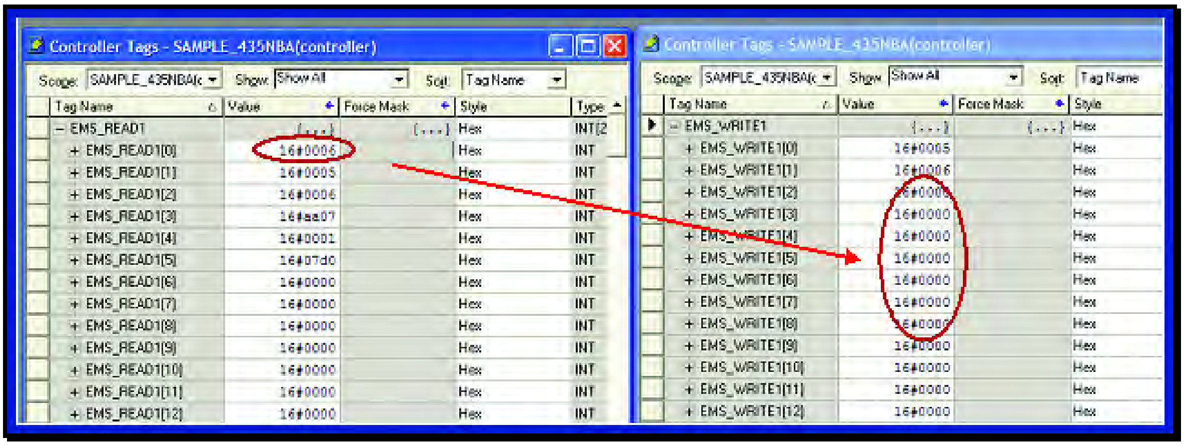
1. The PLC writes the command to the Read Tag (EMS_READ1) and then increments the counter in EMS_READ1 [1]
2. The counter in EMS_READ1 [1] is copied by the Cobalt to EMS_WRITE1 [0] which acknowledges that the command has been received.



3. Following execution of the command, the Cobalt copies the response to EMS_WRITE1 (the Write Tag) and increments the counter in EMS_WRITE1 [1]. This signals that there is new data for the PLC (the Cobalt generated response, in this case).



4. After the PLC has processed the response information, it copies the counter from EMS_WRITE1 [1] to EMS_READ1 [0] which signals to the Cobalt that the PLC has retrieved the response data.



5. The data will then be cleared from EMS_WRITE1. After which the Cobalt will be ready to receive another command.

6.9 ETHERNET/IP: OBJECT MODEL

The ***Object Model*** is the logical organization of attributes (parameters) within classes (objects) and services supported by each device.

Objects are broken down into three categories: ***Required Objects***, ***Vendor Specific Objects*** and ***Application Objects***.

- **Required Objects** are classes that must be supported by all devices on EtherNet/IP. The Cobalt has six Required Objects.
- **Vendor Specific Objects** are classes that add attributes and services that do not fit into the Required Objects or Application Objects categories. The Cobalt has two Vendor Specific Objects.
- **Application Objects** are classes that must be supported by all devices using the same profile. An example of a profile is a Discrete I/O device or an AC

Drive. This ensures that all devices with the same profile have a common look on the network.

DATA TYPE DEFINITION TABLE

EtherNet/IP was designed by the *Open Device Vendors Association* (**ODVA**) as an open protocol. The following table contains a description of the data types used by ODVA that are also found in this chapter.

DATA TYPE	DESCRIPTION
USINT	Unsigned Short Integer (8-bit)
UINT	Unsigned Integer (16-bit)
UDINT	Unsigned Double Integer (32-bit)
STRING	Character String (1 byte per character)
BYTE	Bit String (8-bits)
WORD	Bit String (16-bits)
DWORD	Bit String (32-bits)

Table 6-1: Data Type Definitions

6.9.1 Ethernet/IP Required Objects

Under Ethernet/IP, there are **six** *Required Objects*:

REQUIRED OBJECTS:

Identity Object (0x01)

Message Router Object (0x02)

Assembly Object (0x04)

Connection Manager Object (0x06)

TCP Object (0xF5)

Ethernet Link Object (0xF6)

Identity Object (0x01 - 1 Instance)

Class Attributes

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Revision	UINT	1	Get

Instance Attributes

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Vendor Number	UINT	50 DEC	Get
2	Device Type	UINT	0x0C	Get
3	Product Code Number	UINT	6102 DEC	Get
4	Product Major Revision Product Minor Revision	USINT USINT	01 25	Get
5	Status Word (see below for definition)	WORD	See Below	Get
6	Serial Number	UDINT	Unique 32 Bit Value	Get
7	Product Name: Product Name Size Product Name String	 USINT USINT[26]	HF-CNTL-IND-02 06 "Cobalt"	Get

Status Word

Bit	Bit = 0	Bit = 1
0	No I/O Connection	I/O Connection Allocated
1 – 15	Unused	Unused

Common Services

Service Code	Implementation		Service Name
	Class Level	Instance Level	
0x0E	Yes	Yes	Get Attribute Single
0x05	No	Yes	Reset

Message Router Object (0x02)

This object has no supported attributes.

Assembly Object (0x04 - 3 Instances)

Class Attributes

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Revision	UINT	1	Get
2	Max Instance	UINT	81	Get

Instance 0x64 Attributes (Input Instance)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
3	Status Information:			Get
	Bitmap of Consume Instances with Data	DINT	0	
	Bitmap of Produce Instances with Data	DINT	0	

User Datagram Protocol (UDP) I/O Sequence Number Handshaking

The data producing device increments the data sequence number by one with the transmission of each new serial data packet. Valid sequence numbers are 1-65535. After the consuming device has processed the data, it must echo the sequence number in the handshake to allow the producing device to remove the data from the queue. This is required for I/O communications because UDP is not guaranteed to arrive in order.

If the Node ID number is passed as part of the I/O message, the message is stored to the appropriate location in the Modbus RTU table. Because communications are asynchronous, the Node ID number is also stored as part of the output data. It is the responsibility of the PLC programmer to make sure the proper request lines up with the proper response if the Cobalt is used as a request/response device.

Instance 0x65 Attributes (Input Instance 2)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
3	Serial Produce Data:			Get
	Consume Data Seq. Number Handshake	UINT	0	
	Produce Data Sequence Number	UINT	0	
	Node 1 Serial Produce Data Size	UINT	0	
	Node 1 Serial Produce Data	WORD[100]	All 0's	

Instance 0x66 Attributes (Input Instance 3)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
3	Serial Produce Data:			Get
	Consume Data Seq. Number Handshake	UINT	0	
	Produce Data Sequence Number	UINT	0	
	Node ID (1-32)	UINT	1	
	Node Serial Produce Data Size	UINT	0	
	Node Serial Produce Data	WORD[100]	All 0's	

Instance 0x70 Attributes (Output Instance 1)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
3	Serial Consume Data:			Get / Set
	Produce Data Seq. Number Handshake	UINT	0	
	Consume Data Sequence Number	UINT	0	
	Node 1 Serial Consume Data Size	UINT	0	
	Node 1 Serial Consume Data	WORD[100]	All 0's	

Instance 0x71 Attributes (Output Instance 2)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
3	Serial Consume Data:			Get / Set
	Produce Data Seq. Number Handshake	UINT	0	
	Consume Data Sequence Number	UINT	0	
	Node ID (1-32)	UINT	1	
	Node Serial Consume Data Size	UINT	0	
	Node Serial Consume Data	WORD[100]	All 0's	

Instance 0x80 Attributes (Configuration Instance)

Most I/O clients include a configuration path when opening an I/O connection to a server. There is no configuration data needed.

Instance 0x81 Attributes (Heartbeat Instance – Input Only)

This instance allows clients to monitor input data without providing output data.

Common Services

Service Code	Implementation		Service Name
	Class Level	Instance Level	
0x0E	Yes	Yes	Get Attribute Single
0x10	No	Yes	Set Attribute Single

CONNECTION MANAGER OBJECT (0X06)

This object has no attributes.

TCP OBJECT (0XF5 - 1 INSTANCE)

Class Attributes

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Revision	UINT	1	Get

Instance Attributes

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Status*	DWORD	1	Get
2	Configuration Capability*	DWORD	0	Get
3	Configuration Control*	DWORD	0	Get
4	Physical Link Object*			Get
	Structure of:			
	Path Size	UINT	2	
	Path	Array Of WORD	0x20F6 0x2401	
5	Interface Configuration*			Get
	Structure of:			
	IP Address	UDINT	0	
	Network Mask	UDINT	0	
	Gateway Address	UDINT	0	
	Name Server	UDINT	0	
	Name Server 2	UDINT	0	
	Domain Name Size	UINT	0	
	Domain Name	STRING	0	

6	Host Name* Structure of: Host Name Size Host Name	 UINT STRING	 0 0	Get

*See section 5-3.2.2.1 – 5-3.2.2.6 of "Volume 2: EtherNet/IP Adaptation of CIP" from ODVA for more information regarding these attributes.

