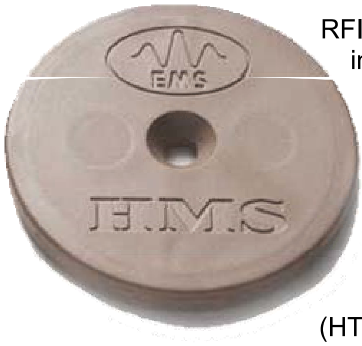
CHAPTER 5: RFID TAGS



RFID tags, which are also referred to as transponders, smart labels, or inlays, come in a variety of sizes, memory capacities, read ranges, frequencies, temperature survivability ranges and physical embodiments.

Escort Memory Systems offers many different RFID tag models. Cobalt Controllers are capable of reading all Escort Memory Systems' HMS and LRP series RFID tags as well most of those produced by other manufacturers. Our patented tags can be read through obstructions such as water, wood, plastic and more. Our specialty high-temperature (HT) models are capable of surviving temperatures of 415° F.

5.1 RFID STANDARDS

It is important to note that not all 13.56MHz RFID tags are compatible with Cobalt Controllers and even tags that are said to be compliant with ISO15693 or ISO14443 standards may not actually be compatible with RFID controllers adhering to the same standards. This is partially due to the fact that these ISO standards are so new that they leave many features open to the discretion and interpretation of the RFID equipment manufacturer to implement or define. When using another manufacturer's tags, ensure compatibility of those tags with your RFID system provider.

5.1.1 ISO 14443A/B

RFID integrated circuits (ICs) designed to meet ISO 14443A and/or ISO 14443B standards were originally intended to be embedded in secure smart cards such as credit cards, passports, bus passes, ski lift tickets, etc. For this reason, there are many security authentication measures implemented within the air protocol between the RFID controller and the tag.

ISO 14443A/B compliant tags and controllers incorporate security authentication through the exchanging of software "keys." The RFID controller and the tag must use the same security keys to authenticate communication before the transfer of data will begin. The Cobalt Controller's operating system manages these security features, making their existence transparent to the user. However, it is important to understand the implications associated with ISO 14443 when using another manufacturer's RFID tags. Because of these security "features," an ISO 14443 tag made by one manufacturer may not necessarily be readable by a Cobalt Controller and, likewise, an Escort Memory Systems ISO 14443 compliant tag might not be readable by another manufacturer's RFID controller. The Cobalt Controllers support Escort Memory Systems' security keys for use on Philips *mifare* ISO 14443A tags.

Escort Memory Systems was one of the first companies to adopt ISO 14443 standards and has incorporated much of the technology into our products designed for industrial automation applications. But because most industrial environments do not require the same level of security that monetary or passport applications necessitate, some features have not been implemented in the Cobalt HF product line.

5.1.2 ISO 15693

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

5.1.3 ISO 18000-3.1

The ISO 18000 standard has not been implemented in the Cobalt HF product line at the time of publication of this manual. It is a planned product enhancement for future releases. The emerging ISO 18000 Standard will provide enhanced support for EPC and *Unique Identification* (UID) tag applications.

5.2 RFID TAG COMPATIBILITY

The following RFID tags are compatible with the Cobalt HF Controller:

5.2.1 HMS Series RFID Tags

Integrated Circuits (ICs) used in Escort Memory Systems' HMS-Series RFID tags include:

- **Philips mifare Classic**, 1 kilobyte (KB) + 32-bit Tag ID (ISO 14443A). One KB is the total memory in the IC. Of this memory, 736 bytes are available for user data.
- **Philips mifare Classic**, 4 KB + 32-bit Tag ID (ISO 14443A). Four KB is the total memory in the IC. Of this memory, 3,440 bytes are available for user data.

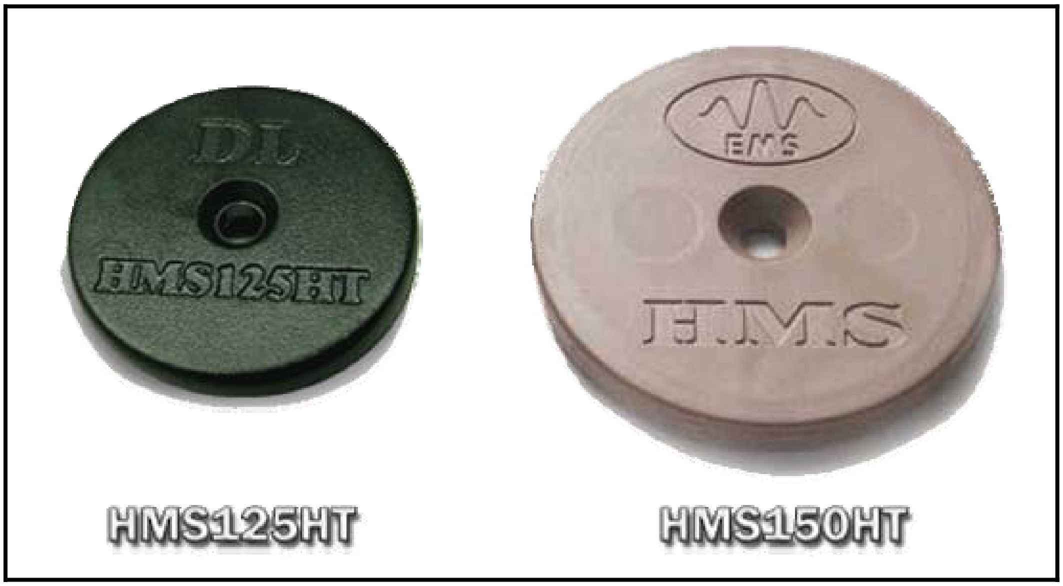


Figure 5-1: HMS125HT and HMS150HT RFID Tags

5.2.2 LRP Series RFID Tags

ICs used in Escort Memory Systems' LRP-Series RFID tags include:

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

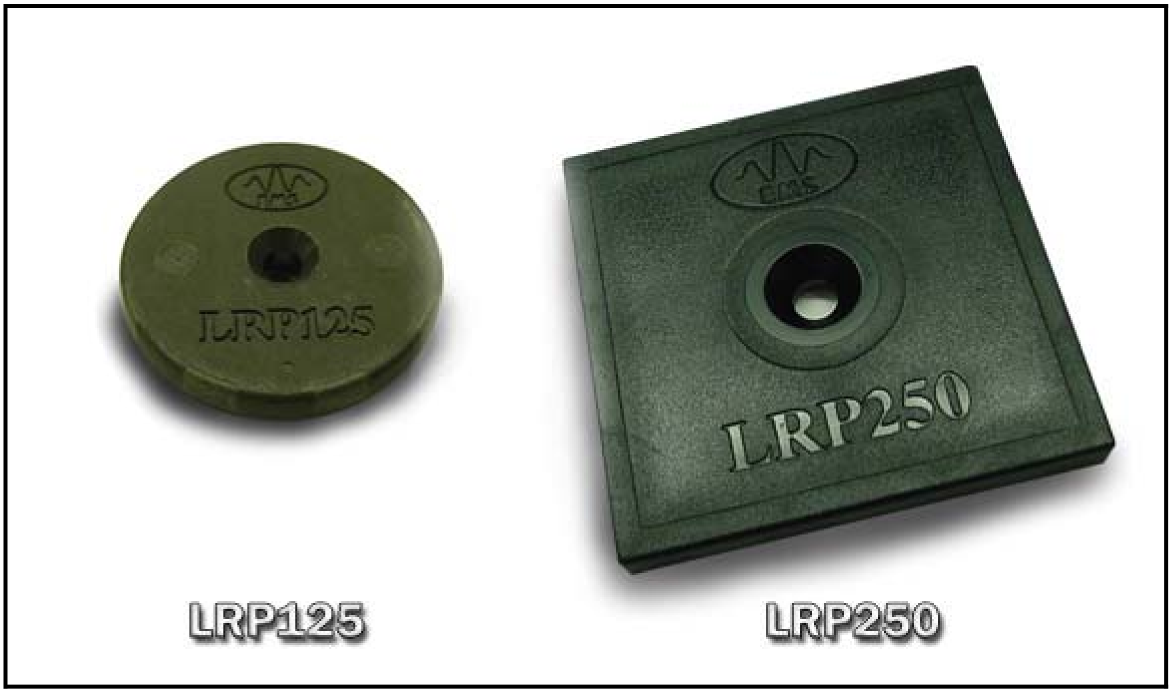


Figure 5-2: LRP125 and LRP250 RFID Tags

5.3 RFID Tag Performance

Many factors can affect the performance between the controller's antenna and the tag's antenna. These include, but are not limited to: the tag integrated circuit (IC), the antenna coil design, the antenna conductor material, the antenna coil substrate, the bonding method between tag IC antenna coil, and the embodiment material.

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

5.4 RFID Tag Embodiments

RFID tags come in a variety of sizes and packages. The most common and cost effective tag embodiment is the RFID label.

5.4.1 RFID Labels

RFID Labels (inlays or inlets) are the lowest cost RFID tag solution and are typically used in an open system in which the tag leaves the facility attached to a product or is destroyed at the end of the process.

An inlay is a substrate (made of polyester or Mylar) with a printed, screened or etched antenna coil. Sometimes the coil consists of a wire that is laid down onto the substrate and is bonded to it with heat. Typically, the RFID IC is attached by means of flip-chip technology and the electrical connections are made by means of conductive epoxies.

RFID inlays are usually applied to sticker backed paper to create label tags which are manufactured in high volumes on roll-to-roll production equipment. Inlays can be laminated an used in smart credit cards, providing a low cost RFID tag with some protection from impact damage.

