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U S E R ' S M A N U A L

ETHERNET
M-MODULE
CARRIER

MODEL
EM405D

Manual Part No: 11028854

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INTRODUCTION

This manual describes the operation and use of the C&H Model EM405D Ethernet M-Module Carrier (Part Number 11028850). This instrument is one of a number of M-module carriers provided by C&H.

Contained within this manual are the physical and electrical specifications, installation and startup procedures, functional description, and configuration and programming guidelines to adequately use the product.

Software drivers for an installed M/MA module may be provided by the M/MA module manufacturer. Some drivers may require modification to operate correctly with the communication protocol and the addressing methodology used by the EM405D. To support initial operation and application software development, C&H provides a software application called Interactive Mezzanine Control (IMC). The application provides immediate access and control of any M/MA module residing on an EM405D. IMC can be downloaded from the support section of C&H's website www.chtech.com.

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1.0 GENERAL DESCRIPTION

The EM405D Ethernet M-Module carrier provides complete Ethernet connectivity to up to two industry standard single-wide or one double-wide M or MA modules. The carrier provides full access to the M/MA module I/O space via the standard TCP/IP networking protocol. M-module triggers are also fully supported allowing them to be connected externally to a 9-pin DSUB connector or to an adjacent M-module. A simple command structure eases software integration and allows reset, identification, control, and configuration of the carrier and M-modules. For a complete list of M-modules compatible with the EM405D carrier, visit the mezzanine section of www.mezzanines.org, or www.vita.com.



Figure 1. EM405D Ethernet M-Module Carrier

1.1 PURPOSE OF EQUIPMENT

The EM405 easily interfaces a VITA 12-199x standard M/MA Module to a typical Ethernet network. The carrier allows the numerous functions available in the M-Module mezzanine format to be remotely located near the unit-under-test, easing many system integration issues. Over 100 M/MA modules are available from numerous manufacturers.

1.2 FEATURES AND SPECIFICATIONS

1.2.1 Key Features

- Supports two ANSI/VITA 12-1996 compliant single-wide M or MA-modules or one double-wide module
- Ethernet 10Base-T, 100Base-TX (Auto-Sensing) or Wi-Fi 802.11b
- Rugged steel/aluminum enclosure (5.6"W × 8.5"D × 1.5"H)
- +12V power input through standard 2.5mm jack or 9-pin DSUB
- Variable speed forced air cooling with software temperature status
- D16 M-module accesses supported
- Flexible block access command provides rapid sequential and FIFO data accesses
- External trigger input/output and inter-module triggers supported
- Isolated and filtered +5V, +12V, and -12V supplies for each M-module
- Interactive Mezzanine Control (IMC) software available

1.2.2 Specifications

MAXIMUM RATINGS

Parameter	Condition	Rating	Units
Operating Temperature		0 to +60	°C
Non-Operating Temperature		-40 to +75	°C
Humidity	non-condensing	5 to 95	%
Input DC Power Level		12.6	V max.
Power Consumption	Support for two M-modules at full power	30	Watts
External Trigger Input	Power Off	± 40	V
	Power On	± 36	V

CHARACTERISTICS

		Limit			
Parameter	**Conditions**	**Min**	**Typ.**	**Max**	**Units**
Data Transfers					
Throughput	Wired Ethernet – block read [1, 3]			90K	bytes/sec
	Wired Ethernet – block write [2, 3]			40K	bytes/sec
	Wireless Ethernet – block read [1, 3]			23K	bytes/sec
	Wireless Ethernet – block write [2, 3]			14K	bytes/sec
Input Power Supply					
Level	DC	11.4	12.0	12.6	V
Current	for full M-module support	2.5			A
Ripple/noise	20MHz bandwidth	-1.5		+1.5	%
Power Consumption					
Carrier	-0001 wired Ethernet	460	470	550	mA
	-0002 wireless Ethernet	500	510	590	mA
M-modules (each position)	+5V			1.0	A
	+12V			200	mA
	-12V			200	mA
Triggers					
Output Level	into a high impedance load	3.8	5.0	5.4	V
Output Impedance			50		Ω
Input Level	TLVL = 0 [4]		2.5		V
	TLVL = 1		1.4		V
Input Impedance	TIMP = 0 [4]	100K			Ω
	TIMP = 1		50		Ω
External Trigger Delay	External connector to M-module		30	40	ns
	M-module to external connector		30	40	ns
	M-module to M-module		30	40	ns
Cooling					
Temperature Rise				20	°C
Temperature Accuracy		-2		+2	°C

Notes:

1. 12-24ms latency occurs on each command issued. The effect of this latency is reduced by transferring large amounts of data with a single block read command. Maximum read throughput is achieved by reading >64K bytes of data from a FIFO type register on an M-module using the Block Read command. Host software may vary and can limit the maximum throughput.
2. The maximum number of bytes that can be written in a single block write command is 1024.
3. Ethernet is a non-deterministic communications interface. Realized throughput may be significantly degraded by network activity or other factors that may affect network performance.
4. TLVL and TIMP refer to register bits in the *Reset & Trigger Control* register. Refer to section 4.3.5.

1.3 Electrical

The EM405D only requires a +12V DC power input. The +12V input is internally converted to the +3.3V power required by the carrier and the +5V, +12V, and -12V power required by the M-modules. A maximum of 30 watts is required to support the carrier and two M-modules operating at the maximum allowed power consumption. The maximum allowed power consumption for each M-module is 1A of +5V and 200ma each of +12V and -12V. The EM405D uses power-off resetable fuses on the incoming +12V supply. If a fault occurs, power must be removed before the fuse will reset. The fuse is rated at 5 amps.

1.4 Mechanical

The EM405D is contained in a metal chassis with an outside dimension of 5.6 inches wide by 8.5 inches deep by 1.5 inches high. A variable speed fan provides forced air for cooling the M-modules. The unit weighs approximately 1.7 lbs with no M-modules installed.

1.5 Environmental

The environmental specifications of the module are:

Operating Temperature:	0°C to +60°C*
Storage Temperature:	-40°C to +75°C
Humidity:	<95% without condensation

* The forced air cooling is designed to allow a maximum 20°C temperature rise for installed M-modules. In other words, with two M-modules operating at full dissipation, the M-modules' temperature can only be maintained within 20°C of the ambient air inlet temperature. Installed M/MAs may differ in environmental specification. Refer to each individual M/MA's documentation for information.

1.6 Bus Compliance

The module complies with the ANSI/VITA 12-1996 Specification for single or double-wide M-Modules and the MA-Module trigger signal extension.

Addressing:	A08 only (extended addressing not supported)
Data:	D16 only
Interrupts:	not supported
DMA:	not supported
Triggers:	Trig A and Trig B Input/Output
Manufacturer ID:	$0FC1_{16}$
Model Number:	$0FDB_{16}$

1.7 APPLICABLE DOCUMENTS

ANSI/VITA 12-1996 American National Standard for The Mezzanine Concept M-Module Specification, Approved May 20, 1997, VMEbus International Trade Association, 7825 E. Gelding Dr. Suite 104, Scottsdale, AZ 85260-3415, E-mail: info@vita.com, www.vita.com

IEEE-802.3 (ANSI 8802.3), Ethernet Network Standard

IEEE-802.11b, Wireless Ethernet Standard

2.0 INSTALLATION

2.1 UNPACKING AND INSPECTION

Verify that there has been no damage to the shipping container. If damage exists then the container should be retained, as it will provide evidence of carrier caused problems. Such problems should be reported to the carrier immediately as well as to C&H. If there is no damage to the shipping container, carefully remove the instrument from its box and inspect for any signs of physical damage. If damage exists, report immediately to C&H.