Common Services

Service Code	Implementation		Service Name
	Class Level	**Instance Level**	
0x0E	Yes	Yes	Get Attribute Single

Ethernet Link Object (0xF6 - 1 Instance)

Class Attributes

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Revision	UINT	1	Get

Instance Attributes

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Interface Speed*	UDINT	100	Get
2	Interface Flags*	DWORD	3	Get
3	Physical Address*	USINT Array[6]	0	Get

*See section 5-4.2.2.1 – 5-4.2.2.3 of "Volume 2: EtherNet/IP Adaptation of CIP" from ODVA for more details on this attribute.

Common Services

Service Code	Implementation		Service Name
	Class Level	**Instance Level**	
0x0E	Yes	Yes	Get Attribute Single

6.9.2 EtherNet/IP: Vendor Specific Objects

The Cobalt has two Vendor Specific Objects:

VENDOR SPECIFIC OBJECTS:

Cobalt Consume Data Object (0x64)

Cobalt Produce Data Object (0x65)

COBALT CONSUME DATA OBJECT (0X64 - 32 INSTANCES)

Class Attributes (Instance 0)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Revision	UINT	1	Get
2	Maximum Consume Data Buffer Size (in words)	UINT	32768	Get
3	Bitmap of Consume Instances with Data Bit 0: Instance 1 … Bit 31: Instance 32	DINT	0	Get

Instance Attributes (Instances 1-32)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Consume Data Size (in words)	UINT	0	Get / Set
2	Consume Data [0-249]	UINT	0	Get / Set
3	Consume Data [250-499]	UINT	0	Get / Set
4	Consume Data [500-749]	UINT	0	Get / Set
5	Consume Data [750-999]	UINT	0	Get / Set
6	Consume Data [1,000-1,249]	UINT	0	Get / Set
…	…	…	…	…
10	Consume Data [2,000-2,249]	UINT	0	Get / Set
…	…	…	…	…
34	Consume Data [8,000-8,249]	UINT	0	Get / Set
…	…	…	…	…
38	Consume Data [9,000-9,249]	UINT	0	Get / Set
…	…	…	…	…
42	Consume Data [10,000-10,249]	UINT	0	Get / Set

…	…	…	…	…
82	Consume Data [20,000-20,249]	UINT	0	Get / Set
…	…	…	…	…
122	Consume Data [30,000-30,249]	UINT	0	Get / Set
…	…	…	…	…
126	Consume Data [31,000-31,249]	UINT	0	Get / Set
…	…	…	…	…
130	Consume Data [32,000-32,249]	UINT	0	Get / Set
131	Consume Data [32,250-32,249]	UINT	0	Get / Set
132	Consume Data [32,500-32,249]	UINT	0	Get / Set
133	Consume Data [32,750-32,767]	UINT	0	Get / Set

Common Services

Service Code	Implementation		Service Name
	Class Level	Instance Level	
0x05	No	Yes	Reset*
0x0E	Yes	Yes	Get Attribute Single
0x10	No	Yes	Set Attribute Single

*This Service Code is used to flush all attributes to zero.

Cobalt Produce Data Object (0x65 - 32 Instances)

Class Attributes (Instance 0)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Revision	UINT	1	Get
2	Maximum Produce Data Buffer Size (in words)	UINT	32768	Get
3	Bitmap of Produce Instances with Data Bit 0: Instance 1 … Bit 31: Instance 32	DINT	0	Get

Instance Attributes (Instances 1-32)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Produce Data Size (in words)	UINT	0	Get / Set
2	Produce Data [0-249]	UINT	0	Get
3	Produce Data [250-499]	UINT	0	Get
4	Produce Data [500-749]	UINT	0	Get
5	Produce Data [750-999]	UINT	0	Get
6	Produce Data [1,000-1,249]	UINT	0	Get
…	…	…	…	…
10	Produce Data [2,000-2,249]	UINT	0	Get
…	…	…	…	…
34	Produce Data [8,000-8,249]	UINT	0	Get
…	…	…	…	…
38	Produce Data [9,000-9,249]	UINT	0	Get
…	…	…	…	…
42	Produce Data [10,000-10,249]	UINT	0	Get
…	…	…	…	…
82	Produce Data [20,000-20,249]	UINT	0	Get
…	…	…	…	…
122	Produce Data [30,000-30,249]	UINT	0	Get
…	…	…	…	…
126	Produce Data [31,000-31,249]	UINT	0	Get
…	…	…	…	…
130	Produce Data [32,000-32,249]	UINT	0	Get
131	Produce Data [32,250-32,249]	UINT	0	Get
132	Produce Data [32,500-32,249]	UINT	0	Get
133	Produce Data [32,750-32,767]	UINT	0	Get

Common Services

Service Code	Implementation		Service Name
	Class Level	Instance Level	
0x05	No	Yes	Reset*
0x0E	Yes	Yes	Get Attribute Single
0x10	No	Yes	Set Attribute Single

*This Service Code is used to flush all attributes to zero.

6.9.3 Application Object (0x67 – 10 Instances)

Class Attributes (Instance 0)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	Revision	UINT	1	Get

Instance Attributes (Instances 1-32)

Attribute ID	Name / Description	Data Type	Default Data Value	Access Rule
1	**Instance Type** (0-3): 0 - Disable 1 – ControlLogix 2 – SLC 5/05 3 – PLC5E	USINT	0	Get
2	**PLC IP Address**	UDINT	0	Get
3	**PLC Slot Location** (0-255)	USINT	0	Get
11	**Max Write Size** in Words: 0 – Disabled 1 – 100 Words	UINT	0	Get
12	**Write Tag Name** (ControlLogix Only)	SHORT STRING	0	Get
13	**Write File Number** (SLC/PLC Only) **NX:0** - where **"X"** is the File Number	UINT	7	Get
14	**Write File Offset** (SLC/PLC Only) **N7:Y** - where **"Y"** is the File Offset	UINT	0	Get

15	**Write "Heartbeat" Timeout** • Measured in 10ms "ticks" • 0 = disabled • Max value: 6000 ticks	UINT	100	Get
21	**Max Read Size** in Words 0 – Disable Max Value: 100	UINT	0	Get
22	**Read Tag Name** (ControlLogix Only)	SHORT STRING	0	Get
23	**Read File Number** (SLC/PLC Only) **NX:0 -** Where **"X"** is the File Number	UINT	7	Get
24	**Read File Offset** (SLC/PLC Only) **N7:Y** - Where **"Y"** is the File Offset	UINT	0	Get
25	**Read Poll Rate** • Measured in 10ms "ticks" • 0 = disabled • 6000 ticks max	UINT	100	Get

Common Services

Service Code	Implementation		Service Name
	Class Level	Instance Level	
0x0E	Yes	Yes	Get Attribute Single

CHAPTER 7: MODBUS TCP INTERFACE

One of the most popular and well-proven industrial automation protocols in use today is Modbus®. Modbus is an open client/server application protocol. Modbus TCP allows the Modbus protocol to be carried over standard Ethernet networks. Modbus TCP is managed by the *Modbus-IDA User Organization*.

7.1 MODBUS TCP OVERVIEW

Under the MODBUS® TCP protocol, the Cobalt acts as a Modbus Server and the PLC acts as a Modbus Client. By utilizing **Produce** and **Consume** registers for mapping commands and responses, data produced by the Cobalt is consumed by the Modbus Client and data produced by the Modbus Client is consumed by the Cobalt.

ATTENTION:

• Modbus Client (Host or PLC) must connect to the Modbus Server (Cobalt) on port 50200

• Maximum number of words transferred to/from an RFID tag per read/write cycle: 100 Words / 200 Bytes

• Disable any firewall services running on the PC. Firewalls can potentially block communications between the Cobalt and the host and/or PLC

7.2 MODBUS TCP CONFIGURATION VIA *HTML SERVER*

To configure the Cobalt for Modbus TCP communications, begin by assigning the controller a locally compatible IP address.

Through a standard Web browser, you can utilize the Cobalt's *HTML Server* to access an embedded suite of controller configuration tools, called the "***OnDemand Utilities***." Among its features is the ability to modify and save changes to the controller's IP address, which is stored internally on the Cobalt.