The materials and procedures used to manufacture an RFID label's antenna coil are critically important. Low cost processes (such as printing or screening) produce low quality antenna coils which can exhibit poor conductivity and cracking when flexed.

Labels with copper wire wound coils are generally considered efficient conductors of RF energy and can usually survive considerable flexing, but are often more expensive due to more involved production processes.

RFID labels with etched copper antenna coils have been found to be the most reliable, semi-low cost tag solution. Etched inlay antenna coils are usually of consistent quality and can survive a great deal of flexing and bending. However, because etching is inherently a subtractive process, the cost per tag increases in part due to copper and other metals discarded during the fabrication process.

As RFID label manufacturing technology advances, there have been several new developments made in the areas of high volume, low cost, antenna coil manufacturing.

One area, in particular, that has shown recent promise is the process of electroplating printed or screened antenna coils with an additional layer of copper to improve durability and conductivity.

5.4.2 Printed Circuit Board RFID Tags

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

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

5.4.3 Molded RFID Tags

Molded tags, which are PCB tags that have been protected with a durable resin overmolding, are the most rugged and reliable type of tag offered by Escort Memory Systems. These tags are designed for closed loop applications where the tag is reused; thereby the cost of the tag can be amortized over the life of the production line.

Typically, molded tags will be mounted to a pallet or carrier which transports the product throughout the production process. Some of the applications for these tags include, but are not limited to: embedding the tag into concrete floors for location identification by forklifts and automatically guided vehicles (AGVs), shelf identification for storage and retrieval systems, and tool identification.

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

5.5 TAG MEMORY

Tag memory addressing begins at address 00 (0x0000), with the highest addressable memory location equal to one less than the total number of bytes in the tag. Each address is equal to one byte (8-bits), where the byte is the smallest addressable unit of data. So for example, writing 8-bytes to a tag beginning at address 00 will actually fill addresses 00 through 07 with 64-bits of data in all.

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

Escort Memory Systems has taken great care to simplify tag memory addressing. The mapping from logical address to physical address is handled by the Cobalt Controller's operating system. Users only need to indicate the starting address location on the tag and the number of bytes to be read or written.

Is it a Bit or a Byte?

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

5.5.1 Mapping Tag Memory

Creating an RFID Tag Memory Map

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

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

Tag Memory Map Example

TAG ADDRESS	USAGE
00 – 15	Serial #
16 - 47	Model #
48 - 63	Production Date
64 - 71	Lot #
72 - 89	Factory ID
90 - 111	Reserved for Future Use

Table 5-1: Tag Memory Map Example

5.5.2 Tag Memory Optimization

Data stored in tag memory is always written in binary (1's and 0's). Binary values are notated using the hexadecimal numbering system (otherwise it might be confusing viewing a page full of 1's and 0's).

Below is an example of how hexadecimal notation is used to simplify the process of expressing the decimal number 52,882.

Decimal	Binary	Hexadecimal
52,882	1100 1110 1001 0010	CE92

Rather than using five bytes to store the five individual ASCII characters representing the numerical values 5, 2, 8, 8, and 2 (*ASCII bytes: 0x35, 0x32, 0x38, 0x38 and 0x32*), by simply writing two Hex bytes (*0xCE and 0x92*), 60% less tag memory is required to store the same amount of information.

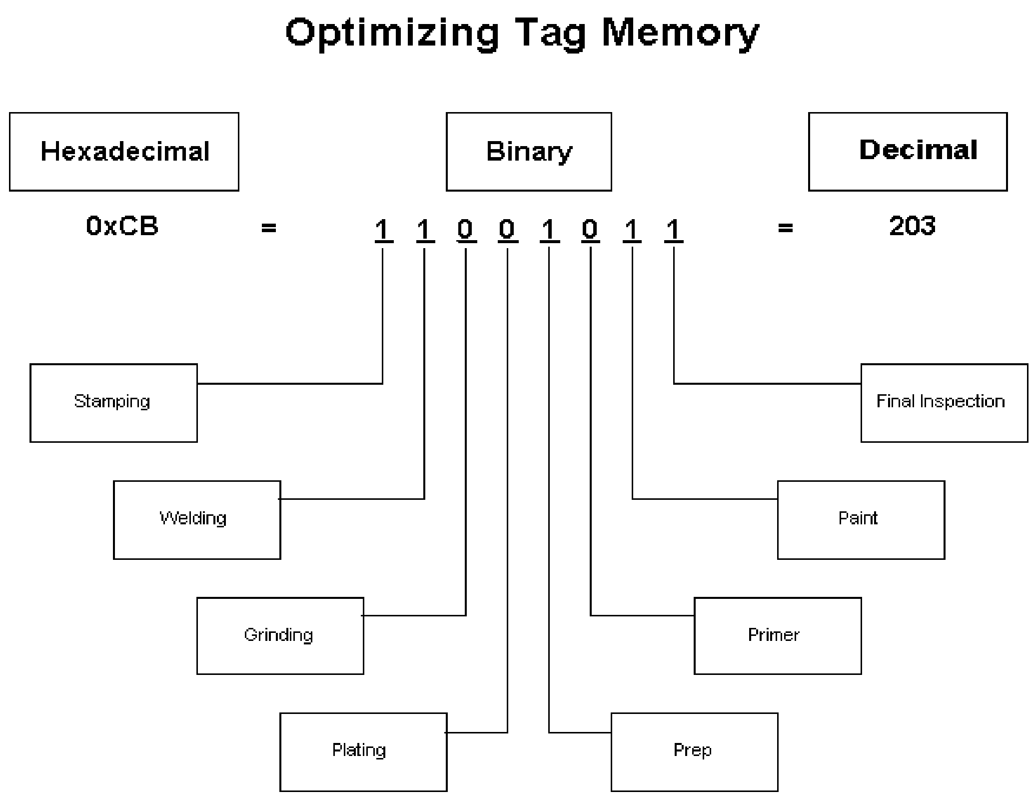
When an alphabetical character is to be written to a tag, the Hex equivalent of the ASCII value is written to the tag. So for example, to write a capital "D" (*ASCII value 0x44*), the Hex value 0x44 is written to the tag.

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

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

OPTIMIZING THE TAG

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



CHAPTER 6: COMMAND PROTOCOLS

6.1 COMMAND PROTOCOL OVERVIEW

In order to correctly recognize and execute commands, the Cobalt HF and the host must be able to communicate using the same language. The language that is used to communicate is referred to as the ***Command Protocol***.

There are ***two*** Command Protocols used by Cobalt HF RFID Controllers.

- **ABx Fast Command Protocol** – for Point-to-Point, Host/Controller applications (-232, -422 and –USB models).
- **CBx Command Protocol** – for multiple RFID controller configurations, Multi-drop (Subnet16) networks and Industrial Ethernet applications (-485 and –IND models).

These two Command Protocols have different packet structures and parameter settings, which are explained later in this chapter.

6.2 ABX FAST COMMAND PROTOCOL

The command protocol used by the Cobalt HF -232, -422 and -USB 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. By default, the HF-CNTL-232, -422 and -USB controllers are configured to use ABx Fast *without* the checksum option. However, when increased data integrity is required, the checksum should be utilized. See *Section 6.2.4* for more on using the checksum parameter.

6.2.1 ABx Fast - Command / Response Procedure

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

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

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

All commands will generate a response from the controller. Before sending another command, the host must first process (remove from memory) any pending response data.

6.2.2 ABx Fast - Command Packet Structure

The packet structure of every ABx Fast command contains certain basic elements, including a Command Header, a number of command parameters and a Terminator.

COMMAND PACKET PARAMETER	CONTENT	SIZE
COMMAND HEADER: The first two bytes of an ABx Fast Command Packet:	0x02, 0x02	2 bytes
COMMAND SIZE: This 2-byte value defines the number of bytes in the packet (excluding Header, Command Size, Checksum and Terminator).	0x0008	2-byte integer
COMMAND ID: This single-byte value indicates the RFID command to execute.	0x06 (*Write Data*)	1 byte
START ADDRESS: The 2-byte Start Address parameter indicates the location of tag memory where a read or write operation shall begin.	0x0000	2-byte integer
READ/WRITE LENGTH: The 2-byte Read/Write Length parameter represents the number of bytes that are to be retrieved from or written to the RFID tag.	0x0001	2-byte integer
TIMEOUT VALUE: This 2-byte integer indicates the maximum length of time for which the controller will attempt to complete the command. Measured in milliseconds, this value can have a range of 0x0001 to 0xFFFE or between 1 and 65,534 msecs (*0x07D0 = 2000 x .001* **=** *2 seconds*).	0x07D0	2-byte integer
ADDITIONAL DATA: This parameter uses one byte to hold a single character for fill operations and supports the use of multiple bytes when several characters are needed for write commands (when applicable).	0x00	One or more bytes (when applicable)
CHECKSUM: This optional parameter holds a single-byte checksum (only applicable when using *ABx Fast with Checksum*).	optional	1 byte (when applicable)
TERMINATOR: Single-byte command packet terminator:	0x03	1 byte

Table 6-1: ABx Fast - Command Packet Structure

6.2.3 ABx Fast - Response Packet Structure

After performing a command, the Cobalt HF will generate a host-bound response message. ABx Fast responses contain a Response Header, a number of response values (or retrieved data bytes), and a Terminator.

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

Table 6-2: ABx Fast - Response Packet Structure

6.2.4 ABx Fast - Command Packet Parameters

Command Size

The ABx Fast protocol requires that the byte count, known as the **Command Size**, be specified as a 2-byte integer. To calculate Command Size, add the total number of bytes within the command packet while excluding the two bytes for the Header, the two bytes for the Command Size, the one byte for the Checksum (if present) and the one byte for the Terminator (see example below).