2.2 HANDLING PRECAUTIONS

The components used in the EM405D are static sensitive. Damage may occur if proper static precautions are not taken. Installation of M-modules should only be done at a properly grounded static free workstation.

> **CAUTION: Read the entire User's Manual before proceeding with the installation and application of power.**

2.3 INSTALLATION OF M-MODULES

To install modules, first remove power from the carrier. Remove the front panel cover by removing the two screws located at the sides of the panel. Do ***not*** remove the screws located on the bottom of the enclosure. Slide the PCB out of enclosure. Install M-modules by firmly pressing the connector on the M-module together with the connector on the carrier as shown in Figure 2. Secure the module through the holes in the PCB using screws provided with the M-module.

> **WARNING: The EM405D supports M-modules that use two or three row interface connectors. When using M-modules with only two rows, row C of connector (rear row) is left unconnected.**

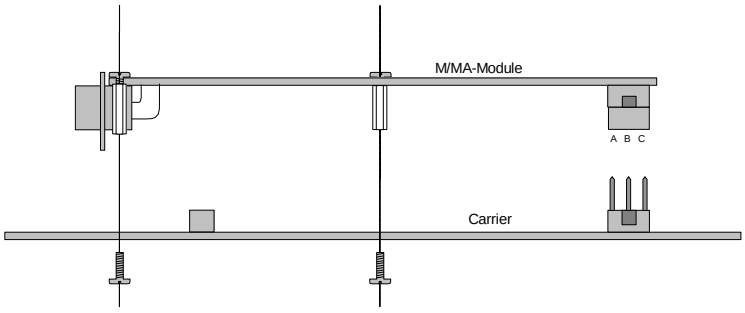


Figure 2. M-module Installation

There are two M-module mounting locations on the EM405D. Single-wide M-modules may be installed in either or both of the positions. A double-wide M-module will occupy both positions. The EM405D configuration is illustrated in Figure 3.

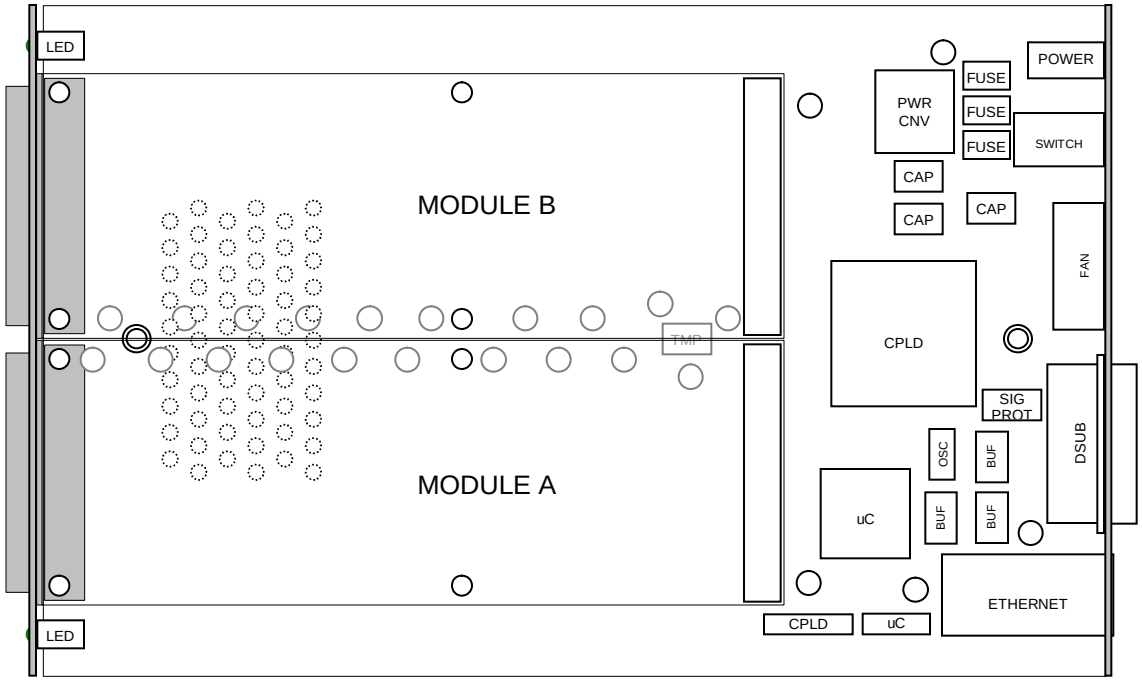


Figure 3. M/MA Configuration Diagram

CAUTION: M-module connectors are NOT keyed. Use extra caution to avoid misalignment. Applying power to a misaligned module can damage the M-module and carrier.

Re-assemble the EM405D by first sliding the carrier into the enclosure. Be careful to align the edges of the carrier with the guide rails of the enclosure. Improper alignment will cause the back panel component to not align with the back panel cutouts. Slide the carrier all the way into the enclosure and re-affix the front panel using the two screw holes located at the sides of the panels.

3.0 FUNCTIONAL DESCRIPTION

3.1 GENERAL

The EM405D provides a mechanical and electrical interface between an Ethernet bus and up to two M-modules. It utilizes an embedded microcontroller to provide buffering and command translation between the Ethernet interface and the M-modules. A simplified functional block diagram is shown in Figure 4.