Cobalt Industrial Ethernet RFID Controller - Default IP Address:

192.168.253.110

7.2.1 Setting the IP Address of the Cobalt

To set the Cobalt's IP address using the *HTML Server,* follow the steps below:

1. Open a Web browser on the host.
2. In the URL address field, enter the Cobalt's IP address (*192.168.253.110 = factory default)***.**
3. Press ***ENTER***.

The *HTML Server - Main Page* will be displayed.

HTML Server – Main Page

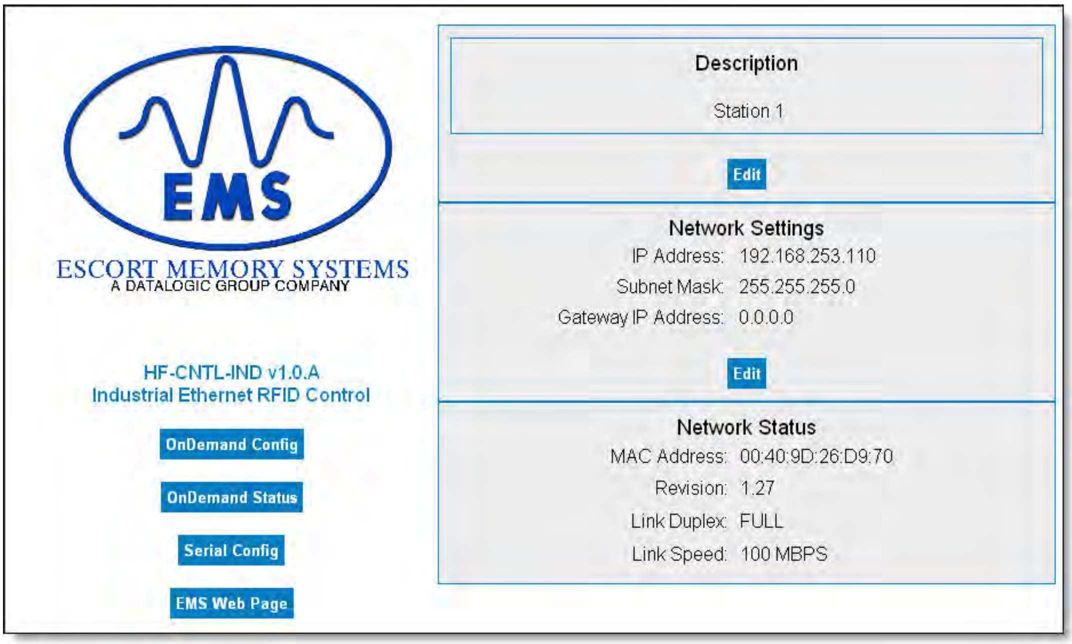
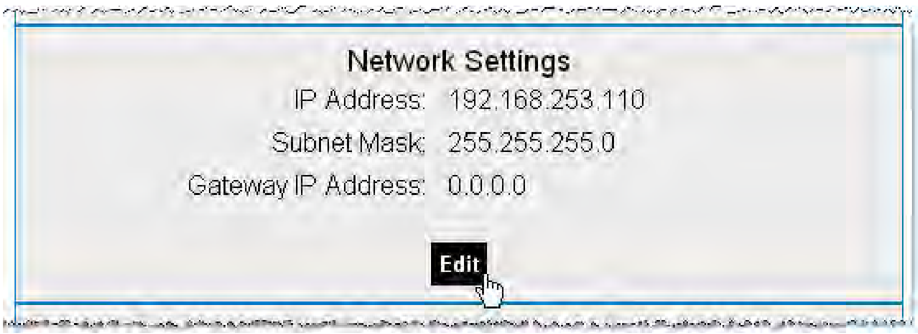


Figure 7-1: The HTML Server - Main Page

The ***HTML Server - Main Page*** lists the network settings (including the IP address) currently stored on the Cobalt.

4. Click the button labeled “***EDIT***”, located below “***Network Settings.***”



The *IP Configuration Page* will be displayed.

IP Configuration Page

The *IP Configuration Page* is used to modify and save changes to the IP Address, Subnet Mask and (Network) Gateway IP Address.

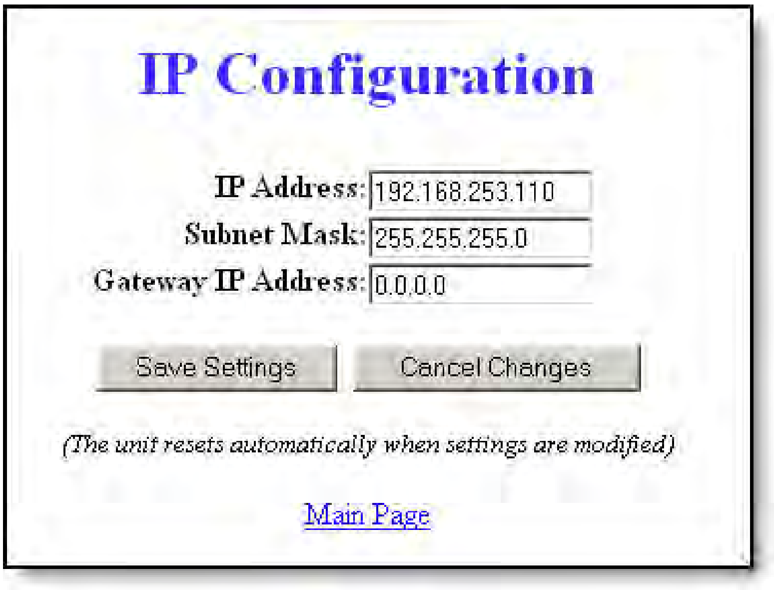


Figure 7-2: The IP Configuration Page

5. In the fields provided, enter your new IP configuration values for the Cobalt.

6. Click the **"*Save Settings*"** button to store your new IP configuration, then cycle power to the UHF-CNTL to store the changes in the main memory. The Ethernet module will reset and your IP changes will be implemented.

7. After the Cobalt has restarted, verify the new IP configuration by opening a Web browser and manually entering the Cobalt's new IP address in the URL field. If successful, you should arrive back at the *HTML Server – Main Page*.

7.2.2 Modbus TCP - Command Packet Structure

Consume Registers hold data that is destined for the Cobalt. Modbus TCP commands must be placed in the holding registers, starting at address 40001, of Device ID 01 (Node Input Page 01). Commands utilize at least six registers (double-byte values or words).

MODBUS ADDRESS (4XXXX / 3XXXX)	READ / WRITE PRIVILEGE	REGISTER DESCRIPTION
(40001) 1	R/W	2-byte Consume Data Overall Length (> 0 indicates data is available; Cobalt clears to 0 after data is processed)
2	R/W	MSB = Reader Type LSB = Command ID
3	R/W	MSB = 0x00 LSB = Node ID (0x01 for the Cobalt)
4	R/W	2-byte Timeout Value (0-65535) measured in milliseconds
5	R/W	2-byte Start Address (0-65535)
6	R/W	2-byte Read/Block Size (0-65535 bytes)
7 – 32774	R/W	Cobalt Consume Data (when applicable)
32775 – 65536	R/W	Reserved

Table 7-1: Modbus TCP - Command Packet Structure

7.2.3 Modbus TCP - Response Packet Structure

Produce Registers hold data that is destined for the host or PLC.

MODBUS ADDRESS (4XXXX / 3XXXX)	READ / WRITE PRIVILEGE	REGISTER DESCRIPTION
(40001) 1	R/W	2-byte Produce Data Overall Length (> 0 indicates data is available; Modbus Client clears to 0 after data is processed)
2	RO	MSB = Reader Type LSB = Command Echo
3	RO	Node ID Number (33 for the Cobalt)
4	RO	Timeout Value (0-65535)
5	RO	Read/Write Start Address (0-65535)
6	RO	Read/Block Size (0-65535 bytes)
7 – 32774	RO	Cobalt Produce Data (when applicable)
32775 – 65536	RO	Reserved

Table 7-2: Modbus TCP - Response Packet Structure

7.2.4 Modbus TCP - Mapping for Node 33

MODBUS ADDRESS (4XXXX)	READ / WRITE PRIVILEGE	REGISTER DESCRIPTION
1	R/W	IP Address 1 (MSB) Example: 192
2	R/W	IP Address 2 Example: 168
3	R/W	IP Address 3 Example: 000
4	R/W	IP Address 4 (LSB) Example: 100
5	R/W	Subnet Mask 1 (MSB) Example: 255
6	R/W	Subnet Mask 2 Example: 255
7	R/W	Subnet Mask 3 Example: 255
8	R/W	Subnet Mask 4 (LSB) Example: 000
9	R/W	Gateway Address 1 (MSB) Example: 192
10	R/W	Gateway Address 2 Example: 168
11	R/W	Gateway Address 3 Example: 000
12	R/W	Gateway Address 4 (LSB) Example: 001