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

Command Size = number of bytes in these fields

In the above command packet example, 8 bytes of data are located between the Command Size parameter and the Checksum parameter. Therefore, the Command Size for this example is ***0x0008***.

Start Address

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

Read/Write Length

The two-byte Read/Write Length parameter indicates the number of bytes that are to be read from or written to the RFID tag.

TIMEOUT VALUE PARAMETER

ABx Fast commands include a two-byte **Timeout Value** parameter (measured in increments of one millisecond) that is used to limit the length of time that the Cobalt HF will attempt to complete a specified operation.

The maximum Timeout Value is 0xFFFE or 65,534 milliseconds (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 HF 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 PARAMETER

The ABx Fast Command Protocol supports the inclusion of an additional checksum byte that is used to verify the integrity of data being transmitted between host and controller.

The checksum is calculated by adding together (summing) the byte values in the command packet (less the Header, Checksum and Terminator 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.

To enable the use of the checksum parameter, download the RFID Dashboard Utility from www.ems-rfid.com, and use it to set the *ABx Protocol* parameter to *ABx Fast with Checksum*.

CHECKSUM EXAMPLE

The following example depicts *Command 0x05* (*Read Data*) using a checksum.

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

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

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

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

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

6.3 CBX COMMAND PROTOCOL

The ***CBx Command Protocol,*** utilized by the Cobalt -485 and -IND models, includes Multi-drop Subnet16 networking support for use with Industrial Ethernet applications.

CBx 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 packet structures described herein are protocol independent and can be implemented the same for all Industrial Ethernet protocols (Ethernet/IP, Modbus TCP, etc.).

6.3.1 CBx – Command Procedure

COBALT HF-CNTL-485-01 – COMMAND PROCEDURE

Commands are initiated by a host PC or Programmable Logic Controller (PLC) and are distributed to the controller via a Subnet16 Gateway or Subnet16 Hub Interface Device that is connected to the host or PLC by standard Ethernet cabling.

After a command is sent, it is executed either directly by the interface device (Gateway or Hub) or is otherwise routed to the RFID controller specified in the command. Note that when issuing controller-bound commands, instructions are directed to the appropriate RFID controller by specifying the "***Node ID Number***" of the particular controller. Each Cobalt -485 Controller on a Multi-drop Subnet16 network is assigned an individual Node ID number.

COBALT HF-CNTL-IND-01 – COMMAND PROCEDURE

Commands are initiated by a host PC or Programmable Logic Controller (PLC) and are distributed directly to the controller via an M12 D-Code to Ethernet cable.

After a command is sent, it is immediately executed by the Cobalt Controller. Note that instructions are directed to the controller by specifying in the command the "***Node ID Number***" of the Cobalt Controller. For the Cobalt HF-CNTL-IND-01, the Node ID will always be 01 (0x01).

6.3.2 CBx – Response Procedure

Following the execution of an RFID command, the controller will automatically generate a host-bound response message that contains EITHER the results of the attempted command or an error code if the operation could no be completed successfully.

Similar to ABx Fast, all CBx commands will generate a response from the controller. Before the host can send another command to the controller, it must first process (remove from memory) the controller's pending response data.

6.3.3 CBx - Command Packet Structure

As noted, CBx commands contain a minimum of six words. Below is the structure of a standard CBx command packet. For the Cobalt HF-CNTL-485-01 model, refer to the Subnet16 Gateway or Subnet16 Hub - Operator's Manuals.

WORD #	COMMAND PACKET PARAMETER	MSB	LSB
01	**Overall Length**: 2-byte integer indicating the number of 16-bit "***words***" in the entire command packet. 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	**AA** in MSB **Command ID**: single-byte value indicating command to perform in LSB.	0xAA	Command ID
03	**00** in MSB **Node ID**: single-byte Node ID number of the controller to which the command is intended. (Must be 0x01 for Cobalt -IND).	0x00	0x01
04	**Timeout Value**: 2-byte integer representing the length of time allowed for the completion of the command, measured in 1 millisecond units (when applicable).	Timeout MSB	Timeout LSB
05	**Start Address**: 2-byte integer indicating the location of tag memory where the Read/Write operation will begin (when applicable).	Start MSB	Start LSB
06	**Read/Write Length**: 2-byte integer indicating the number of bytes that are to be Read/Written beginning at the Start Address (when applicable).	Length MSB	Length 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 2-bytes of data for writes and fills (when applicable).	D3	D4

Table 6-3: CBx - Command Packet Structure

6.3.4 CBx - Response Packet Structure

After performing a command, the Cobalt HF RFID Controller will issue a host-bound response message. Below is the packet structure of a standard CBx response message.

WORD #	RESPONSE PACKET PARAMETER	MSB	LSB
01	**Overall Length**: 2-byte value indicating the number of "***words***" in the response packet. This value will always be at least ***6 words***.	0x00	06 + (number of additional data words retrieved)
02	**AA** in MSB **Command Echo**: single-byte value indicating the command that was performed in LSB.	0xAA	Command Echo
03	**Instance Counter** in MSB (*see description below*) **Node ID Echo** in LSB (*will be 0x01 for the Cobalt -IND*)	Instance Counter	Node ID Echo
04	**Month** and **Day** timestamp	Month	DOM
05	**Hour** and **Minute** timestamp	Hour	Minutes
06	**Second** timestamp in MSB **Number of Additional Data Bytes Retrieved** in LSB	Seconds	N-bytes
07	**Retrieved Data –** (bytes 1 & 2) used to hold 2-bytes of retrieved data (*when applicable*).	D1	D2
08	**Retrieved Data –** (bytes 3 & 4) used to hold 2-bytes of retrieved data (*when applicable*).	D3	D4

Table 6-4: CBx - Response Packet Structure

INSTANCE COUNTER

The **Instance Counter** is a one-byte value used by a Subnet16 Gateway or Subnet16 Hub to track the number of responses generated by a given Node ID number. The Gateway/Hub tallies in its internal RAM separate Instance Counter values for each Node ID. The Instance Counter value is incremented by one following each response. If, for example, 10 responses were generated by the controller assigned Node ID 01, its Instance Counter value will read 10. When the Gateway/Hub is power cycled or rebooted, all Instance Counter values will be reset to zero (0x00).

6.3.5 CBx - Command Example

In the example below, *Command 0x05 (Read Data)* is issued to the Cobalt Controller assigned to Node ID 01. The controller will be instructed to read 4 bytes of data from a tag beginning at tag address 0x20. The Timeout Value has been set to two seconds for the completion of this command (*0x07D0 = 2000 x .001 = 2 seconds*).

WORD #	DESCRIPTION	MSB	LSB
01	**Overall Length of Command** (*in words*)	0x00	0x06
02	**AA** in MSB **Command ID** in LSB: (*0x05: Read Data*)	0xAA	0x05
03	**00** in MSB **Node ID** in LSB: (0x*01 for the Cobalt*)	0x00	0x01
04	2-byte **Timeout Value** measured in ms	0x07	0xD0
05	2-byte **Start Address** for the Read Operation: (*0x0020*)	0x00	0x20
06	2-byte **Read Length**: (*0x0004*)	0x00	0x04

6.3.6 CBx - Response Example

Below is an example of a typical controller response after successfully executing the Read Data command (as issued in the previous example).

WORD #	DESCRIPTION	MSB	LSB
01	**Overall Length of Response** (*in words*)	0x00	0x08
02	**AA** in MSB **Command Echo** in LSB: (*0x05 Read Data*)	0xAA	0x05
03	**00** in MSB **Node ID Echo** in LSB	0x00	0x01
04	**Month** and **Day** timestamp: (*March 19th*)	0x03	0x13
05	**Hour** and **Minute** timestamp (*10:11: AM*)	0x0A	0x0B
06	**Seconds** timestamp in MSB (*:36 seconds*) **# of Additional Data Bytes Retrieved** in LSB: (*0x04*)	0x24	0x04
07	**Retrieved Data** (*bytes 1 & 2*)	0x01	0x02
08	**Retrieved Data** (*bytes 3 & 4*)	0x03	0x04

CHAPTER 7: RFID COMMANDS

Most RFID commands can be divided into **two** primary categories: ***READ*** and ***WRITE***. Read commands retrieve data from a tag or obtain information from the controller. Write commands transfer information to a tag or update settings on the controller.

7.1 RFID COMMANDS TABLE

COMMAND ID	COMMAND	DESCRIPTION
0x04	Fill Tag	Writes a specified data byte to all defined tag addresses.
0x05	Read Data	Reads a specified length of data from contiguous (sequential) areas of tag memory.
0x06	Write Data	Writes a specified number of bytes to a contiguous area of tag memory.
0x07	Read Tag ID	Reads a tag's unique tag ID number.
0x08	Tag Search	Instructs the controller to search for a tag in its RF field.
0x0D	Start/Stop Continuous Read	Instructs the controller to start or stop Continuous Read mode.
0x35	Reset Controller	Resets power to the controller.
0x38	Get Controller Info	Reads hardware, firmware and serial number information from the controller.

Table 7-1: RFID Commands Table

COMMAND 04: FILL TAG

Command 04 instructs the RFID controller to fill multiple contiguous addresses of an RFID tag with a single data byte value. This command is commonly used to clear sequential segments of tag memory by writing a one-byte value repeatedly across a specified range of tag addresses.