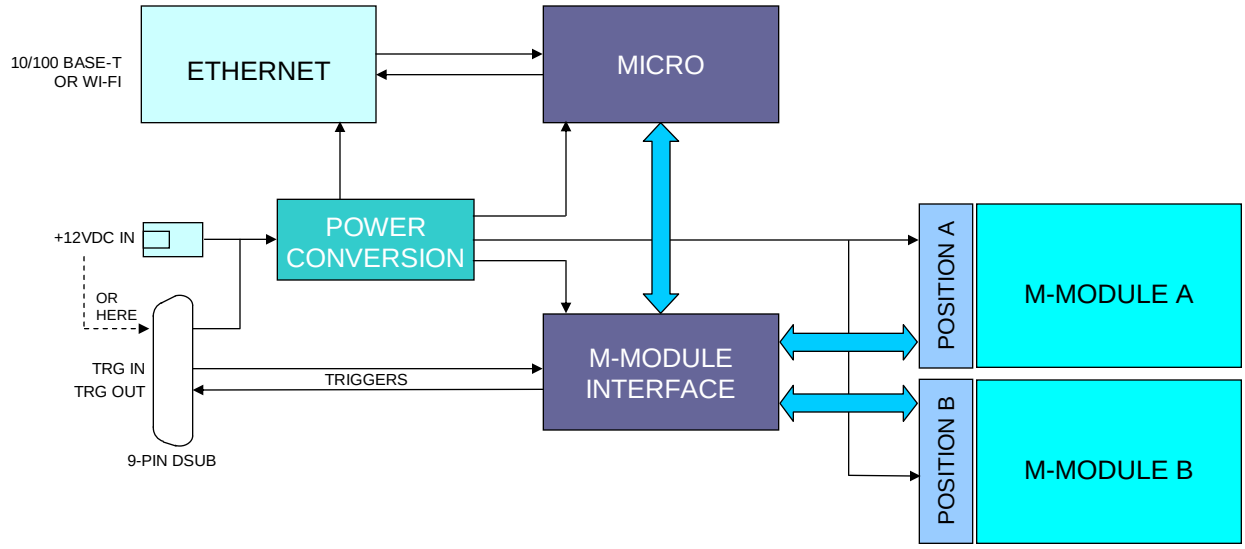


Figure 4. Functional Block Diagram

3.1.1 Embedded Controller

The embedded controller is implemented using a high-performance microcontroller. The microcontroller executes system firmware that controls the translation between Ethernet and the M-module interface. The system firmware implements a simple command protocol that allows access to the M-modules I/O space, trigger mapping and carrier information and status. It also provides data buffering and fan control.

3.1.2 Ethernet Interface

The Ethernet interface provides the physical and logical connection to the EM405D allowing remote control of the M-modules. The EM405D is available with either wired 10/100 Base-T Ethernet or wireless Ethernet (Wi-Fi). The interface supports the TPC/IP protocol for control of the M-modules. It also supports DHCP, AutoIP, Telnet, HTTP and other standard protocols for device configuration and management.

3.1.3 M-module Interface

The M-module interface provides the mechanism for the microcontroller to access the M-modules. It is implemented using programmable logic that emulates a bridge between the microcontroller and the M-module bus. The logic also provides trigger configuration and control.

3.1.4 Power Conversion

The +12V input power is converted to the +3.3V power required by the carrier and the +5V, +12V, and -12V power required by the M-modules. The input power can be supplied through the 2.5mm power jack connector or through pins on the 9-pin DSUB connector.

3.2 REAR PANEL

The rear panel of the EM405D contains a +12V power input connection, an Ethernet connection or wireless antenna and a 9-pin DSUB connector that provides connection to M-module trigger lines and an alternate power input connection. Also found on the rear panel are the fan and an On/Off switch. Figure 5 shows the rear panel of the module. Refer to Appendix A for pin-out details of the 9-pin DSUB connector.

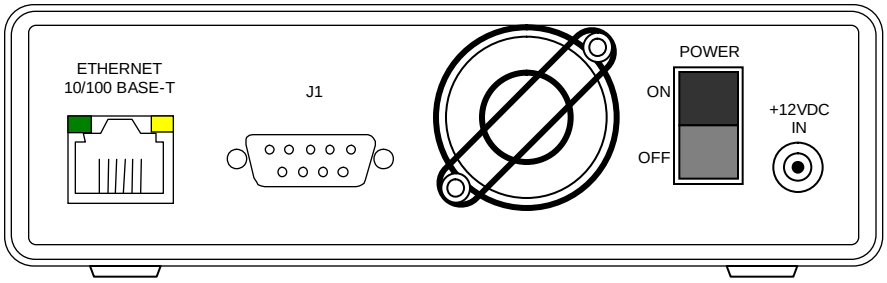


Figure 5. Rear Panel

3.3 FRONT PANEL

The front panel of the EM405D contains two openings for access to the M-modules' front panel connections and three LED indicators as shown in Figure 6. As mandated by the M-module specification, each M-module should provide a front panel connector containing the M-module I/O signals. The two openings on the EM405D's front panel provide access to these connectors. The functions of the three front-panel LED indicators are:

PWR: indicates that power is supplied to the module and that the power switch is ON. The units should be operating normally.

A, B: indicates that M-module A or B is currently being accessed. The LED will illuminate temporarily each time the module is accessed by the host software.

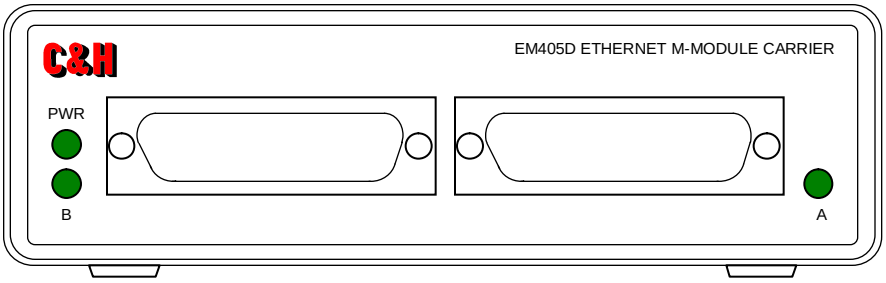


Figure 6. Front Panel

4.0 OPERATING INSTRUCTIONS

4.1 GENERAL

The EM405D is controlled through the Ethernet interface using the TCP/IP protocol to carry a simple command structure to the module. The carrier contains a set of software controlled registers that allow the user to request status from the carrier, identify the carrier, and configure the carrier. All other M/MA controls are dependent on the specific M-module(s) that reside on the carrier.

4.2 CONFIGURING THE ETHERNET INTERFACE

The Ethernet interface must be properly configured to work on the user's network. The flexibility of the EM405D's Ethernet interface allows it to be used in a large number of possible network configurations. The unit is delivered with a default configuration that may or may not be appropriate for the user's network. It is up to the user and the user's network administrator to use the information provided throughout this section to determine what configuration is best for the given network.

4.2.1 IP Address

The EM405D must have a unique IP address before it can communicate on a network. There are several options for assigning an IP address to the unit. The option to choose is dependant upon the type of network for which the EM405D is being configured.

DHCP: The Dynamic Host Control Protocol (DHCP) allows the module to dynamically retrieve an IP address from a DHCP server at power-up. If DHCP is used, the EM405D may have a different IP address assigned each time it is powered on or connected to the network. For the wired EM405D, DHCP is automatically enabled if the IP address is set to 0.0.0.0. For the wireless EM405D, DHCP is a separate setting. **DHCP enabled is the default setting.**

AutoIP: The AutoIP protocol allows the module to automatically assign itself an IP address on networks that do not have a DHCP server. If a DHCP server is not found, the EM405D will select an IP address from the AutoIP reserved range (168.254.0.1 to 168.254.255.1). The unit will then send out an address resolution (ARP) request on the network to determine if the chosen address is already in use. If another device is using the selected IP address then the EM405D will select another address from the range and repeat the address resolution request. This continues unit the device finds an IP address that is not in use. For the wired EM405D, manually setting the IP address to 0.0.0.0 enables AutoIP as well as DHCP and manually setting the IP address to 0.0.1.0 will disable AutoIP but keep DHCP enabled. For the wireless EM405D both AutoIP and DHCP have separate enable/disable settings. **AutoIP enabled is the default setting.**

Static: For the wired EM405D, manually setting the IP address to something other than 0.0.0.0 will configure the EM405D to use the IP address specified. For the wireless EM405D DHCP must be disabled and the IP address must be manually set. The configured IP address will remain static even after power is removed from the module. For proper operation, the IP address must be chosen according to the network the module is being connected to.