13	RO	MAC Address 1 (MSB) Example: 0x00
14	RO	MAC Address 2 Example: 0x40
15	RO	MAC Address 3 Example: 0x9D
16	RO	MAC Address 4 Example: 0x12
17	RO	MAC Address 5 Example: 0x34
18	RO	MAC Address 6 (LSB) Example: 0x56
19	RO	Link Status: 0 = No Link 1 = Link is OK
20	RO	Ethernet Speed (10M or 100M bits)
21	RO	Link Duplex: 0 = Half Duplex 1 = Full Duplex
22	RO	Revision (Major/Minor)
23 – 1000	R/W	Reserved
1001	RO	(Input) Data Ready Mask - Nodes 1 - 16
1002	RO	(Input) Data Ready Mask - Nodes 17 - 32
1003	RO	(Output) Data Ready Mask - Nodes 33 - 48
1004	RO	(Output) Data Ready Mask - Nodes 49 - 64
1005-10099	R/W	Reserved
10100 – 10199	R/W	Reserved
10200 – 10299	R/W	Reserved
…	…	…
13100 – 13199	R/W	Reserved
13200 – 13299	R/W	Reserved
13300 – 65536	R/W	Reserved

Table 7-3: Modbus TCP - Mapping for Node 33

7.3 MODBUS TCP – HANDSHAKING

Due to the process with which commands and responses are passed between the Cobalt and the host, a handshaking procedure is used to notify the host that returning data is available for retrieval.

OVERALL LENGTH

The handshaking process is governed by the changing of the "***Overall Length***" value within a data packet. The Overall Length value is typically the first word (2-bytes) of a command or response and indicates the total number of data words in the packet.

NODE INPUT AND NODE OUTPUT PAGES

Under the Modbus TCP protocol, host-generated data is written to a pre-defined region of the Cobalt's own memory known as the ***Node Input Page***. Host-bound data generated by the Cobalt, is written to a separate region of the Cobalt's memory known as the ***Node Output Page*** (in Modbus TCP these regions of memory are called **Device IDs**). Node Input and Node Output Pages are used to temporarily hold incoming (controller-bound) and outgoing (host-bound) data.

OUTPUT DATA READY MASK

To notify the host that new data is waiting to be retrieved from the Node Output Page, the Cobalt utilizes a separate 32-bit block of internal memory, called the ***Output Data Ready Mask***.

The first bit of the 32-bit Output Data Ready Mask represents the status of the Node Output Page. For example, the first or lowest bit (*bit 01*) represents Node Output Page 33 - which holds output data from Node 01.

The Cobalt, itself, is assigned Node 01 and thus, its corresponding Node Output Page is 33. As noted, Node Output Page 33 is represented by the first bit (*bit 01*) in the Output Data Ready Mask.

HOLDING REGISTERS

When writing host-bound data to Node Output Page 33, the Cobalt actually places each byte of the data packet into pre-defined "***holding registers***" within the Node Output Page. Note that a single holding register stores 2-bytes or one word of data. The 2-byte *Overall Length* value, for example, is written to the first holding register (which is location **40001)** of the Node Output Page.

Then, as the Cobalt finishes writing host-bound data to the Node Output Page, the Overall Length value (stored at holding register 40001) will change from its default value of *0x00* to reflect the number of data words within the newly written host-bound data packet. This change to the Overall Length value (i.e. register 40001) within the Node Output Page, triggers the Cobalt to enable (change from zero to one) bit one in the Output Data Ready Mask. It is when bit one in the Output Data Ready Mask has become enabled, that the host will recognize the pending data.

Finally, after the host has retrieved its pending data, the enabled bit in the Output Data Ready Mask and the Overall Length value at holding register 40001 of the Node Output Page will be reset to zero (0x00), indicating that the host has received and processed its pending data.

7.3.1 Modbus TCP - Host/Cobalt Handshaking

When the host issues a command, it must first write the entire command to the Node Input Page, leaving the Overall Length value to be written last.

For example, for the host to issue the 6-word command "*Read Data*," it must first write the last five words of the command to Node Input Page 01, beginning at register 40002. After which, the host will fill in the first word (at holding register 40001) with the Overall Length of the command packet.

Last Five Words of a Read Data Command

WORD	MSB	LSB	DESCRIPTION
02	0xAA	0x05	**Command ID:** Read Data
03	0x00	0x01	**Node ID:** 0x01
04	0x03	0xE8	**Timeout Value:** 1 second
05	0x00	0x20	**Read Start Address**: 0x0020
06	0x00	0x04	**Block Size**: 4 Bytes

After writing the last five words of the command, the host will write the Overall Length value to holding register 40001 of Node Input Page 01.

First Word of a Read Data Command

WORD	MSB	LSB	DESCRIPTION
01	0x00	0x06	**Overall Length** (*in words*)

The moment the Overall Length value (at holding register 40001) of Node Input Page 01 changes from 0x0000 to a "non-zero" value, the Cobalt will recognize the waiting data and will execute the command.

7.3.2 Modbus TCP - Handshaking Example

1. The host or PLC issues an RFID command to the Cobalt, writing the command string to the holding registers for Device ID 01 (Node Input Page 01). An Overall Length value of 0x0006 is written last to holding register 40001.
2. The Cobalt recognizes that the Overall Length value at holding register 40001 has changed for Device ID 01 (Node Input Page 01), indicating that a command is waiting to be executed.
3. The Cobalt executes the command and then clears the Overall Length holding register of Device ID 01 (Node Input Page 01), setting it back the default value of zero (0x0000).

NOTE: when the Node Input Page's value at register 40001 is returned to 0x0000, the host can assume that the command was at least received and execution was attempted. The host can also assume that it is OK to clear the remaining holding registers and write another command to the Device ID (Node Input Page).

4. After the Cobalt executes its given command instructions, it will write the command response to the holding registers for Device ID 33 (Node Output Page 33). Again, the Overall Length value is written last to holding register 40001.

NOTE: Host-bound data is always written to Device ID 33 (Node Output Page 33).

5. With holding register 40001 of Device ID 33 (Node Output Page 33) now containing a non-zero length value, the Cobalt will enable (change from zero to 1) the first bit in the ***Output Data Ready Mask.*** (The first bit is allocated to Node Output Page 33).
6. Once bit 01 in the *Output Data Ready Mask* becomes enabled, the host retrieves the data string stored in the holding register area for Device ID 33 (Node Output Page 33).
7. After importing the data from Device ID 33 (Node Output Page 33), the host clears (sets back to 0x0000) the Overall Length value at holding register 40001 of Device ID 33 (Node Output Page 33). In doing so, bit 01 in the Output Data Ready Mask is also cleared.

NOTE: the clearing of bit 01 in the Output Data Ready Mask indicates to the Cobalt that the host has received the response and that it is now OK to write another response to Node Output Page 33.

This completes the Modbus TCP handshaking cycle.

CHAPTER 8: STANDARD TCP/IP INTERFACE

8.1 STANDARD TCP/IP OVERVIEW

Another means of communicating with the Cobalt is through the standard TCP/IP protocol. For this manual, the protocol is referred to as ***standard TCP/IP*** to distinguish it from other industrial protocols.

In this environment, the Cobalt acts as the server and the host or PLC acts as client. Standard TCP/IP sessions are established between the host computer and the Cobalt via TCP/IP client software. A TCP/IP session generally consists of three stages: *connection setup, data transactions* and *connection termination*.

All connections to the Cobalt are initiated by client side software only. If, for example, an existing connection terminates unexpectedly, the Cobalt will not attempt to contact the client software or re-establish a connection. The client is responsible for opening, maintaining, and closing all TCP/IP sessions.

After establishing a successful connection, communications between the host and the Cobalt can proceed. When communication is no longer necessary, it is the responsibility of the client side application to terminate the connection.

ATTENTION:

• The TCP/IP client software (running on the host or PLC) must connect to the TCP/IP server (Cobalt) on port 50200

• Maximum number of words transferred to/from an RFID tag per read/write cycle: 100 Words / 200 Bytes

• Disable any firewall services running on the PC. Firewalls can potentially block communications between the Cobalt and the host and/or PLC

8.2 STANDARD TCP/IP – IP CONFIGURATION VIA *HTML SERVER*

To configure the Cobalt for standard TCP/IP communications, begin by assigning the controller a locally compatible IP address.

Through a standard Web browser, you can utilize the Cobalt's *HTML Server* to access an embedded suite of controller configuration tools, called the "***OnDemand Utilities***." Among its features is the ability to modify and save changes to the controller's IP address, which is stored internally on the Cobalt.