This command requires one Data Byte Value, a Start Address and a Fill Length. It will then proceed to fill the tag with the Data Byte Value, for the specified number of consecutive bytes, beginning at the Start Address.

When the Start Address is set to zero (0x0000), the fill will begin at the first available byte of tag memory. When the Fill Length is set to zero (0x0000), the controller will write fill data from the Start Address to the end of the tag's memory. The Timeout Value is measured in 1-millisecond increments and can have a value of 0x0001 to 0xFFFE (1 - 65,534 milliseconds). If the Fill Length extends beyond the last byte in the tag, the controller will return an error.

COMMAND 04 (FILL TAG) - ABX FAST COMMAND STRUCTURE

PARAMETER FIELD	CONTENT
Header	0x02, 0x02 (*the header for all ABx Fast commands*).
Command Size	0x0008
Command ID	1-byte Command ID Number (*0x04*).
Start Address	2-byte value indicating tag address where fill will start.
Fill Length	2-byte value indicating the total number of bytes to be filled.
Timeout Value	2-byte value (*0x0001 – 0xFFFE*).
Data Byte Value	1-byte value for the data byte to be used as fill.
Checksum	Optional
Terminator	0x03 (*the terminator for all ABx Fast commands*).

COMMAND 04 (FILL TAG) - ABX FAST COMMAND EXAMPLE

This example instructs the Cobalt HF to fill an entire tag with the ASCII character 'A' (Data Byte Value 0x41) starting at the beginning of the tag (address 0x0000). A Timeout Value of 2 seconds (0x07D0) is set for the completion of the command.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0008
Command ID	0x04
Start Address	0x0000
Fill Length	0x0000
Timeout Value	0x07D0
Data Byte Value	0x41
Checksum	Optional
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0001
Command Echo	0x04
Checksum	Optional
Terminator	0x03

Command 04 (Fill Tag) - CBx Command Example

This example instructs the Cobalt Controller to fill an entire tag with the ASCII character 'A' (Data Byte Value 0x41) starting at the beginning of the tag (address 0x0000). A Timeout Value of 2 seconds (0x07D0) is set for the completion of the command.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x07
AA in MSB **Command ID** in LSB: (0x*04*)	0xAA	**0x04**
00 in MSB **Node ID** in LSB (*Cobalt –IND = 01*)	0x00	0x01
2-byte **Timeout Value** measured in ms (*0x07D0 = 2 seconds*)	0x07	0xD0
Start Address	0x00	0x00
Fill Length	0x00	0x00
Fill Byte in MSB (*A = 0x41*) **00** in LSB	0x41	0x00

Note: The “Fill Length” in the Tag Fill Command represents the number of bytes to fill on the tag, not the length of the ‘fill byte data’ provided in the command, which is always just a single byte.

Response from Controller

DESCRIPTION	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06
AA in MSB **Command Echo** in LSB (*0x04*)	0xAA	**0x04**
00 in MSB **Node ID Echo** in LSB (*Cobalt –IND = 0x01*)	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **00** in LSB	Seconds	0x00

COMMAND 05: READ DATA

Command 05 instructs the controller to retrieve a specific number of bytes of data from a contiguous (sequential) area of an RFID tag's memory.

When the Start Address is set to zero (0x0000), the controller will start reading at the beginning (or first accessible byte) of the tag. The minimum Read Length is one byte, the maximum is the entire read/write address space of the tag. Timeout Value is measured in 1-millisecond increments and can have a value of 0x0001 to 0xFFFE (1 to 65,534 milliseconds). If the Read Length exceeds beyond the last available tag address, the controller will return an error code.

COMMAND 05 (READ DATA) - ABX FAST COMMAND STRUCTURE

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0007
Command ID	1-byte Command ID (*0x05*).
Start Address	2-byte value for the starting read address.
Read Length	2-byte value for the number of bytes to read.
Timeout Value	2-byte value measured in 1-ms units (*0x0001 – 0xFFFE*).
Checksum	Optional
Terminator	0x03

COMMAND 05 (READ DATA) - ABX FAST COMMAND EXAMPLE

This example instructs the controller to read four bytes of data from a tag starting at address 0x0001. A Timeout Value of 2 seconds (0x07D0 = 2000 x 1 millisecond increments) is set for the completion of the command.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0007
Command ID	0x05
Start Address	0x0001
Read Length	0x0004
Timeout Value	0x07D0
Checksum	Optional
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0005
Command Echo	0x05
Data from Address 0x0001	0x05
Data from Address 0x0002	0xAA
Data from Address 0x0003	0xE7
Data from Address 0x0004	0x0A
Checksum	Optional
Terminator	0x03

Command 05 (Read Data) - CBx Command Example

This example instructs the controller to read four bytes of data from a tag starting at address 0x0001. A Timeout Value of 2 seconds (0x07D0 = 2000 x 1 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
AA in MSB **Command ID** in LSB (*0x05*)	0xAA	**0x05**
0x00 in MSB **Node ID** in LSB (*Cobalt -IND = 0x01*)	0x00	0x01
2-byte **Timeout Value** measured in ms (*0x07D0 = 2 seconds*)	0x07	0xD0
Start Address	0x00	0x01
Read Length	0x00	0x04

Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x08
AA in MSB **Command Echo** in LSB	0xAA	**0x05**
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **# of Bytes Read Data** in LSB	Seconds	0x04
Read Data (*bytes 1 and 2*)	0x01	0x02
Read Data (*bytes 3 and 4*)	0x03	0x04

COMMAND 06: WRITE DATA

Command 06 instructs the controller to write information to an RFID tag. This command is used to store segments of data in contiguous tag memory locations. It is capable of transferring up to 100 bytes of data from the host to the tag with one command.

The shortest possible Write Length is one (0x0001). When the Start Address is set to zero (0x0000), the controller will begin writing to the first available byte of tag memory.

The Timeout Value is measured in 1-millisecond increments and can have a value of 0x0001 to 0xFFFE (1 to 65,534 milliseconds). If the Write Length exceeds beyond the last available tag address, the controller will return an error code.

COMMAND 06 (WRITE DATA) - ABX FAST COMMAND STRUCTURE

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0007 + N (*where N = the number of Data Bytes to be written*).
Command ID	0x06
Start Address	2-byte value for the tag address where the write will begin.
Write Length	2-byte value for the number of bytes to write.
Timeout Value	2-byte value measured in 1 millisecond units (*0x0001 – 0xFFFE*).
Data Byte Value	1-byte for each data value to be written to tag.
Checksum	Optional
Terminator	0x03

COMMAND 06 (WRITE DATA) – ABX FAST COMMAND EXAMPLE

This example writes the five ASCII characters **H, E, L, L, O** (Data Byte Values: 0x48, 0x45, 0x4C, 0x4C and 0x4F) to the tag starting at address 0x0000. A Timeout Value of 2 seconds (0x07D0 = 2000 x 1 millisecond increments) is set for the completion of this command.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x000C
Command ID	0x06
Start Address	0x0000
Write Length	0x0005
Timeout Value	0x07D0
Data Byte Value = H	0x48
Data Byte Value = E	0x45
Data Byte Value = L	0x4C
Data Byte Value = L	0x4C
Data Byte Value = O	0x4F
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0001
Command Echo	0x06
Terminator	0x03

COMMAND 06 (WRITE DATA) – CBX COMMAND EXAMPLE

This example writes the five ASCII characters **H, E, L, L, O** (Data Byte Values: 0x48, 0x45, 0x4C, 0x4C and 0x4F) to the tag starting at address 0x0000. A Timeout Value of 2 seconds (0x07D0 = 2000 x 1 millisecond increments) is set for the completion of this command.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x09
AA in MSB **Command ID** in LSB (*0x06*)	0xAA	**0x06**
00 in MSB **Node ID** in LSB (*Cobalt -IND = 01*)	0x00	0x01
2-byte **Timeout Value** measured in ms	0x07	0xD0
Start Address	0x00	0x00
Length of Write (*in bytes*)	0x00	0x05
Write Data (*bytes 1 and 2*)	0x48	0x45
Write Data (*bytes 3 and 4*)	0x4C	0x4C
Write Data (*byte 5*) in MSB **00** in LSB	0x4F	0x00

Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06
AA in MSB **Command Echo** in LSB	0xAA	**0x06**
00 in MSB **Node ID Echo** in LSB (*Cobalt = 01*)	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **00** in LSB	Seconds	0x00

COMMAND 07: READ TAG ID

This command instructs the RFID controller to locate a tag in RF range and retrieve its unique tag identification number.

RFID tags are assigned a unique tag ID number during the manufacturing process. After a tag ID number has been assigned to a tag, the value cannot be altered and is not considered part of the available read/write memory space of the tag.

- ISO 14443 compliant tags receive a 4-byte tag ID number. By using just four bytes, tag manufacturers can generate over 4.2 billion possible ISO 14443 compliant tag ID numbers.
- ISO 15693 compliant tags are given an 8-byte tag ID number. When using eight bytes, manufacturers can generate over 280 trillion possible tag ID numbers.