RECOMMENDATION

The EM405D is an embedded device without an input device or display that can be used to determine the current configuration of the device. This can cause difficulties in determining at what IP address to access the module. For this reason, it is highly recommended, but not required, that the EM405D be configured to use a static IP address.

4.2.2 Subnet Mask

The subnet mask defines the number of bits that are taken from the IP address to refer to the given network subsection. The subnet mask allows Ethernet based networks to be separated into various subnets. The EM405D should be in the same subnet as the controlling PC.

The default subnet mask is: 255.255.255.0

4.2.3 Gateway

The gateway address allows the EM405D to communicate with other network segments. If communication outside of the given network segment is necessary, the gateway address should be set to the IP address of the router connecting the local network segment to the outside world. The gateway address, if needed, must be within the local network.

The default gateway address is: 0.0.0.0

4.2.4 Port Numbers

Every TCP connection to the device is defined by a destination IP address and a port number. The port number must be known by the software to communicate with the module. ***The port number is configurable but it is rarely, if ever, necessary to change it from its default setting.*** Port 9999 is reserved for Telnet access to the EM405D's configuration utility.

The default port number for standard module access is: 10001

4.2.5 Wireless Settings

Wireless EM405D's have other settings that must be configured for the carrier to work on a wireless network.

Network Mode: A wireless network can operate in one of two modes, *infrastructure* or *ad-hoc*. In infrastructure mode, all wireless network traffic passes through an access point. An access point can be a bridge, a router, or a combination bridge + router device. The access point may handle data encryption, bridging to wired networks, assigning IP addresses via DHCP, or a host

of other tasks. In ad-hoc mode, wireless devices may communicate directly with each other and an access point is not needed. In this case, all devices on the network must be configured to use ad-hoc mode. **The default network mode is: infrastructure.**

SSID: The Set Service Identifier (SSID) is a name given to a wireless access point to identify the access point on a wireless network. Most access points can be configured to periodically broadcast the SSID or to keep it private. Wireless devices can query the network for known SSID and thus communicate with access points that do not broadcast it. The EM405D can be configured to communicate with any available SSID or to query for a specific SSID and use the owning access point if found. **The default setting is to use any available SID.**

Channel: The 802.11b specification defines a total of 14 frequency channels that can be used for wireless communication. However, not all channels may be available for use. For example, the FCC only allows for the use of channels 1 through 11 in the US; whereas most of Europe can use channels 1 through 13. Other countries or locations may differ. All wireless communication is done over a common channel. Another consideration in regards to channels is interference. Interference can occur between access points or may be caused by other equipment such as microwave ovens and cordless phones. The EM405D can be set to *auto-scan* mode in which the device searches for the best wireless channel or it can be configured to use a specific channel. **The default setting is: Auto-Scan.**

Country: Some countries restrict certain channel ranges and other transmission properties. The EM405D should be configured for the country in which the device is being used. **The default setting is: USA.**

Security Settings: The EM405D supports WEP and WPA security protocols. WEP is an encryption protocol used for secure data transfers. WPA is an authentication protocol used to authenticate and associate a device and a wireless access point. WPA is not available in ah-hoc mode. The security settings must be set according to the wireless network being connected to. **The default settings are: WEP disabled and WPA disabled.**

4.2.6 Performing the Configuration – Wired Ethernet

There are two ways to configure the wired version of the EM405D: a web-based interface and a Telnet interface. Both ways work equally as well and the choice of which to use is based solely on the user's preferences. In either case, the IP address of the module must be known to perform the configurations. If the IP address of the module is not known, one can be assigned to the module as discussed in section 4.2.6.3.

4.2.6.1 Wed-based Configuration

To use the wed-based interface to configure the wired EM405D, open a Java enabled web browser and enter the device's IP address as the web address to open. This will download and run a Java applet from the device allowing the user to make changes to the devices configuration. Navigate through the pages of the web interface making the necessary changes to the configuration. When finished, click on the "Update Settings" button to apply the changes.

Note: *If the web page does not display or operate correctly, there may be some incompatibilities between the Java applet and the Java run-time environment on the PC. This is especially true for users using Microsoft Internet Explorer and the Microsoft Java Virtual Machine. It is recommended that the user download the latest Java runtime environment from www.java.com and disable the Microsoft Virtual Machine. The java applet served by the wired EM405D is compatible with Java 1.3.1x or higher.*

4.2.6.2 Telnet Configuration

To use the telnet interface, open a telnet session to port 9999 at the device's IP address. In Windows, this can be done by opening a command prompt window or going to **Run** under the Windows **Start** menu and in both cases typing the following, where x.x.x.x is the IP address:

```
telnet x.x.x.x 9999
```

PC's running environments other than Windows may require a different instruction but the concept remains the same. Once a telnet session is opened, the screen will display the configuration utility. Navigate through the various menu items and follow the instructions to configure the module. The configurations are not applied until the telnet session is exited with the **Save and Exit** menu item.

4.2.6.3 Configuring a Device with an Unknown IP address

To configure the device through either the web-based interface or the telnet interface, the EM405D must be connected to a network and have a valid IP address known to the user. This creates an obvious dilemma. How do you configure a device via the network if it is not configured for the network? The EM405D provides a method to overcome this dilemma using a process sometimes referred to as address "gleaning." This method uses the Address Resolution Protocol (ARP) and telnet to assign a temporary IP address to the device. This temporary address can then be used to connect to the web-based interface or the telnet interface to configure the device for the network. To assign a temporary IP address to a device using this method:

1) Locate the device's hardware (MAC) address and write it down. The address is displayed on a label inside the EM405D's cover. View the label by removing the two screws at the front of the module, removing the front panel, then sliding the top cover of the enclosure forward, exposing the rear section of the PCB. The MAC address can be found on the device that the Ethernet cable physically plugs into. It is a six part number

always starting with 00-20-4A identifying the manufacturer of the device. The last three parts of the number are unique to each unit.

Example: 00-20-4A-11-68-4C

2) Create an entry in the host computer's ARP table using the intended temporary IP address and the hardware address of the EM405D found in step 1. To perform this action on a Windows-based host, open the command prompt and type (the IP address can be any available address on your network and xx-xx-xx is the last three numbers in the unit's MAC address):

```
arp –s 192.168.1.7 00-20-4a-xx-xx-xx
```

View the ARP table to verify that the entry was successful by typing the following:

```
arp –a
```

The ARP commands might be slightly different on non Windows based hosts.

Note: On a Windows 95 machine, the ARP command will not work unless at least one IP address is in the ARP table. To view the ARP table, type: `arp –a`. *If no IP addresses are found in the table, you must ping an existing IP address on the network. If the ping is successful, the IP address should be automatically added to the ARP table.*

3) Open a Telnet connection to port 1 of the intended temporary IP address. To perform this action type the following at the command prompt:

```
telnet 192.168.1.7 1
```

The connection will fail but will cause the EM05D to temporarily change its IP address to the one specified.

4) Use the Telnet interface or the wed-based interface to open a session to the module using the new temporary IP address. At this point the IP address can be configured to a more permanent setting. The module will retain the temporary IP address until a new configuration is applied or the module is powered-off.