Cobalt Industrial Ethernet RFID Controller Default IP Address:

192.168.253.110

8.2.1 Setting the IP Address of the Cobalt

To set the Cobalt's IP address using the *HTML Server,* follow the steps below:

1. Open a Web browser on the PC.
2. In the URL address field, enter the Cobalt's IP address (*192.168.253.110 = factory default*).
3. Press ENTER.

The *HTML Server - Main Page* will be displayed.

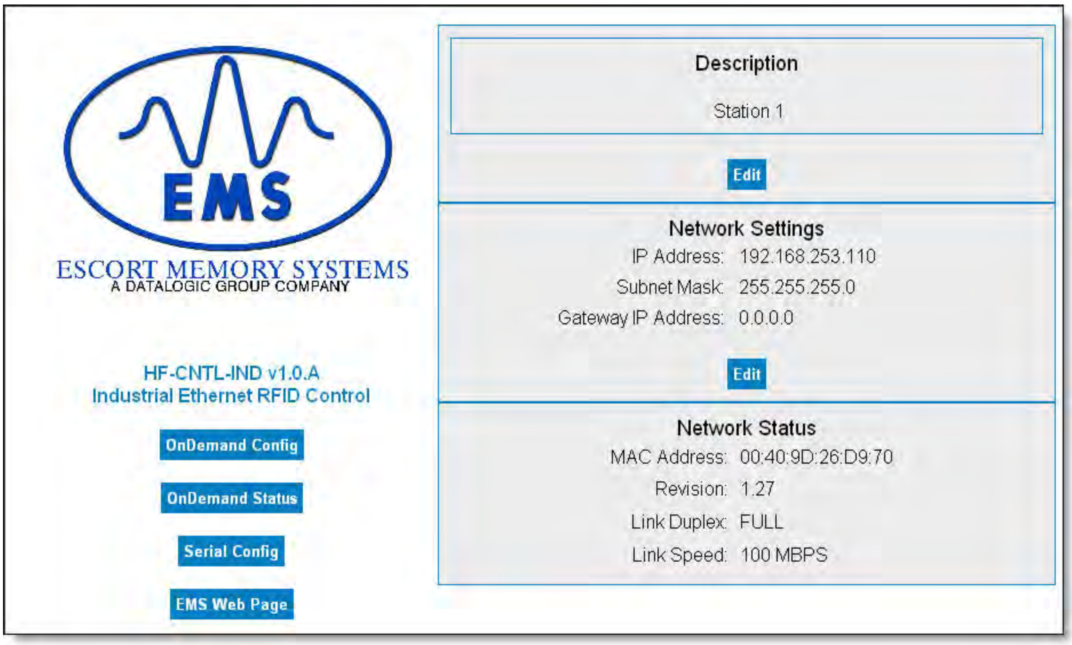
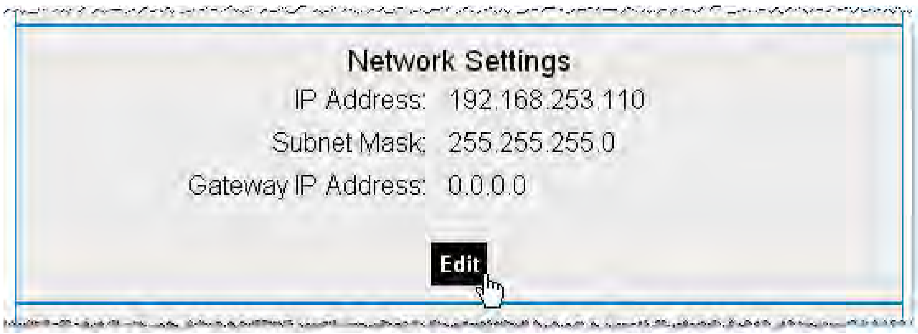


Figure 8-1: The HTML Server - Main Page

The ***HTML Server - Main Page*** lists the network settings (including the IP address) currently stored on the Cobalt.

4. Click the button labeled "***EDIT***", located below "***Network Settings.***"



The *IP Configuration Page* will be displayed.

IP Configuration Page

The *IP Configuration Page* is used to modify and save changes to the IP Address, Subnet Mask and (Network) Gateway IP Address.

Figure 8-2: The IP Configuration Page

5. In the fields provided, enter your new IP configuration values for the Cobalt.

6. Click the **"*Save Settings*"** button to store your new IP configuration. The Cobalt will completely reset and your IP changes will be implemented.

7. After the Cobalt has restarted, verify the new IP configuration by opening a Web browser and manually entering the Cobalt's new IP address in the URL field. If successful, you should arrive back at the *HTML Server – Main Page*.

8.3 STANDARD TCP/IP – COMMAND & RESPONSE EXAMPLES

In standard TCP/IP, RFID commands issued by the host resemble Modbus TCP commands. The Cobalt handles all handshaking tasks.

Moreover, the command & response packets need an additional word at the beginning of the string:

Protocol Header 0xFF in MSB, **<Node ID>** in LSB.

Please notice that these two bytes are not considered part of the CBx command packet and should not be counted in the *Overall Length.*

Below is the structure of the additional word required, named as **Word # 00**:

WORD #	COMMAND PACKET ELEMENT	MSB	LSB
00	**Protocol Header** in MSB: *0xFF* **Node ID** in LSB	0xFF	<Node ID>

And similarly for the response:

WORD #	RESPONSE PACKET ELEMENT	MSB	LSB
00	**Protocol Header** in MSB: 0xFF **Node ID Echo** in LSB	0xFF	<Node ID Echo>

NOTE: These first two bytes will not be returned in the response packet for commands executed by Node 01.

Therefore, the command packet structure for standard TCP/IP applications is:

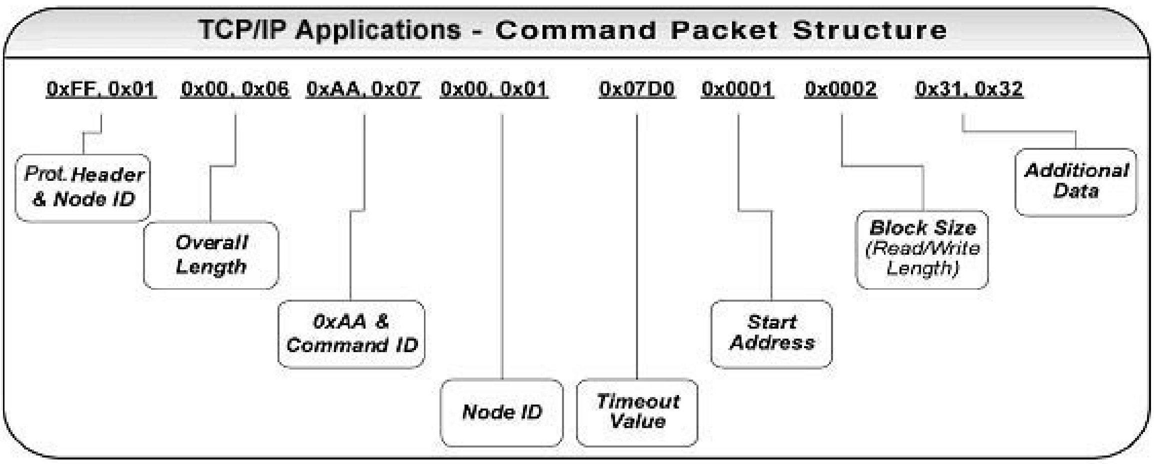


Figure 8-3: Standard TCP/IP Protocol Command Packet Structure

8.3.1 Standard TCP/IP - Command Structure & Example

In the following example, a 12-byte command has been issued to the Cobalt, instructing the controller to read six bytes from a tag within RF range. A *Timeout Value* of five seconds has been set for the completion of the command.