COMMAND 07 (READ TAG ID) – ABX FAST COMMAND STRUCTURE

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0003
Command ID	0x07
Timeout Value	2-byte value, measured in 1 millisecond units. (*0x0001 – 0xFFFE*).
Checksum	Optional
Terminator	0x03

COMMAND 07 (READ TAG ID) – ABX FAST COMMAND EXAMPLE

This example instructs the controller to retrieve a tag's ID. In this example, the 8-byte tag ID number is *E0040100002E16AD*. A Timeout Value of two seconds is set for the completion of this command.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0003
Command ID	0x07
Timeout Value	0x07D0
Checksum	Optional
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0009
Command Echo	0x07
Tag ID (*bytes 1-8*)	0xE0 0x04 0x01 0x00 0x00 0x2E 0x16 0xAD
Checksum	Optional
Terminator	0x03

COMMAND 07 (READ TAG ID) – CBX COMMAND EXAMPLE

This example instructs the controller to retrieve a tag's ID. In this example the 8-byte tag ID number is *E0040100002E16AD*. A Timeout Value of 2 seconds is set for the completion of this command.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x06
AA in MSB **Command ID** in LSB (*0x07*)	0xAA	**0x07**
00 in MSB **Node ID** in LSB (*Cobalt –IND = 01*)	0x00	0x01
2-byte **Timeout Value** measured in ms (*0x07D0 = 2 seconds*)	0x07	0xD0
Not Used: (*0x00, 0x00*)	0x00	0x00
Not Used: (*0x00, 0x00*)	0x00	0x00

Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x0A
AA in MSB **Command Echo** in LSB	0xAA	0x**07**
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **Number of Tag ID Bytes Retrieved** in LSB (*0x08*)	Seconds	0x08
Tag ID (*bytes 1 & 2*)	0xE0	0x04
Tag ID (*bytes 3 & 4*)	0x01	0x00
Tag ID (*bytes 5 & 6*)	0x00	0x2E
Tag ID (*bytes 7 & 8*)	0x16	0xAD

Response if tag not found

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x07
Error Flag in MSB **Command Echo** in LSB	0xFF	**0x07**
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **# of Additional Data Bytes Retrieved** in LSB	Seconds	0x01
Error Code in MSB (*0x07 = "Tag Not Found Error"*) **00** in LSB	0x07	0x00

COMMAND 08: TAG SEARCH

Command 08 instructs the controller to search for the presence of a tag within RF range of the antenna. If the controller finds a tag it will return a Command Response to the host. The Timeout Value is measured in 1-millisecond increments and can have a value of 0x0001 to 0xFFFE (1 to 65,534 milliseconds).

COMMAND 08 (TAG SEARCH) – ABX FAST COMMAND STRUCTURE

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0003 for this command
Command ID	0x08
Timeout Value	2-byte value measured in 1 millisecond units (*0x0001 – 0xFFFE*).
Checksum	Optional
Terminator	0x03

COMMAND 08 (TAG SEARCH) – ABX FAST COMMAND EXAMPLE

This example checks for an RFID tag within range of the antenna. The checksum is enabled and the Timeout Value is set for 2 seconds (0x07D0 = 2000 milliseconds) for the completion of this command.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0003
Command ID	0x08
Timeout Value	0x07D0
Checksum	0x1D
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0001
Command Echo	0x08
Checksum	0xF6
Terminator	0x03

COMMAND 08 (TAG SEARCH) – CBX COMMAND EXAMPLE

This command will instruct the controller to search for the presence of a tag within RF range of the antenna.

Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x06
AA in MSB **Command ID** in LSB (*0x08*)	0xAA	**0x08**
00 in MSB **Node ID** in LSB (*Cobalt = 1*)	0x00	0x01
2-byte **Timeout Value** measured in ms (*0x07D0 = 2 seconds*)	0x07	0xD0
Not Used: (*0x00, 0x00*)	0x00	0x00
Not Used: (*0x00, 0x00*)	0x00	0x00

Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06
AA in MSB **Command Echo** in LSB	0xAA	**0x08**
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **00** in LSB	Seconds	0x00

Response if tag not found

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x07
Error Flag in MSB **Command Echo** in LSB	0xFF	**0x08**
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Min
Seconds timestamp in MSB **Number of Additional Data Bytes**: 0x01	Seconds	0x01
Error Code in MSB (*0x07 = "Tag Not Found Error"*) **00** in LSB	0x07	0x00

COMMAND 0D: START/STOP CONTINUOUS READ

Command 0D instructs the controller to start (or stop) Continuous Read Mode.

When the Cobalt Controller is in Continuous Read Mode, it will constantly emit RF energy in an attempt to read any tag that comes into range of the antenna. As a tag enters the antenna field, it is immediately read and the data is passed to the host. The controller will continue to read the tag but will not re-send the same data to the host until the tag has moved outside the RF field for a specified time period. This parameter is known as the *Delay Between Duplicate Reads*, which prevents redundant data transmissions when the controller is in Continuous Read Mode.

If another RFID command is executed while the controller is in Continuous Read Mode, the Cobalt HF will temporarily stop Continuous Reading to execute the command, after which the controller will return to Continuous Read Mode.

The Start/Stop Continuous Read command contains three primary components: a **Start Address,** a **Read Length** and a **Delay Between Duplicate Reads** value**.**

- **Start Address:** The Start Address is a 2-byte integer indicating the tag address location where the read will begin.
- **Read Length:** The Read Length is a 2-byte integer that represents the number of tag data bytes of retrieve. By setting this parameter to one (0x01) or higher, Continuous Read Mode will be switched ON at the completion of the command. Setting the Read Length to zero (0x00) will turn Continuous Read Mode off.
- **Delay Between Duplicate Reads:** During Continuous Read Mode, any tag that comes within range of the antenna will be constantly read and the requested data from the tag will be passed to the host. This single-byte delay parameter indicates the number of seconds that a tag must remain out of RF range before it can be re-read and have its data sent to the host for a second time. It is implemented to enable the operator to limit the volume of information sent by the controller. The Delay Between Duplicate Reads parameter can have a value of 0 to 60 seconds. When the Delay Between Duplicate Reads value is set to 0, the controller will continuously read AND transmit duplicate tag data to the host.

Continuous Read at Power-up

By default, Continuous Read Mode is not restarted if the controller is reset. However, through the use of the ***RFID Dashboard Utility,*** the Cobalt Controller can be configured to enter Continuous Read Mode automatically after a reset or power-up. See *Section 3.1* for more information regarding the RFID Dashboard Utility or visit: www.ems-rfid.com.

CONTINUOUS READ MODE LED BEHAVIOR

LED	BEHAVIOR	DESCRIPTION
PWR	ON	The controller is powered and functioning.
COM	BLINKS ONCE	Delay Between Duplicate Reads is set to 1 or greater and a tag has entered the RF field.
COM	BLINKING	Delay Between Duplicate Reads is set to 0 and a tag is in the RF field.
RF	BLINKING	Delay Between Duplicate Reads is set to 0 and a tag is in the RF field.
RF	BLINKS ONCE	Delay Between Duplicate Reads is set to 1 or greater and a tag has entered the RF field.
RF	ON	The controller is in Continuous Read Mode and no tag is present.

Table 7-2: Continuous Read Mode - LED Behavior

COMMAND 0D (START/STOP CONTINUOUS READ) – ABX FAST COMMAND STRUCTURE

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0006
Command ID	**0x0D**
Start Address	2-byte value for the tag address where the read will start.
Read Length	2-byte value for number of bytes to be read.
Delay Between Duplicate Reads	1-byte value for number of seconds a tag must be out of RF range before the controller will re-transmit data from same tag.
Checksum	Optional
Terminator	0x03

Command 0D (Start/Stop Continuous Read) – ABx Fast Command Example

This example places the controller in Continuous Read mode and reads four bytes of data from the tag starting at address 0x0001. The Delay Between Duplicate Reads is set to two seconds (0x02 = 2 x 1 second increments).

Starting Continuous Read - Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0006
Command ID	**0x0D**
Start Address	0x0001
Read Length	0x0004
Delay Between Duplicate Reads	0x02
Checksum	Optional
Terminator	0x03

Starting Continuous Read - Initial Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0001
Command Echo	**0x0D**
Checksum	Optional
Terminator	0x03

Continuous Read Mode Evoked - Response from Controller (after Tag Read)

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0005
Command Echo	**0x0D**
Data from address 0x0001	0x05
Data from address 0x0002	0xAA
Data from address 0x0003	0xE7
Data from address 0x0004	0x0A
Checksum	Optional
Terminator	0x03

To exit out of Continuous Read mode, issue Command 0D with zero (*0x0000*) in the Read Length parameter field.

Stopping Continuous Read - Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0006
Command ID	**0x0D**
Start Address	0x0001
Read Length	0x0000
Delay Between Duplicate Reads	0x02
Checksum	Optional
Terminator	0x03

Stopping Continuous Read - Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0001
Command Echo	**0x0D**
Checksum	Optional
Terminator	0x03

COMMAND 0D (START/STOP CONTINUOUS READ) – CBX COMMAND EXAMPLE

This example places the controller in Continuous Read Mode and reads 4 bytes of data from the tag starting at address 0x0001. The Delay Between Duplicate Reads is set to 2 seconds (0x02 = 2 x 1 second increments).

Starting Continuous Read - Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x06
AA in MSB **Command ID** in LSB (*0x0D*)	0xAA	**0x0D**
00 in MSB **Node ID** in LSB (*Cobalt -IND = 01*)	0x00	0x01
00 in MSB 1-byte **Delay Between Duplicate Reads** in LSB	0x00	0x02
Start Address	0x00	0x01
Read Length (*in bytes*)	0x00	0x04

Starting Continuous Read - Initial Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06
AA in MSB **Command Echo** in LSB	0xAA	**0x0D**
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Min
Seconds timestamp in MSB **00** in LSB	Seconds	0x00

Continuous Read Mode Evoked - Response from Controller (after Tag Read)

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x08
AA in MSB **Command Echo** in LSB	0xAA	**0x05**
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **# of Bytes Read Data**	Seconds	0x04
Read Data (bytes 1 & 2)	0x05	0xAA
Read Data (bytes 3 & 4)	0xE7	0x0A

To exit out of Continuous Read Mode, re-issue the command with zero (0x0000) for the Read Length.