4.2.7 Performing the Configuration – Wireless Ethernet (Wi-Fi)

The wireless version of the EM405D provides a web-based interface to perform network and device configuration. A Telnet interface is not supported. To use the web-based interface, the user must know the carrier's IP address and the user must be able to connect to the module via a wireless access point, router, or another wireless device capable of communicating directly with other wireless devices (ad-hoc). If the EM405D's configuration is not known, it can be reset to known defaults as described in section 4.2.7.2.

4.2.7.1 Wed-based Configuration

To use the wed-based interface to configure the wireless EM405D, open a web browser and enter the device's IP address as the web address to open. This will launch the main web page of the configuration utility. Navigate through the pages of the web interface making the necessary changes to the configuration. When finished making changes in any given section, click on that pages "Apply" button to apply the changes. Some changes may require that the wireless Ethernet interface be rebooted, in which case the user will need to re-connect to the device.

4.2.7.2 Restoring Factory Defaults

Similar to the wired version, the wireless version of the EM405D has a dilemma in which the carrier must be connected to a network in order to configure its network properties. The dilemma is made worse in the wireless version by the fact that there is no physical connection to the device and there are additional configuration settings that must be known in order to connect to the device, such as the network mode, security settings (WEP, WPA), channel setting, and the SSID. If the EM405D configuration is not known and thus the user cannot connect to the carrier, it is possible to reset the configuration settings to known defaults using a small push-button switch found on the inside the EM405D enclosure.

CAUTION: The following procedure requires opening the EM405D enclosure and applying power while the PCB is exposed. Use extreme caution when attempting to perform the procedure as to not damage the carrier or any of its components.

To restore the factory defaults:

1) Turn power *Off*.
2) Remove the front panel cover by removing the two screws located at the sides of the panel. Do ***not*** remove the screws located on the bottom of the enclosure.
3) Slide the top cover of the enclosure forward exposing the rear portion of the PCB.
4) Locate the tiny push button switch near the Ethernet device (bottom right hand corner of the PCB when the carrier is oriented as shown in Figure 3).
5) Using a finger or a tool, such as the eraser end of a pencil, press and hold the button.
6) While holding the button down, turn the device *On*.
7) Continue holding the button pressed until the amber colored LED on the back of the Ethernet device flashes a 1-5-1 sequence.
8) Once the 1-5-1 sequence is complete, the device has been reset to its factory defaults and the user may release the button.
9) Re-assemble the EM405D by sliding the top cover back into place and re-installing the front panel.

The defaults that are restored using the above procedure are those set by the manufacturer of the Ethernet device and not by C&H Technologies, Inc. The default settings of the carrier as received from the factory at C&H are different in several key areas. The user must manually return these settings to the default as set by C&H in order for the carrier to operate properly. Refer to APPENDIX C or details on the factory default settings as received from C&H Technologies, Inc.

4.3 COMMUNICATING WITH THE CARRIER AND M-MODULES

The EM405D uses a simple binary command structure to communicate with the host software. The commands allow the user to either write or read registers residing on the EM405D or on each M-module. By writing registers residing on the EM405D, the user can identify the module, perform device configuration, and receive status. The registers residing on each M-module are specific to the particular M-module. Refer to the M-module's documentation for register details.

Each command consists of a command-id byte, a module number on which the command is to be executed and parameters, if required. The commands are listed in Table I. Details of each command are found throughout the rest of this section.

Table I. Command Summary

Binary Command-id	Function
0x20	Write Data
0x30	Read Data
0x40	Block Write
0x50	Block Read

4.3.1 Error Handling

Each command will return a status code as the last byte returned. This status code will indicate whether the command completed successfully or whether an error occurred while the EM405D was performing the command. Table II shows a list of potential status codes that may be returned.

Table II. Status Code (SC)

Value	Meaning
0x00	Successful
0x01	Invalid Command
0x02	Invalid Parameter
0x03	Module did not respond*

* Note: Applies to M-module requests only.

Successful (0x00): The command completed successfully without error.

Invalid Command (0x01): The first byte received was not a valid command-id value from the list in Table I.

Invalid Parameter (0x02): The EM405D received a valid command however the command could not be completed because one of the command parameters was invalid or out of range. Refer to the description of each individual command for parameter details.

Module Did Not Respond (0x03): The EM405D received a valid command with valid parameters; however, the specified module did not respond to the access. This error code applies to M-module accesses only. The error code could result from the specified M-module being absent, the specified address being outside the range of addresses supported by the particular M-module, or more serious hardware problems with the M-module itself.

Once any of the above status codes are returned, the EM405D will set the *Reset Error (RERR)* status bit in the EM405D *Reset Error and Manufacturer ID* register (refer to section 4.3.5 for details on this register) and cease responding to further commands except the **Read Data** and **Write Data** commands to the *Reset Error and Manufacturer ID* register. To recover from this condition, the user must clear the *RERR* bit by writing a '1' to that bit location in the *Reset Error and Manufacturer ID* register.

This functionality is implemented so that when the EM405D recognizes an error at the beginning of a command, it can search the buffer for the next command without having to send a status code response for each byte remaining in the buffer. For example, assume this functionality didn't exist and the user wanted to perform a block write with a 1024 byte block. The full command for this action, including data, requires 1033 bytes to be placed into the EM405D's buffer. If the third byte in the command is an invalid parameter, the EM405D would return an *Invalid Parameter* (0x02) status code followed by one thousand and thirty *Invalid Command* (0x01) status codes, one for each byte in the buffer after the invalid parameter. By implementing this functionality, the EM405D will ignore the one thousand and thirty bytes and any following bytes in the buffer unless the command is a **Read Data** or **Write Data** of the *Reset Error and Manufacturer ID* register or until the *RERR* bit is reset to '0'.

The software must be written such that it checks for error conditions and performs the appropriate action to reset the RERR bit. In most cases error conditions are generated by errors in the software source code, therefore, once the software has been debugged and verified, error codes will rarely, if ever be received.

4.3.2 Write Data command

The Write Data command writes data to an EM405D control register or to a register residing on an M-module. The command consists of seven bytes including the command-id, the module to which the data should be written, an address space selector, the access width, the address, and two data bytes. The return value consists of a single status byte.

Command Syntax:

0x20 md as ws ad dh dl

Return:

SC

where
- md = module (0 = EM405D control, 1 = M-module A, 2 = M-module B)
- as = address space (0 = I/O, 1 = future use)
- ws = word size (2 = 16-bit word, other values for future use)
- ad = address (0 to FF)
- dh = data (MSB)
- dl = data (LSB)
- SC = Status Code

Example (values shown hex):

To write the data value 0x1234 to M-module A, send the following command:

	cd	md	as	ws	ad	dh	dl
Command:							
Send:	20	01	00	02	06	12	34

Receive: 00 (if successful)

4.3.3 Read Data command

The Read Data command reads data from an EM405D control/status register or from a register residing on an M-module. The command consists of five bytes including the command-id, the module from which the data should be read, as address space selector, the access width and the address from which to read. The return value consists of two data bytes followed by a single status byte.