WORD	DESCRIPTION	MSB	LSB
00	**Protocol Header** in MSB = 0xFF **Node ID** in LSB = default value for Cobalt -IND is one (0x01)	0xFF	0x01
01	**Overall Length:** 2-byte integer indicating number of "*words*" in the command packet	0x00	0x06
02	**MSB** = 0xAA **LSB** = Command ID: (example: *0x05 – Read Data*)	0xAA	0x05
03	**MSB** = 0x00 **LSB** = Node ID: default value for Cobalt -IND is one (0x01)	0x00	0x01
04	**Timeout Value:** 2-byte integer measured in .10 (1/10th) second increments. (*0x0032 = 50 x .10 or 5 seconds*)	0x00	0x32
05	**Start Address:** 2-byte integer identifies tag address where read will begin	0x00	0x01
06	**Block Size:** 2-byte integer indicates number of bytes to retrieve	0x00	0x06

Table 8-1: Standard TCP/IP - Command Structure & Example

8.3.2 Standard TCP/IP - Response Structure & Example

The following resembles a typical response to the command issued in the previous example:

WORD	DESCRIPTION	MSB	LSB
00	**Protocol Header** in MSB = **0xFF** **Node ID** in LSB = default value for Cobalt -IND is one (**0x01**)	0xFF	0x01
01	**Overall Length:** 2-byte integer indicating number of "*words*" in the response packet	0x00	0x09
02	**MSB** = 0xAA **LSB** = Command Echo: (*0x05 - Read Data)*	0xAA	0x05
03	**MSB** = Instance Counter **LSB** = Node ID: *0x01*	<IC>	0x01
04	**Time Stamp:** Month / Day (*March 19th*)	0x03	0x13
05	**Time Stamp:** Hour / Minute (*8:15 a.m.)*	0x08	0x0E
06	**MSB** = Time Stamp: Seconds **LSB** = Number of Additional Bytes Retrieved: *6*	0x00	0x06
07	**Retrieved Bytes** 1 & 2	0x61	0x62
08	**Retrieved Bytes** 3 & 4	0x63	0x64
09	**Retrieved Bytes** 5 & 6	0x65	0x66

Table 8-2: Standard TCP/IP - Response Structure & Example

CHAPTER 9: RFID OVERVIEW

9.1 RFID OVERVIEW

Cobalt UHF-Series products are designed for use with passive RFID tags, which do not require batteries or contain an internal power supply. The tags collect the power necessary to operate from the RF field generated by the reader and through a process called backscattering they can reflect some of this power back to the reader, thus creating a communication channel.

When a passive tag comes in contact with the RF field from an RFID antenna, the incoming radio frequency signal generates a small, but sufficient, electrical current that powers the passive tag's integrated circuit (IC)

When mounting RFID antennas and tags, it is important to understanding certain principles. If your RFID application requires that the tag be attached directly to a metal surface, always use a non-metallic tag spacer to avoid a possible reduction in read/write range.

In addition, motors, conveyors and other automation equipment can produce excessive electrical noise that may also negatively affect RF performance. Cobalt UHF-Series products should only be used with well-grounded systems. Conveyor equipment should be tied directly to an earth ground by an electrician. All cables used on or around Cobalt UHF RFID devices must be shielded. Cable shields typically should be grounded at only one end.

The majority of the *Antenna-to-Tag* range results specified in this publication were measured in a free air environment – where no metallic objects were within the antenna's RF field. Yet because proximity to metals and other environmental conditions can adversely affect read and write range, it is not possible to state absolute range results achieved under all conditions. System integrators should validate the RF performance of the RFID products used and should not rely solely on Datalogic's published range specifications.

9.2 Overview on Ultra High Frequency RFID Applications

9.2.1 UHF Standards and Regulations

One of the most important aspects of a tag and reader coupling is the frequency at which it operates. Frequency of operation can vary based on the application, standards, and regulations.

The most common RFID frequency ranges are Low Frequency (LF) at 135kHz or less, High Frequency (HF) at 13.56MHz, Ultra High Frequency (UHF) starting at 300MHz. Microwave Frequency at 2.45GHz and 5.4GHz is also used in some applications.

Ultra High Frequency (UHF) designates a range (or band) of electromagnetic waves with frequencies between 300 MHz and 2.45 GHz (2,450 MHz).

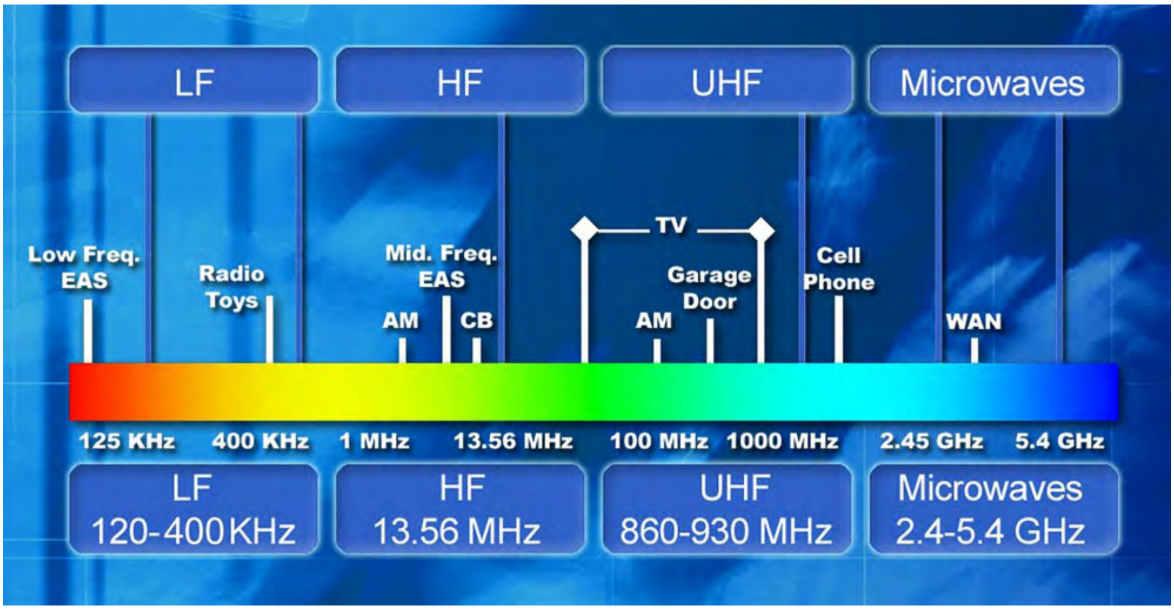


Figure 9-1: Radiowaves Spectrum Diagram

There are different UHF operating frequency standards all over the world, regulated by governmental authorities in most countries: for instance, Federal Communications Commission (FCC) in the United States and ETSI (European Telecommunications Standards Institute) in Europe.

Globally, each country has its own frequency allocation for RFID.
For instance, RFID UHF bands are:

865–870 MHz in Europe

902–928 MHz in North and South America

950–956 MHz in Japan and some Asian countries

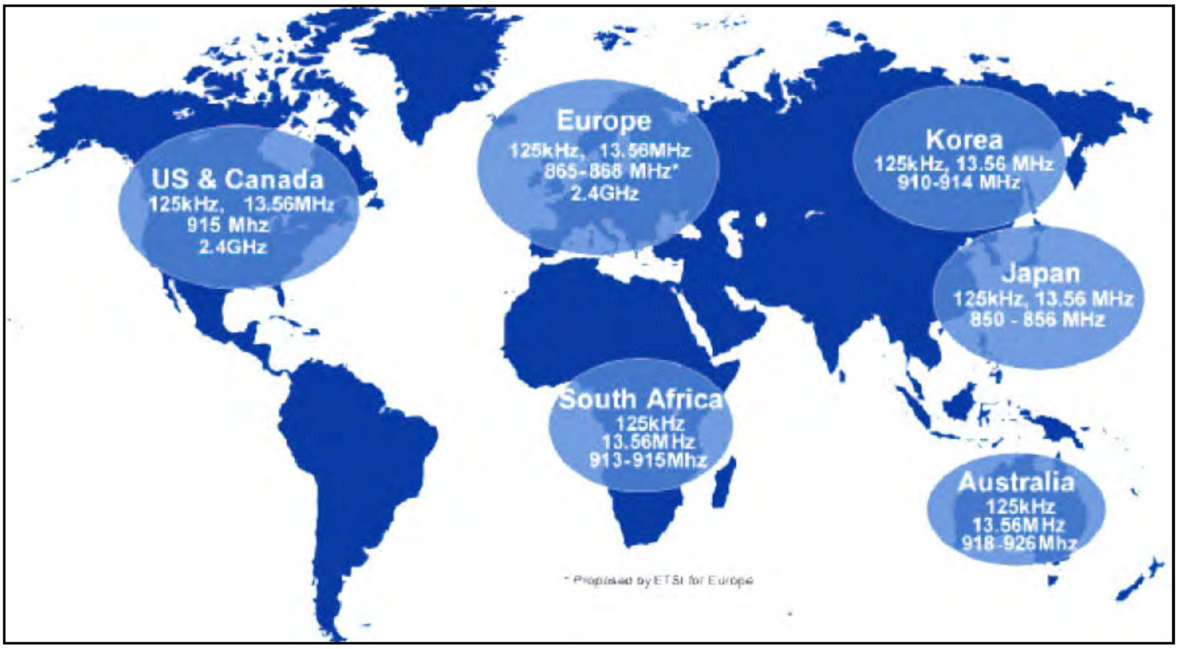


Figure 9-2: Radiofrequency Bands Allocation

With reference to power limits, the maximum allowed reader radiated power is 4 Watts in the US, and 2 Watts in Europe.