Stopping Continuous Read - Command from Host

PARAMETER FIELD	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x06
AA in MSB **Command ID** in LSB (*0x0D*)	0xAA	0x0D
00 in MSB **Node ID** in LSB (*Cobalt = 01*)	0x00	0x01
00 in MSB 1-byte **Delay Between Duplicate Reads** in LSB	0x00	0x02
Start Address	0x00	0x00
Read Length (*in bytes*)	0x00	0x00

Stopping Continuous Read - Response from Controller

PARAMETER FIELD	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06
AA in MSB **Command Echo** in LSB	0xAA	**0x0D**
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **00** in LSB	Seconds	0x00

COMMAND 35:
RESET CONTROLLER

Command 35 will cause the controller to cycle power - effectively rebooting the device - without clearing any stored configuration information. Command 35 will reset the controller's configuration to default settings when a Configuration Tag is placed in the antenna's RF field prior to execution.

COMMAND 35 (RESET CONTROLLER) – ABX FAST COMMAND STRUCTURE

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0001
Command ID	0x35
Checksum	optional
Terminator	0x03

COMMAND 35 (RESET CONTROLLER) – ABX FAST COMMAND EXAMPLE

This example resets power to the controller.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0001
Command ID	0x35
Checksum	Optional
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0001
Command Echo	0x35
Checksum	Optional
Terminator	0x03

Command 35 (Reset Controller) – CBx Command Example

Command from Host

DESCRIPTION	MSB	LSB
Overall Length of Command (*in words*)	0x00	0x06
AA in MSB **Command ID** in LSB	0xAA	**0x35**
00 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

DESCRIPTION	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06
AA in MSB **Command Echo** in LSB	0xAA	**0x35**
Instance Counter in MSB **Node Echo** in LSB	Instance Counter	0x01
Month and **Day** timestamp	Month	Day
Hour and **Minute** timestamp	Hour	Min
Seconds timestamp in MSB **00** in LSB	Seconds	0x00

COMMAND 38: GET CONTROLLER INFO

Command 38 is used to retrieve hardware version, serial number and installed firmware identification information from the controller.

COMMAND 38 (GET CONTROLLER INFO) – ABx FAST COMMAND STRUCTURE

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0001
Command ID	0x38
Checksum	Optional
Terminator	0x03

COMMAND 38 (GET CONTROLLER INFO) – ABx FAST COMMAND EXAMPLE

This example will query the Cobalt HF and retrieve specific internal hardware information.

Command from Host

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Command Size	0x0001
Command ID	0x38
Checksum	Optional
Terminator	0x03

Response from Controller

PARAMETER FIELD	CONTENT DESCRIPTION	CONTENT SAMPLE
Header	2-byte Response Header (*0x02, 0x02*)	0x02, 0x02
Response Size	2-byte value for the total number of bytes in the response packet, less Header, Command Size, Checksum and Terminator bytes.	0x001B
Command Echo	0x38	0x38
RF Controller Type	Controller Type default = 1 (*0x01*)	0x01
Major Release Digit	The MAJOR release ASCII digit in the product version number. Example product version number: **0.0t.14**. Major Release Digit in this example = 0	0x30
Minor Release Digit	The MINOR release ASCII digit in the product version number. Example product version number: **0.0t.14**. Minor Release Digit in this example = 0	0x30
Correction Release Digit	The CORRECTION ASCII digit in the product version number. Example product version number: **0.0t.14.** Correction Release Digit in this example = t	0x74
Point Release Digit	The POINT RELEASE digit in the product version number. Example product version number: **0.0t.14.** Point Release Digit in this example = 14	0x0E
Hardware Version	Cobalt HF-xxx-01Hardware Version, default = 01 (*0x01*)	0x01
Block 0, 1, and 2 CRC	2-byte value for block 0, 1, and 2 CRC: (*example: 986E*)	0x986E
Block 3, and 4 CRC	2-byte value for block 3, and 4 CRC: (*example: 986E*)	0x986E
RC632 ID	5-byte value for the RC632 ID: (*example: 30FFFF0F04*)	0x30, 0xFF, 0xFF, 0x0F, 0x04
RC632 RFU	3-byte value for the RC632 RFU. (*example: 000000*)	0x00, 0x00, 0x00
RC632 Serial Number	4-byte value for the RC632 Serial Number. (*example: 05E19644*)	0x05, 0xE1, 0x96, 0x44
RC632 Internal Information	2-byte value for the RC632 internal. (*example: B669*)	0xB669

RC632 RsMaxP	Single-byte value for the RC632 RsMaxP: (*example: 65*)	0x65
RC632 Information CRC	Single-byte value for the RC632 Information CRC. (*example: A6*)	0xA6
Terminator	0x03	0x03

Controller Information (retrieved in the above example response)

RF Controller Type:	1
Product Version Number:	0.0T.5
Hardware Version:	01
Block 0, 1, and 2 CRC:	986E
Block 3, and 4 CRC:	986E
RC632 ID:	30FFFF0F04
RC632 RFU:	000000
RC632 Serial Number:	05E19644
RC632 internal:	B669
RC632 RsMaxP:	65
RC632 Information CRC:	A6

COMMAND 38 (GET CONTROLLER INFO) – CBX COMMAND EXAMPLE

Command from Host

DESCRIPTION	MSB	LSB
Overall Length of Command	0x00	0x06
AA in MSB **Command ID** in LSB (*0x38:Get Controller Info*)	0xAA	**0x38**
0x00 in MSB **Node ID in LSB** (*Cobalt –IND = 01*)	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

DESCRIPTION	MSB	LSB
Overall Length of Response (*in words*)	0x00	0x06 + number of additional data words retrieved
Command Echo	0xAA	**0x38**
Instance Counter in MSB **Node ID Echo** in LSB	Instance Counter	0x01
Month and **Day** timestamp	Month	Day
Hour and **Minute** timestamp	Hour	Min
Seconds timestamp in MSB **Number of Additional Data Bytes Retrieved** in LSB	Seconds	N-bytes
Node Info: (*bytes 1 & 2*)	Node Info - byte 1	Node Info - byte 2
Node Info: (*bytes 3 & 4*) (…etc.)	Node Info - byte 3	Node Info - byte 4

CHAPTER 8: ERROR CODES

If the Cobalt Controller encounters a fault during operation, the response that is generated will include a 1-byte error code. Entering an invalid Start Address for a Read Data command, for example, will generate Error Code 0x32 (Invalid Programming Address).

8.1 ERROR CODE TABLE

ERROR CODE	ERROR NAME	DESCRIPTION
0x04	FILL TAG FAILED	Fill Operation Failed
0x05	READ DATA FAILED	Read Data Command Failed
0x06	WRITE DATA FAILED	Write Data Command Failed
0x07	READ TAG ID FAILED	Read Tag ID Command Failed
0x08	TAG SEARCH FAILED	Tag Search Command Failed / No Tag Found
0x21	INVALID SYNTAX	Command Contained a Syntax Error
0x23	INVALID TAG TYPE	Invalid or Unsupported Tag Type
0x30	INTERNAL CONTROLLER ERROR	Generic Internal Controller Error
0x31	INVALID CONTROLLER TYPE	Invalid Controller Type (when Setting Configuration)
0x32	INVALID PROGRAMMING ADDRESS	Invalid Tag Address Specified in the Command
0x34	INVALID VERSION	Invalid Software Version (when Setting Configuration)
0x35	INVALID RESET	Invalid Hardware Reset
0x36	SET CONFIGURATION FAILED	Set Configuration Command Failed
0x37	GET CONFIGURATION FAILED	Get Configuration Command Failed
0x83	COMMAND INVALID OPCODE	An invalid Command ID number was 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 Hub'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	MODBUS NODE MISMATCH ERROR	The Node specified in the command did not match the Node to which the command was sent (MUX32 mode).
0x94	MODBUS CRC ERROR	Internal Communications Error (MUX32 mode)
0x95	MODBUS PROTOCOL ERROR	Internal Communications Error (MUX32 mode)

Table 8-1: Error Code Table

8.2 ABx Fast: Error Response Packet Structure

For any ABx Fast error response, a single-byte **Error Code** always follows the **0xFF** byte (Error Flag byte).

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0002
Error Flag	0xFF
Error Code	1-byte error code
Checksum	optional
Terminator	0x03

Table 8-2: ABx Fast - Error Response Structure

ABx Fast - Error Response Example

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

PARAMETER FIELD	CONTENT
Header	0x02, 0x02
Response Size	0x0002
Error Flag	0xFF
Error Code	0x06
Checksum	0xF8
Terminator	0x03

8.3 CBx Protocol: Error Response Packet Structure

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

PARAMETER FIELD	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 Byte: 0xFF in the MSB indicates that an error occurred. **Command ID Echo**: 1-byte value in the LSB indicates the command that was attempted when the error occurred.	0xFF	Command ID Echo
Instance Counter: This 1-byte value tallies the number of responses from a given Node ID. **Node ID**: 1-byte value in LSB indicates the Node ID of the controller that experienced or generated the error. (*Cobalt -IND = 01*)	Instance Counter	0x01
Month and **Day** timestamp	Month	Day
Hour and **Minute** timestamp	Hour	Minute
Seconds timestamp in MSB **# of Additional Bytes Retrieved** in LSB (*0x01 for error responses*).	Seconds	0x01
Error Code: 1-byte Error Code in MSB **00** in LSB	Error Code	0x00

Table 8-3: CBx Error Response Structure

CBx - Error Response Example

Below is an example of a CBx error response (error code 0x08) for a failed Tag Search (Command ID: 0x08).