Command Syntax:

0x30 md as ws ad

Return:

dh dl SC

where
- md = module (0 = EM405D control, 1 = M-module A, 2 = M-module B)
- as = address space (0 = I/O, 1 = future use)
- ws = word size (2 = 16-bit word, other values for future use)
- ad = address (0 to FF)
- dh = data (MSB)
- dl = data (LSB)
- SC = Status Code

Example (values shown hex):

To read the Device Identification Register on the EM405D, send the following command:

Command:	cd	md	as	ws	ad
Send:	30	00	00	02	02
Receive:	0F	DB	00	(if successful)	

4.3.4 Block Access

The EM405D provides a flexible block access feature that can be used to significantly improve data throughput. Both a block read and a block write command is implemented. The flexibility of the bock access feature is in the command protocol. The protocol allows the user to specify four parameters in addition to the standard parameters also found in the single data read and write commands: *starting address*, *block size*, *number of blocks*, and *address increment*.

The EM405D firmware will execute the command by reading or writing a block of data the size of the *block size* parameter, starting from the *starting address* and ending at:

starting address + (*block size* * *word size*)

The firmware will then repeat this process *N* number of times depending on the *number of blocks* parameter. If the *address increment* parameter is not equal to 0, the firmware will increment the starting address by the specified amount after each read or write of a single block.

The M-module I/O space is a maximum of 256 bytes. Care must be taken when performing a block access that an address greater than 0xFF is never accessed. Otherwise, an error will occur and the block access will terminate immediately.

The following examples further illustrate the block access feature.

Example 1: Read a single block of 32 words (64 bytes) starting at address 0x4.

starting address = 0x4
block size = 32
number of blocks = 1
address increment = don't care

Example 2: Read 32 words (64 bytes) from a FIFO at address 0x8.

starting address = 0x8
block size = 1
number of blocks = 32
address increment = 0

Example 3: Read 32 words from two FIFOs one at address 0x8 and another at address 0xA

starting address = 0x8
block size = 2
number of blocks = 32
address increment = 0

Example 4: Read 32 words starting at address 0x0 followed by 32 words starting at address 0x80

starting address = 0x0
block size = 32
number of blocks = 2
address increment = 128

4.3.4.1 Block Write command

The Block Write command writes a block of data to an M-module. A maximum of 1024 bytes can be written in a single command. The number of bytes written in any given command is equal to:

*number of bytes = number of blocks * block size * word size*

The block write command consists of nine command bytes and any number (up to 1024) of data bytes. The return value is a single status byte indicating the success of the command.

Command Syntax:
0x40 md as ws ad ai nh nl bs d1 d0 …

Return:
SC

where
md = module (0 = invalid, 1 = M-module A, 2 = M-module B)
as = address space (0 = I/O, 1 = future use)
ws = word size (2 = 16-bit word, other values for future use)
ad = starting address (0 to FF)
ai = address increment (number to increment address by after each write)
nh = number of blocks to read (upper 4 bits)
nl = number of blocks to read (lower 8 bits)
bs = block size in words (i.e., number of words per block)
d1 = data (MSB)
d0 = data (LSB)
… = the number of data bytes = ws × bs × nb
SC = Status Code

Example (values shown hex):
To write the data values 0x1234, 0x5678, 0x9ABC to M-module A starting at I/O Register 4, send the following command:

Command:	cd	md	as	ws	ad	ai	nh	nl	bs	dh1	dl1	dh2	dl2	dh3	dl3
Send:	40	01	00	02	04	02	00	03	01	12	34	56	78	9A	BC

Receive: 00 (if successful)

4.3.4.2 Block Read command

The Block Read command reads a block of data from an M-module. Unlike the block write command, block read does not have a restriction on the number of bytes that can be read with a single command. The number of bytes read in any given command is equal to:

*number of bytes = number of blocks * block size * word size*

The block read command consists of nine command bytes. The return value is any number of data bytes followed by a single status byte indicating the success of the command.

Command Syntax:

0x50 md as ws ad ai nh nl bs

Return:

d1 d0 ... SC

where
- md = module (0 = invalid, 1 = M-module A, 2 = M-module B)
- as = address space (0 = I/O, 1 = future use)
- ws = word size (2 = 16-bit word, other values for future use)
- ad = starting address (0 to FF)
- ai = address increment (number to increment address by after each write)
- nh = number of blocks to read (upper 4 bits)
- nl = number of blocks to read (lower 8 bits)
- bs = block size in words (i.e., number of words per block)
- d1 = data (MSB)
- d0 = data (LSB)
- … = the number of data bytes = ws × bs × number of blocks (nh:nl)
- SC = Status Code

Example (values shown hex):

To read three data values from a 32-bit FIFO located at I/O Register 6 and 8 on M-module B, send the following command:

Command:	cd	md	as	ws	ad	ai	nh	nl	bs
Send:	50	02	00	02	06	00	00	03	02

Receive: da1 db1 dc1 dd1 da2 db2 dc2 dd2 da3 db3 dc3 dd3 00 (if successful)

where
- dax = MSB of register 6
- dbx = LSB of register 6
- dcx = MSB of register 8
- ddx = LSB of register 8

Note: x = 1 is first read, x = 2 is second read, x = 3 is third read

4.3.5 EM405D Configuration/Status Registers

The EM405D contains a set of registers that are used to identify the carrier, configure the carrier, and retrieve status from the carrier. These registers are independent of the M-modules residing on the board. Table III summarizes the register map. Bit level details of each register can be found in Figure 7. These registers are accessed using the **Read Data** and **Write Data** commands with the module field of the command set to '0'.

Table III. Register Summary

Offset	Register
0x00	Reset Error & Manufacturer Identification
0x02	Device Identification
0x04	Hardware Version
0x06	Firmware Version
0x08	Reset & Trigger Control
0x0A	Fan Control & Temperature Status

Reset Error & Manufacturer Identification (0x00): A read of this register will return the 12-bit manufacturer ID value of the EM405D and the reset error bit. The manufacturer ID field is read-only. Writing a '1' to the reset error bit will clear the error condition. Refer to section 4.3.1 for details on error handling.

Device Identification (0x02): This read-only register returns the device ID value of the EM405D and a bit indicating whether the EM405D is a wired or wireless (Wi-Fi) version.

Hardware Version (0x04): This read-only register returns the hardware version number of the EM405D being accessed.

Firmware Version (0x06): This read-only register returns the firmware version number of the EM405D being accessed.

Reset & Trigger Control (0x08): This read/write register can be used to reset the M-modules residing on the EM405D and to control the triggers. An independent reset bit is available for each module as well as numerous bits that allow the user to configure the external trigger lines and to map each M-module trigger.

Fan Control & Temperature Status (0x0A): A read of this register will return a value representative of the current temperature inside the EM405D casing and will return the current setting of the fan control bit. The temperature field of this register is read only. By writing to the fan control bit, the user can select whether the fan is set to full-on or variable speed.

Reset Error & Manufacturer Identification

Reg. 00

Byte	1								0							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	RERR	-	-	-	Read Only											
Read	RERR	0	0	0	MID											

RERR ⇨ Reset Error (writing a 1 clears the error condition) [1]
MID ⇨ Manufacturer ID (always $FC1_{16}$ - C&H)

Notes:

1. This bit is set if a command error occurs. If an error exists, only reads or writes to this register are allowed. The RERR bit must be cleared by writing a 1 to this bit before normal command operation will resume. See 4.3.1 for further details.