REGION	REGULATIONS	RADIATED POWER
USA	FCC Part 15	4 W EIRP (36 dBm)
Europe	EN 302 208	2 W ERP (35 dBm)

Table 9-1:Reader Radiated Power Limits Expressed in Watt or dBm

9.2.2 UHF Signal Propagation

In general, the frequency defines the data transfer rate (speed) between the tag and the reader. For this reason, UHF systems feature long range, and high speed read/write rates.

Small antennas and even smaller tags have proven this to be an effective frequency for tracking pallets through dock doors, as well as trucking and transportation applications. Industrial UHF applications have also begun to effectively be developed for tracking parts, product and carriers through production.

In this context, Cobalt UHF is ideal for industrial applications where single or multiple tags must be read at long distance and at high speed.

The main advantage of UHF transmission is the physically short wave that is produced by the high frequency. The size of transmission and reception equipment, (particularly antennas), is related to the size of the radio wave.

The higher the frequency, the shorter the wavelength for RF transmission. Without going into the details of the physics, the shorter the wavelength, the better a small antenna like an RFID tag is able to receive a transmission at greater distances. Therefore, smaller and less conspicuous antennas can be used with higher frequency bands.

For the Cobalt UHF- Series product line, Datalogic offers a range of circular polarized antennas, for which tag orientation is less critical.

In effect, the helical nature of the field from a circular polarized antenna allows it to read tags in random orientation.

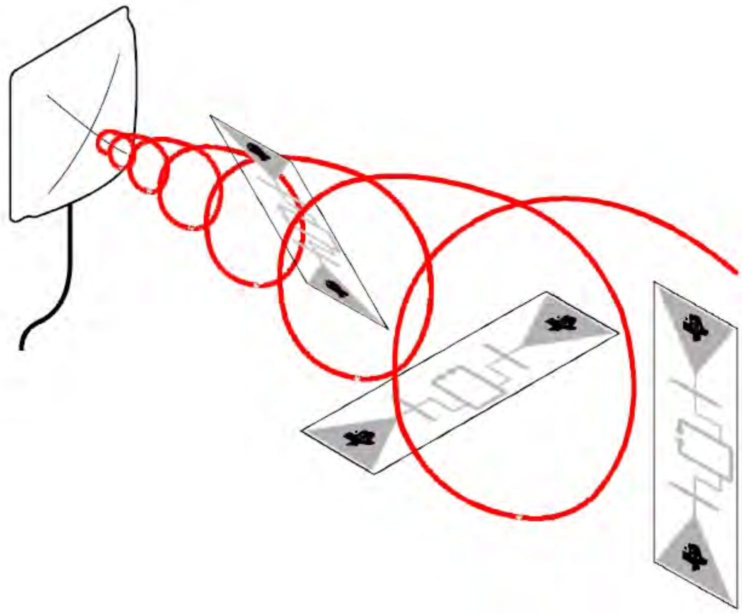
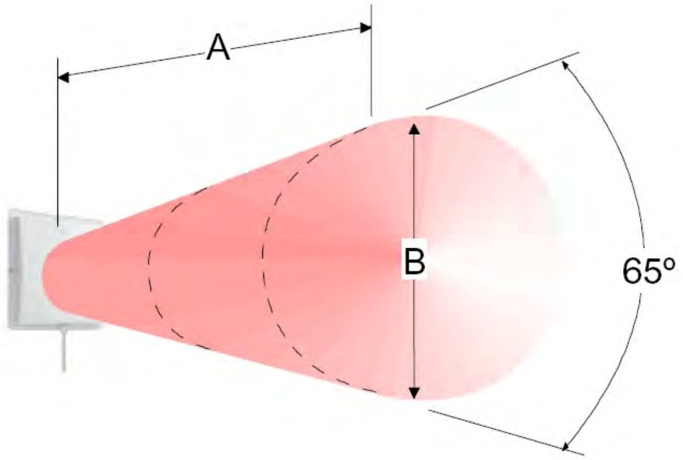


Figure 9-3: Circular Polarized Antenna's Field Pattern

Furthermore, the Cobalt UHF antennas feature a 3dB Beamwidth, 63° or 65°, providing a large reading zone.

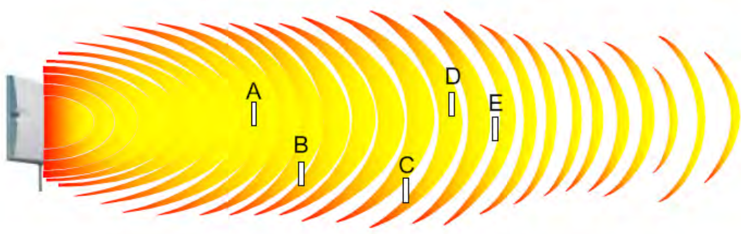


3 DB BEAM WIDTH	
A	B
0.5	0.6
1.0	1.3
1.5	2.0
2.0	2.6
2.5	3.1
3.0	3.7

Figure 9-4: Circular Polarized Antenna's Reading Range

As considered above, the ability for signals to propagate within environment is dependent on the signal wavelength, and hence frequency. UHF will have challenges with crowded environments: within warehouses, truck yards, and other facilities, the ability for an RFID system to operate in and around obstructions is critical. These obstructions are often metallic, such as vehicles and metal shelving racks, requiring signals to propagate "around" rather than "through" the obstructions. For that reason, for industrial applications involving significant environmental obstructions HF is a preferred frequency.

At UHF frequencies, multi-path RF waves caused by reflections from the floor and other obstructions may combine constructively or destructively. When these signals are in-phase they combine to give a stronger signal, but when out-of-phase, they cancel and create 'reading holes that get worse with distance from the antenna.



Therefore, referring to the picture above:

Tags A and D are in strong zones and will read.

Tag B will read if its antenna is long enough to 'span the gap'

Tag C and E will not read

All materials reduce the power of the RF signal to some extent, but direct contact on metals and liquids can cause particular problems:

- **Metals** reflect the signal**.** A metal object may change the *tuning* of a tag (or frequency on which it can receive signals), reflecting the RF waves from a reader, or block communication from a specific antenna.

- **Liquids** (including atmospheric moisture) absorb the signal. All radio waves are partially absorbed by atmospheric moisture. Atmospheric absorption reduces, or attenuates, the strength of radio signals over long distances. In addition, the effects of attenuation increases according to the frequency; thereby, UHF signals are generally more degraded by moisture than lower bands.

9.2.3 Limiting Interference and UHF Signal Attenuation

The following hints may be useful to get the best performance from your RFID application.

Reading holes can be reduced in a number of ways:

- By removing metal from the reading area: if the reflections can be reduced so will the holes

- By movement of the tag past the antenna.
  As the tag moves, it will cross the holes and be read at some point. The exact speed is a compromise between the number of tags and the bandwidth of the system. Because of Governmental regulation, for instance, readers are capable of reading more tags in the same time in the USA than is possible in Europe.

Multiple readers operating in the same environment may interfere with one another. A number of techniques can help limit these unwanted effects:

- Use photo-cell triggering to initiate reading - don't have the reader transmitting all the time

- Reduce the power

- Reduce the downlink rate

- Shield between reading systems with absorptive material (metals could make the problem worse)

Most important, testing should be performed in the actual environment to achieve more precise range results.

APPENDIX A: TECHNICAL SPECIFICATIONS

COBALT UHF CONTROLLERS – TECHNICAL SPECIFICATIONS

ELECTRICAL

DC Input Voltage Range	12 – 30 VDC
Power	6.7 W (280 mA @24 VDC)
Reverse Polarity Protection	Series Diode protection on DC power pins
Tolerable Ripple	100 mVpp
Over-current Protection	1 amp internal limit

RADIO

Transmitter	
Frequency	902 to 928 MHz (FCC part 15) 865.600 to 867.600 (ETSI EN 302 208)
Output Power	Programmable in 8 steps up to 500 mW conducted @ 5 V (27 dBm)
Antenna Connector	Reverse TNC
Frequency Tolerance	±10 ppm over the entire temperature range
Number of Channels	10 channels (compliant to ETSI EN 302 208) 50 hopping channels (compliant to FCC part 15)
Air Interface	
Standard Compliance	EPC C1G2

COMMUNICATION

UHF-CNTL-232-02	Point-to-Point: RS232 Baudrate: 9.6 to 115 kbit/s data rate (configurable) Data Bits: 8; Stop Bits: 1; Parity: none; Flow control: none
UHF-CNTL-485-02	Multi-drop: Subnet16 (RS485)
UHF-CNTL-IND-02	Ethernet: Ethernet/IP, MODBUS TCP, TCP/IP

MECHANICAL

Dimensions	163mm (6.4 inches) H x 112mm (4.4 inches) L x 48mm (1.9 inches) W
Weight	.56 KG (.97 lb., 560 grams)
Enclosure	Powder-coated Aluminum

ENVIRONMENTAL

Operating Temperature	-20° to 50°C (-4° to 122°F),
Storage Temperature	-40° to 85°C (-40° to 185°F)
Humidity	90% non-condensing
Protection Class	IP65
Shock Resistance	IEC 68-2-27 Test EA 30g, 11 milliseconds, 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.