Command from Host

PARAMETER FIELD	MSB	LSB
00 in MSB **Overall Length of Command** in LSB (*in words*)	0x00	0x06
AA in MSB **Command ID** in LSB: (*0x08 – Tag Search*)	0xAA	0x08
00 in MSB **Node ID** in LSB (*Cobalt –IND = 01*)	0x00	0x01
2-byte **Timeout Value** measured in ms: (*0x07D0 = 2 seconds*)	0x07	0xD0
Not Used: (*0x00, 0x00*)	0x00	0x00
Not Used: (*0x00, 0x00*)	0x00	0x00

Error Response (if no tag is found)

PARAMETER FIELD	MSB	LSB
00 in MSB **Overall Length of Response** in LSB (*in words*)	0x00	0x07
Error Flag in MSB **Command Echo** in LSB	0xFF	0x08
00 in MSB **Node ID Echo** in LSB	0x00	0x01
Month and **Day** timestamp	Month	DOM
Hour and **Minute** timestamp	Hour	Minutes
Seconds timestamp in MSB **# of Additional Data Bytes**: (*0x01*)	Seconds	0x01
Error Code in MSB: (*0x08 = "Tag Search Failed"*) **00** in LSB	0x08	0x00

APPENDIX A:
COBALT HF SPECIFICATIONS

ELECTRICAL

Supply Voltage:	10~30VDC
Power Consumption:	12W (450mA @ 24VDC)

COMMUNICATION

Communication Interfaces:	• Point-to-Point: *RS232, RS422, USB* • Multi-drop: *Subnet16 (RS485)* • Ethernet: *Ethernet/IP, Modbus TCP, TCP/IP*
RFID Interface:	Cobalt HF-Series RFID System
RF Output Power:	1W
Air Protocols:	I·CODE 1, ISO 15693, ISO 14443 A
Air Protocol Speed:	26.5kBaud/106kBaud with CRC error detection
RS232/RS422/485 Baud Rates:	9600 (default), 19.2k, 38.4k, 57.6k, 115.2k

MECHANICAL

Dimensions:	Refer to *Chapter 1, Section 1.4*
Weight:	.44 KG (1 lb. – 440 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°)
Humidity:	100%
Protection Class:	IP66
Shock Resistance:	IEC 68-2-27 Test EA 30g, 11milliseconds, 3 shocks each axis
Vibration Resistance	IEC 68-2-6 Test FC 1.5mm; 10 to 55Hz; 2 hours each axis

APPENDIX B: MODELS & ACCESSORIES

COBALT HF RFID CONTROLLER MODELS

There are five models of the **Cobalt HF RFID Controller**:

HF-CNTL-232-01 – for RS232 interface connections

HF-CNTL-422-01 – for RS422 interface connections

HF-CNTL-485-01 – for RS485 interface connections

HF-CNTL-USB-01 – for USB interface connections

HF-CNTL-IND-01 – for Industrial Ethernet interface connections

COBALT HF ANTENNA MODELS

There are four models of the **Cobalt HF Antenna**:

HF-ANT-1010-01 – 10cm x 10cm

HF-ANT-2020-01 – 20cm x 20cm

HF-ANT-3030-01 – 30cm x 30cm

HF-ANT-0750-01 – 7cm x 50cm (for conveyor applications)

SUBNET16 GATEWAYS

GWY-01-TCP-01
Subnet16™ TCP/IP Gateway – for commercial TCP/IP environments

GWY-01-IND-01
Subnet16™ Industrial Ethernet Gateway – for Industrial Ethernet environments

SUBNET16 HUBS

HUB-04-TCP-01
Subnet16™ TCP/IP Hub (4-port) – for commercial TCP/IP environments

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

Power Supplies

00-1166: 24VDC, 1.88A max, 45W, Universal Input (90-264VAC, 47-63Hz), 5.5x2.5mm plug, positive tip; Note: Requires country specific power cord to mate to IEC 320 power cord receptacle.

00-1167: 24VDC, 4.17A max, 100W, Universal Input (90-264VAC, 47-63Hz), 5.5x2.5mm plug, positive tip; Note: Requires country specific power cord to mate to IEC 320 power cord receptacle.

00-1168: 24VDC, 5.0A max, 120W, Universal Input (88-132VAC/176-264VAC switch selectable, 47-63Hz) DIN Rail Mount; Note: AC wire receptacles are spring clamp for direct wire connection.

Cobalt HF Software Applications

RFID Dashboard: provides users with complete control over their Escort Memory Systems RFID system. The RFID Dashboard allows system operators to configure, monitor and control Cobalt HF-Series RFID devices from anywhere on their network.

C-MacroBuilder: an easy to use GUI-driven utility that allows users to create, edit and save powerful RFID macros.

Cobalt HF-SDK: Cobalt HF Controller - Software Development Kit (requires Microsoft® Visual Studio® .Net). Contact your distributor.

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

Cobalt Cables & Connectors

CBL-1478 - RS232 Cable with DB9 Female Plug and 2.5mm DC Jack

CBL-1480-0.2 - Male/Female, ThinNet Drop Cable, 0.2m

CBL-1480-02 - Male/Female, ThinNet Drop Cable, 2m

CBL-1480-10 - Male/Female, ThinNet Drop Cable, 10m (for Hubs only)

CBL-1481-0.2 - Male/Male, ThinNet Drop Cable, 0.2m

CBL-1481-01 - Male/Male, ThinNet Drop Cable, 1m

CBL-1481-02 - Male/Male, ThinNet Drop Cable, 2m (Gateway to T)

CBL-1482-02 - Male/90 Degree Female, ThinNet Drop, Cable, 2m

CBL-1482-10 - Male/90 Degree Female, ThinNet Drop, Cable, 10m

CBL-1483 - Male/Female, ThickNet Trunk Cable, 10m

CBL-1484 - Female w/ Bare Wire, ThickNet Trunk Cable, 2m

CBL-1485 - ThickNet to ThinNet Drop-T

CBL-1486 - ThinNet to ThinNet Drop-T

CBL-1487 – Straight Female M12 Field Mountable Connector

CBL-1488 - M12-8, Female w/ Bare Wires Cable, 2m, (-232- & -422)

CBL-1489 - Male 7/8-16 ThickNet 120-Ohm Termination Resistor Plug

CBL-1490 - Male M12 ThinNet 120-Ohm Termination Resistor Plug

CBL-1491 - 90 Degree Female M12 Field Mountable Connector

CBL-1492 - M12-8, 90 Degree Female w/ Bare Wires Cable, 2m, (-232 & -422)

CBL-1493 - M12-8, Straight Female Field Mountable Connector

CBL-1513 – M12, 5-Pin, Male, Reverse Keyed to Type A, USB Cable 3M

CBL-1514 – M12, 5-Pin, Straight Male, Reverse Keyed Connector for USB

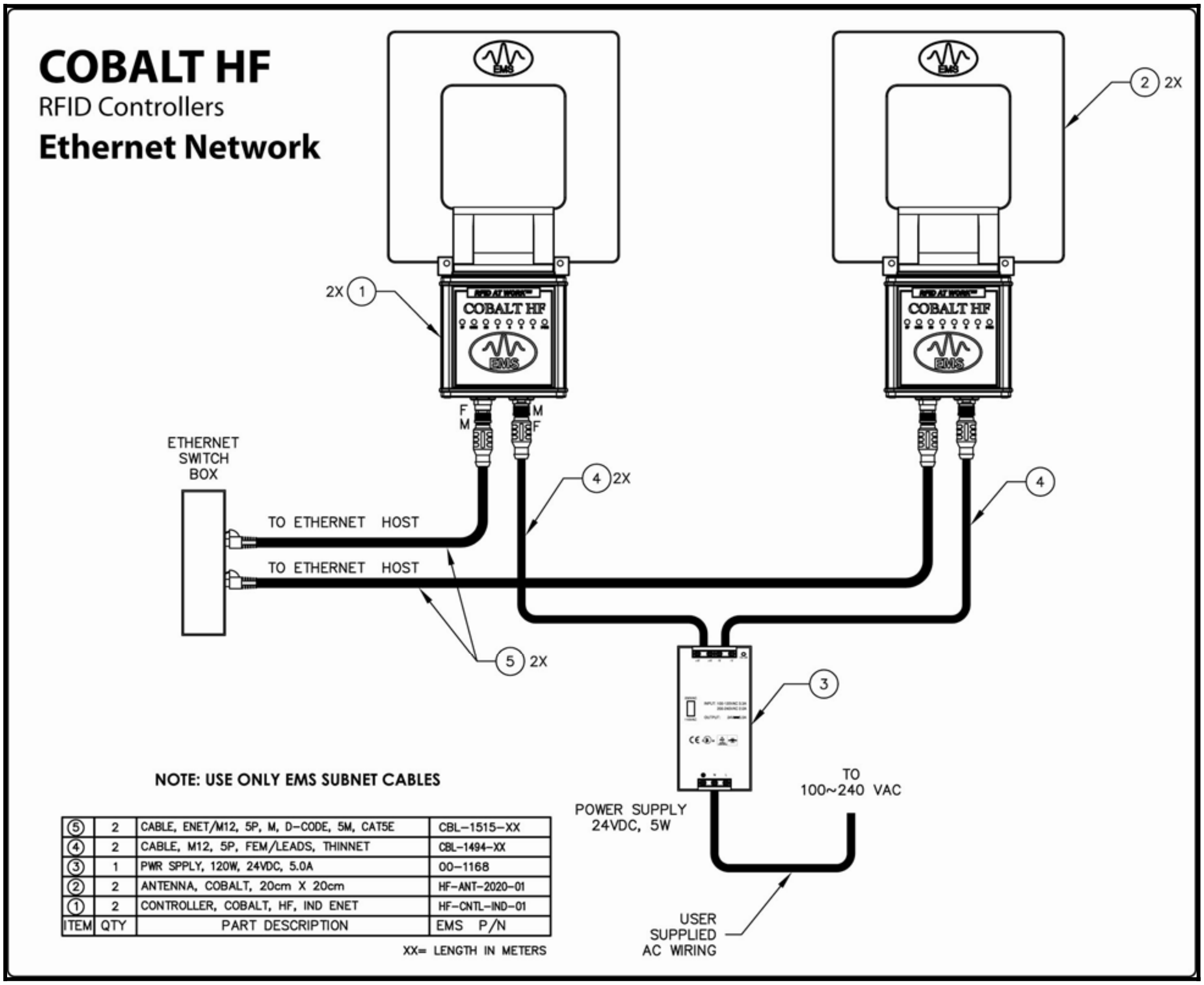
CBL-1515-05 – Cable, Ethernet/M12, 5-Pin, Male, D-Code, 5M