Device Identification

Reg. 02

Byte	3								2							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	-	-	-	-	Read Only											
Read	ETH	0	0	0	DID											

ETH ⇨ Ethernet Type (0 = wired, 1 = wireless (Wi-Fi))
DID ⇨ Device ID (always FDB_{16} - EM405D)

Hardware Version

Reg. 04

Byte	5								4							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Read Only								Read Only							
Read	HW Major								HW Minor							

HW Major ⇨ Major Version Level of EM405D Hardware
HW Minor ⇨ Minor Version Level of EM405D Hardware

Firmware Version

Reg. 06

Byte	7								6							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Read Only								Read Only							
Read	FW Major								FW Minor							

FW Major ⇨ Major Version Level of EM405D Firmware
FW Minor ⇨ Minor Version Level of EM405D Firmware

Figure 7. EM405D Registers

Reset & Trigger Control

Reg. 08

Byte	9								8							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	RSTB	RSTA	TLVL	TIMP	BTBD	BTBM		BTAD	BTAM		ATBD	ATBM		ATAD	ATAM	
Read	RSTB	RSTA	TLVL	TIMP	BTBD	BTBM		BTAD	BTAM		ATBD	ATBM		ATAD	ATAM	

RSTB ⇨ Reset M-module B (0 = normal, 1 = reset) [1]
RSTA ⇨ Reset M-module A (0 = normal, 1 = reset) [1]
TLVL ⇨ External Trigger Input Threshold Level (0 = +2.5V, 1 = +1.4V)
TIMP ⇨ External Trigger Input Impedance (0 = high (>100KΩ), 1 = 50Ω)
BTBD ⇨ Module B Trigger B Direction (0 = input, 1 = output) [2]
BTBM ⇨ Module B Trigger B Mode
- 0 0 Disabled
- 0 1 to/from External Trigger
- 1 0 to/from Module A Trigger A
- 1 1 to/from Module A Trigger B

BTAD ⇨ Module B Trigger A Direction (0 = input, 1 = output) [2]
BTAM ⇨ Module B Trigger A Mode
- 0 0 Disabled
- 0 1 to/from External Trigger
- 1 0 to/from Module A Trigger A
- 1 1 to/from Module A Trigger B

ATBD ⇨ Module A Trigger B Direction (0 = input, 1 = output) [2]
ATBM ⇨ Module A Trigger B Mode
- 0 0 Disabled
- 0 1 to/from External Trigger
- 1 0 to/from Module B Trigger A
- 1 1 to/from Module B Trigger B

ATAD ⇨ Module A Trigger A Direction (0 = input, 1 = output) [2]
ATAM ⇨ Module A Trigger A Mode
- 0 0 Disabled
- 0 1 to/from External Trigger
- 1 0 to/from Module B Trigger A
- 1 1 to/from Module B Trigger B

Notes:
1. This bit must be cleared by user software to return the M-module to normal operation. The reset bit need only be set to a 1 for a minimum of 1μs to properly reset an M-module.
2. The direction is with respect to the M-module specified. For intermodule triggers, the M-module trigger directions must be set opposite one another for proper operation.

Fan Control & Temperature Status

Reg. 0A

Byte	B								A							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	VARF	-	-	-	Read Only											
Read	VARF	0	0	0	TEMP											

VARF ⇨ Variable Speed Fan (0 = variable, 1 = full ON)
TEMP ⇨ Enclosure Temperature (°C = (TEMP – 281) / 4.6)

Figure 7. EM405D Registers **(continued)**

4.4 CONTROLLING THE TRIGGERS

The carrier implements flexible trigger control capabilities providing the user with many options for using triggers. Each M-module can support two trigger lines (labeled A & B) which can be mapped to one of two external trigger lines (one input and one output) available on the carrier or to the trigger lines of the adjacent M-module.

The carrier's external trigger lines can be accessed at the 9-pin DSUB connector on the back panel of the EM405D. Refer to Appendix A for pin-out details of the 9-pin DSUB connector. The input trigger line has a software configurable threshold and input impedance. The input threshold is configurable using the TLVL bit in the *Reset & Trigger Control* register and can be set to either +1.4 volts or +2.5 volts. The input impedance is configurable using the TIMP bit in the *Reset & Trigger Control* register and can be set to either high impedance (>100KΩ) or 50Ω. The output trigger line has a set output impedance of 50Ω and a set output drive level of +5V (typical) into a high impedance load.

Each M-module trigger line can be configured to be either an input or an output and can be mapped to either the external trigger lines or to one of the trigger lines on the other M-module. Each trigger line contains two bit fields in the *Reset & Trigger Control* register. The xTzD bit controls the trigger direction and the xTzM controls the trigger mapping, where x specifies the module and z specifies the trigger (for example ATBM is module A trigger B). If the xTzM bit field is set to map the trigger line to the external trigger, the trigger is connected to either the external input or the external output depending on the value of the xTzD bit. If the xTzM bit field is set to map the trigger line to another M-module trigger line, then the two triggers must be configured to be opposite directions. Also the second M-module trigger line must be mapped to the first M-module trigger line. For example, if module A trigger B is to be outputted to module B trigger A then the corresponding bit fields must be set as follows:

```
ATBD = output
ATBM = to/from Module B Trigger A
BTAD = input
BTAM = to/from Module A Trigger B
```

The following values would be invalid:

```
ATBD = output
ATBM = to/from Module B Trigger A
BTAD = output
BTAM = to/from Module A Trigger B

      or

ATBD = output
ATBM = to/from Module B Trigger A
BTAD = input
BTAM = to/from external trigger
```

The function of each M-module trigger line is fully dependent upon the M-module. Refer to the particular M-module's documentation for further details.

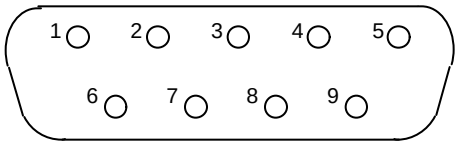
4.5 FAN AND TEMPERATURE CONTROL

The EM405D contains an on-board temperature sensor placed near the M-module positions. The current temperature inside the EM405D case can be determined by reading the *Fan & Temperature Control* register of the EM405D. The TEMP field inside this register represents the current temperature as read by the temperature sensor. To translate the TEMP value in to degrees Celsius use the following equation:

$$°C = (TEMP - 281) / 4.6$$

The temperature sensor is also read by the firmware and used to control the variable speed fan. When the fan is set to *variable*, the firmware constantly monitors the temperature and speeds up the fan as the temperature rises. The variable fan is designed to maintain a maximum 20° C rise in temperature from the ambient inlet air. The user may select the fan to remain full on at all times by setting the VARF bit in the *Fan & temperature Control* register to a '1'.