COBALT UHF ANTENNAS – TECHNICAL SPECIFICATIONS

ELECTRICAL

UHF-ANT-2626-01-86	
Frequency Range	865 - 870 MHz
Gain	8.5 dBic (min) - 9.5 dBic (max)
3 dB Beamwidth	65° (typ)
Polarization	RHCP
Input Impedance	50 (Ohm)
Input Power	6 Watt (max)
UHF-ANT-3030-01-91	
Frequency Range	902 – 928 MHZ
Gain	9 dBic (min) - 10 dBic (max)
3 dB Beamwidth	63° (typ)
Polarization	RHCP
Input Impedance	50 (Ohm)
Input Power	6 Watt (max)

MECHANICAL

UHF-ANT-2626-01-86	
Dimensions (LxWxD)	260x260x30 mm (max)
Weight	1 Kg (max)
Connector	N – type female
UHF-ANT-3030-01-91	
Dimensions (LxWxD)	305x305x25 mm
Weight	1,2 Kg (max)
Connector	N – type female

NOTE: Specifications are subject to change without notice.

APPENDIX B: MODELS & ACCESSORIES

Datalogic Automation designs, manufactures and distributes a wide range of ultra high frequency (UHF) 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 Cobalt UHF-Series RFID product family. To purchase any of the items listed below contact your EMS distributor or visit our Web site: **http://www.ems-rfid.com**.

Cobalt UHF Series Accessories

The following accessories are available for the Cobalt UHF Series RFID Controllers:

MODEL	PART NUMBER	DESCRIPTION
UHF-CBL-01	970106002	Coaxial Cable Controller-Antenna, TNC-Reverse Male to N-Plug Male, 1 meter
UHF-CBL-03	970106003	Coaxial Cable Controller-Antenna, TNC-Reverse Male to N-Plug Male, 3 meters
Mounting Kit for Antenna	970103035	Mounting Kit for large size UHF Antennas

Table Appendix B-1:Cobalt UHF Series Accessories

Cobalt UHF-Series RFID Controllers

There are **six** models of the **Cobalt UHF RFID Controllers**:

EU- BAND MODELS (865-870 MHZ)

UHF-CNTL-232-02 EU for RS232 interface connections

UHF-CNTL-485-02 EU for Subnet16 Multidrop connections

UHF-CNTL-IND-02 EU for Ethernet Industrial interface connections

US- BAND MODELS (902-928 MHZ)

UHF-CNTL-232-02 US for RS232 interface connections

UHF-CNTL-485-02 US for Subnet16 Multidrop connections

UHF-CNTL-IND-02 US for Ethernet Industrial interface connections

Cobalt UHF-Series Antennas
(compatible with the UHF Series Controllers above)

There are **two** models of the **Cobalt UHF RFID Antenna**:

UHF-ANT-2626-01-86	26cm x 26cm, 868 MHz
UHF-ANT-3030-01-91	30cm x 30cm, 915 MHz

Subnet16 Gateways
(compatible with the UHF-CNTL-485-02 Controller Model)

There are **four** models of the **Subnet16 Gateway**:

GWY-01-232-01
Subnet16™ RS232 Gateway

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

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

GWY-01-DNT-01
Subnet16™ DeviceNet Gateway

Subnet16 Hubs
(compatible with the UHF-CNTL-485-02 Controller Model)

There are **two** models of the **Subnet16 Hub.**

HUB-04-TCP-01
Subnet16™ TCP/IP Hub (4-port)

HUB-04-IND-01
Subnet16™ Industrial Ethernet Hub (4-port)

Power Supplies

00-1166

1.88A max @ 24VDC (45W), 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

4.17A max @ 24VDC (100W), 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).

00-1168

5.0A max @ 24VDC (120W), Universal Input (88-132VAC/176-264VAC switch selectable, 47-63Hz) DIN Rail Mount (AC wire receptacles are spring clamped for direct wire connections).

Software Applications

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

Cobalt Dashboard

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 Utility

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

Cobalt Cables & Accessories

EMS P/N	DESCRIPTION
CBL-1478	Cable Assembly: RS232, with 2.5mm DC Power Jack, 2m
CBL-1480-XX	Cable: M12, 5-pin, Male/Female, ThinNet
CBL-1481-XX	Cable: M12, 5-pin, Male/Male, ThinNet
CBL-1481-02	Cable: M12, 5-pin, Male/Male, ThinNet, 2m (Gateway to Drop-T)
CBL-1482-XX	Cable: M12, 5-pin, Male/Right-Angle Female, ThinNet
CBL-1483-XX	Cable: 7/8–16, 5-pin, Male/Female, ThickNet
CBL-1484-XX	Cable: 7/8-16, 5-pin, Right-Angle Male/Bare Wire, ThickNet
CBL-1485	Drop-T Connector: 5-pin, 7/8-16 F / M12 F / 7/8-16 M (ThickNet to ThinNet)
CBL-1486	Drop-T Connector: 5-pin M12, F/F/M (ThinNet to ThinNet)
CBL-1487	Field Mountable Connector: 5-pos, Straight Female M12,
CBL-1488-XX	Cable: 8-pin, Female M12 / Bare Wires
CBL-1489	Termination Resistor Plug: 7/8-16, Male, 5-pin, (ThickNet)
CBL-1490	Termination Resistor Plug: M12, Male, 5-pin, (ThinNet)
CBL-1491	Connector: 5-pos, Right-Angle Female M12, Field Mountable

CBL-1492-XX	Cable: 8-pin, Right-Angle Female M12 / Bare Wires
CBL-1493	Connector: 8-pos, Straight Female M12, Field Mountable
CBL-1494-01	Cable: M12, 5P, F/Bare Wire Leads, ThinNet, 1M
CBL-1495-XX	Cable: 7/8-16, 5P F/Bare Wire Leads
CBL-1496	Plug: Termination Resistor M12, 5P, F
CBL-1497	Plug: Termination Resistor, 7/8-16, 5P, F
CBL-1498-02	Cable: M12, 5P, M/Bare Wire Leads, ThinNet, 2M
CBL-1513	Cable Assembly: M12, 5-Pin, Male, Reverse Keyed to Type A, USB, 3M
CBL-1514	Connector: M12, Male, 5-Pin, Straight, Reverse Keyed (for USB)
CBL-1515-05	Cable: CAT5E Shielded Ethernet/M12, 5-Pin, Male, D-Code, 5M

Table Appendix B-2: Cobalt Cables and Accessories

XX = Length in Meters

WARRANTY

Datalogic Automation warrants that all EMS RFID products of its own manufacturing conform to Datalogic Automation's 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 Datalogic Automation 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 Datalogic Automation's sole opinion proves to be defective within the scope of this Warranty.

In the event Datalogic Automation 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. Datalogic Automation must be notified in writing of the defect or nonconformity within the warranty period and the affected product returned to Datalogic Automation 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 Datalogic Automation.

This is Datalogic Automation's 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 Datalogic Automation which is not contained in this warranty, will be binding upon Datalogic Automation, unless made in writing and executed by an authorized Datalogic Automation employee.

Datalogic Automation 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 Datalogic Automation and excluded from this agreement.

Under no circumstances shall Datalogic Automation 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. Datalogic Automation 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 Datalogic Automation in the contract for such custom equipment. This warranty is the only warranty made by Datalogic Automation 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 Datalogic Automation and accepted by the Buyer.

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

EMS™ and the Escort Memory Systems logo are registered trademarks of Datalogic Automation.

DATALOGIC AUTOMATION RFID BU HQ
Via S. Vitalino 13, 40012
Lippo di Calderara di Reno,
BO Italy
Tel. +39 051 314 7011

AMERICAS
3000 Earhart Ct., Ste 135
Hebron KY 41048
Inside USA Tel. 1-800-849-5358
Outside USA Tel. 1-859-689-7000

ASIA
Unit 808A, Tower 1,
833 Cheung Sha Wan Road,
Kowloon, Hong Kong, China
Tel. +852 2785 3912

EMEA
Via S. Vitalino 13, 40012
Lippo di Calderara di Reno,
BO Italy
Tel. +39 051 314 7011