RFID TAGS

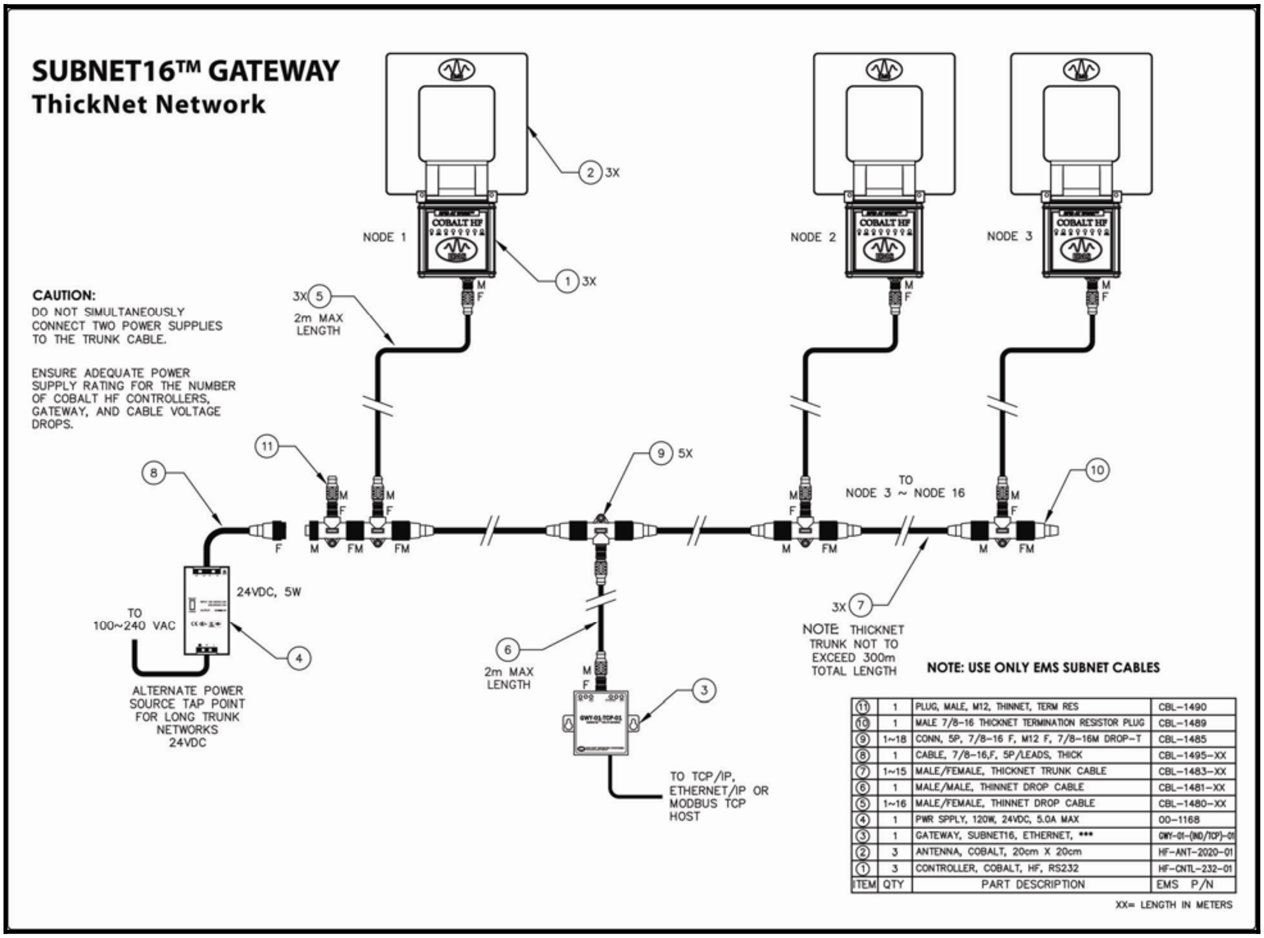
Escort Memory Systems designs and manufactures several lines of RFID tags. LRP and HMS-Series passive read/write RFID tags are specially suited for the Cobalt HF Series product line.

APPENDIX C: NETWORK DIAGRAMS

- Cobalt Ethernet Network
- Subnet16 Gateway ThickNet Network



ITEM	QTY	PART DESCRIPTION	EMS P/N
5	2	CABLE, ENET/M12, 5P, M, D-CODE, 5M, CAT5E	CBL-1515-XX
4	2	CABLE, M12, 5P, FEM/LEADS, THINNET	CBL-1494-XX
3	1	PWR SPPLY, 120W, 24VDC, 5.0A	00-1168
2	2	ANTENNA, COBALT, 20cm X 20cm	HF-ANT-2020-01
1	2	CONTROLLER, COBALT, HF, IND ENET	HF-CNTL-IND-01



ITEM	QTY	PART DESCRIPTION	EMS P/N
11	1	PLUG, MALE, M12, THINNET, TERM RES	CBL-1490
10	1	MALE 7/8-16 THICKNET TERMINATION RESISTOR PLUG	CBL-1489
9	1~18	CONN, 5P, 7/8-16 F, M12 F, 7/8-16M DROP-T	CBL-1485
8	1	CABLE, 7/8-16,F, 5P/LEADS, THICK	CBL-1495-XX
7	1~15	MALE/FEMALE, THICKNET TRUNK CABLE	CBL-1483-XX
6	1	MALE/MALE, THINNET DROP CABLE	CBL-1481-XX
5	1~16	MALE/FEMALE, THINNET DROP CABLE	CBL-1480-XX
4	1	PWR SPPLY, 120W, 24VDC, 5.0A MAX	00-1168
3	1	GATEWAY, SUBNET16, ETHERNET, ***	GWY-01-(IND/TCP)-01
2	3	ANTENNA, COBALT, 20cm X 20cm	HF-ANT-2020-01
1	3	CONTROLLER, COBALT, HF, RS232	HF-CNTL-232-01

XX= LENGTH IN METERS

APPENDIX D: ASCII CHART

ASCII Chart

Decimal	Hex	Character
000	00	NUL
001	01	SOH
002	02	STX
003	03	ETX
004	04	EOT
005	05	ENQ
006	06	ACK
007	07	BEL
008	08	BS
009	09	HT
010	0A	LF
011	0B	VT
012	0C	FF
013	0D	CR
014	0E	SO
015	0F	SI
016	10	DLE
017	11	DC1
018	12	DC2
019	13	DC3
020	14	DC4
021	15	NAK
022	16	SYN
023	17	ETB
024	18	CAN
025	19	EM
026	1A	SUB
027	1B	ESC
028	1C	FS
029	1D	GS
030	1E	RS
031	1F	US
032	20	(SPACE)
033	21	!
034	22	"
035	23	#
036	24	$
037	25	%
038	26	&
039	27	'
040	28	(
041	29	)
042	2A	*
043	2B	+
044	2C	,
045	2D	-
046	2E	.
047	2F	/
048	30	0
049	31	1
050	32	2
051	33	3
052	34	4
053	35	5
054	36	6
055	37	7
056	38	8
057	39	9
058	3A	:
059	3B	;
060	3C	<
061	3D	=

Decimal	Hex	Character	Decimal	Hex	Character
062	3E	>	095	5F	_
063	3F	?	096	60	‘
064	40	@	097	61	a
065	41	A	098	62	b
066	42	B	099	63	c
067	43	C	100	64	d
068	44	D	101	65	e
069	45	E	102	66	f
070	46	F	103	67	g
071	47	G	104	68	h
072	48	H	105	69	i
073	49	I	106	6A	j
074	4A	J	107	6B	k
075	4B	K	108	6C	l
076	4C	L	109	6D	m
077	4D	M	110	6E	n
078	4E	N	111	6F	o
079	4F	O	112	70	p
080	50	P	113	71	q
081	51	Q	114	72	r
082	52	R	115	73	s
083	53	S	116	74	t
084	54	T	117	75	u
085	55	U	118	76	v
086	56	V	119	77	w
087	57	W	120	78	x
088	58	X	121	79	y
089	59	Y	122	7A	z
090	5A	Z	123	7B	{
091	5B	[	124	7C	|
092	5C	\	125	7D	}
093	5D	]	126	7E	~
094	5E	^	127	7F	DEL

ESCORT MEMORY SYSTEMS
A DATALOGIC GROUP COMPANY
EMS

WARRANTY

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

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

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