APPENDIX A - CONNECTORS



PIN	DESCRIPTION
1	+12V INPUT
2	+12V INPUT
3	+12V INPUT
4	TRIGGER OUT
5	TRIGGER IN
6	GND
7	GND
8	GND
9	GND

Figure A-1. 9-Pin DSUB Connector

APPENDIX B – WIRED ETHERNET DEFAULT SETTINGS

The Ethernet interface device on the wired version of the EM405D contains many configurable settings that allow it to be used in a large number of applications. Many of these settings must be set to certain values in order for the EM405D to operate normally. Other settings are not applicable to the EM405D. When the user tries to configure the network settings via the web-interface or the telnet interface, he/she will see options to change many of these settings. Changing some of these may make the EM405D inoperable. For this reason, it is highly recommended that the user does not change any settings other than the following:

- IP Address
- Subnet Mask
- Gateway Address

Table B-1 lists the various settings and their default values as set my C&H during manufacturing of the EM405D. If the carrier fails to operate, verify that these settings are set to their default values prior to calling C&H for technical support. Settings that are emphasized in ***bold italics*** are required settings that if changed will render the carrier inoperable.

Table B-1. Ethernet Interface Default Settings.

Server Properties	
IP Address	0.0.0.0
Subnet Mask	0.0.0.0
Gateway Address	0.0.0.0
Serial Settings	
Baud Rate	***921600***
Data bits	***8***
Parity	***None***
Stop bits	***1***
Flow control	***None***
UDP Datagram Mode	
Datagram Mode	False
Datagram Type	N/A
Passive Connection	
Password Required	False
Port Password	N/A
Accept Passive Connection	***Yes***
Local Port**	***10001***
Auto Increment Source Port	False

** The EM405D will operate with any port number; however, many software applications expect the port to be set to the default as shown in this table. Changing the port number will not render the EM405D inoperable but may render these software applications inoperable.

Table B-1. Ethernet Interface Default Settings. (continued)

Active Connection	
Active Connection	***None***
Telnet Mod	N/A
Terminal Type	N/A
Remote Port	N/A
Connection Response	None
Modem Emulation Mode	None
Use Host List	N/A
Remote Host	N/A
Disconnection	
Disconnect with EOT	***N/A***
Disconnect with DTRDrop	***False***
Disable Hard Disconnect	***False***
Inactivity Timeout	***00:00***
Connection	
Connection LED	Blink
Buffer Flushing	
Flush Output Buffer	
- At Time of Disconnect	False
- On Passive Connection	***True***
- On Active Connection	False
Flush Input Buffer	
- At Time of Disconnect	False
- On Passive Connection	***True***
- On Active Connection	False
Packing	
Enable Packing	***True***
Send Trailing Bytes	***None***
Send Frame Only	***False***
Match Two Byte Sequence	***False***
Idle Time	***Force Transmit 12ms***
Match Byte 2	***00***
Match Byte 1	***00***
Device	
Firmware Type	N/A
Firmware Version	N/A
Product Type	N/A

Table B-1. Ethernet Interface Default Settings. (continued)

Email Notification	
Domain Name	*blank*
Mail Server	0.0.0.0
Recipients	(Collection)
Triggers	(Collection)
Unit Name	*blank*
Host List	
Host List	(Collection)
Retry Counter	3
Retry Timeout	250
OEM Configurable Pins	
Pin 1	IN1
Pin 2	IN2
Pin 3	IN3
User IO	ActiveLow
XPort-03	
CPU Performance	***High***

APPENDIX C – WIRELESS ETHERNET (Wi-Fi) DEFAULT SETTINGS

The Ethernet interface device on the Wireless version of the EM405D contains many configurable settings that allow it to be used in a large number of applications. Many of these settings must be set to certain values in order for the EM405D to operate normally. Other settings are not applicable to the EM405D. When the user tries to configure the network settings via the web-interface, he/she will see options to change many of these settings. Changing some of these may make the EM405D inoperable. For this reason, it is highly recommended that the user does not change any settings other than the following:

- IP Address
- Subnet Mask
- Gateway Address
- Wireless LAN Settings
- Wireless Security Settings

Table C-1 lists the various settings and their default values as set my C&H during manufacturing of the EM405D. If the carrier fails to operate, verify that these settings are set to their default values prior to calling C&H for technical support. Settings that are emphasized in ***bold italics*** are required settings that if changed will render the carrier inoperable.

Table C-1. Wireless Ethernet Configuration Default Settings.

Network	
IP Settings	
Obtain an IP address automatically using DHCP	True
Wireless LAN Settings	
Connect to wireless access points (infrastructure)	True
Connect to any available wireless network	True
Country	United States
Channel	Auto-Scan
Wireless Security Settings	
Enable WEP security	False
Enable WPA authentication	False
Network Services Settings	
Enable ADDP	True
- Port	2362
Enable Encrypted RealPort	True
- Port	1027
Enable HTTP & HTTPS	True
- HTTP Port	80
- HTTPS Port	443

Table C-1. Wireless Ethernet Configuration Default Settings. (continued)

Enable Line Printer Daemon (LPD)	True
- Port	515
Enable RealPort	True
- Port	771
Enable Remote Login (rlogin)	True
- Port	513
Enable Remote Shell (rsh)	True
- Port	514
Enable SNMP	True
- Port	161
Enable Telnet	True
- Port	23
Advanced Network Settings	
Enable AutoIP address assignment	True
RTS Threshold	2347
Fragmentation Threshold	2346
Serial Port	
Port Profile Settings	
Current Port Profile	***TCP Sockets***
TCP Server Settings	
Enable Telnet access using TCP Port	False
- Port	N/A
Enable Raw TCP access using TCP Port	***True***
- Port**	***10001***
Enable Secure Socket access using TCP Port	False
- Port	N/A
TCP Client Settings	
Automatically establish TCP connections	***False***
Basic Serial Settings	
Description	*blank*
Baud Rate	***230400***
Data Bits	***8***
Parity	***None***
Stop Bits	***1***
Flow Control	***None***

** The EM405D will operate with any port number; however, many software applications expect the port to be set to the default as shown in this table. Changing the port number will not render the EM405D inoperable but may render these software applications inoperable.

Table C-1. Wireless Ethernet Configuration Default Settings. (continued)

Advanced Serial Settings	
Enable Port Logging	False
Enable RTS Toggle	False
Enable RCI over Serial (DSR)	False
Send Socket ID	False
Send data only under any of the following conditions	***True***
- Send when data is present on the serial line	***False***
- Send after the following number of idle milliseconds	***True - 12 ms***
- Send after the following number of bytes	***1024***
- Close connection after the following number of idle seconds	***False***
- Close connection when DCD goes low	***False***
- Close connection when DSR goes low	***False***
GPIO	
General Purpose Input/Output Pins	
Pin 1	In
Pin 2	In
Pin 3	In
Pin 4	In
Pin 5	In
Alarms	
Alarm Notification Settings	
Enable Alarm Notifications	False
Alarm Conditions	
Alarm 1 …Alarm 32	False
Security	
Administrator Password	
Enable Password Authentication	False
System	
System Settings	
Description	*blank*
Contact	*blank*
Location	*blank*
Simple Network Management Protocol (SNMP) Settings	
Enable Simple Network Management Protocol (SNMP)	True
- Public community	public
- Private community	private
- Allow SNMP clients to set device settings through SNMP	False
Enable Simple Network Management Protocol (SNMP) traps	False

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