HORNER APG

User Manual for

HE-NX220, HE-NX221, HE-NX222
HE-NX250, HE-NX251, HE-NX252
SmartStack, SmartStix

NX OCS

PREFACE

This manual explains how to use the NX OCS Modules.

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To obtain warranty service, return the product to your distributor with a description of the problem, proof of purchase, post paid, insured and in a suitable package.

ABOUT PROGRAMMING EXAMPLES

Any example programs and program segments in this manual or provided on accompanying diskettes are included solely for illustrative purposes. Due to the many variables and requirements associated with any particular installation, Horner APG cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the NX OCS module to appropriately design the end system, to appropriately integrate the NX OCS module and to make safety provisions for the end equipment as is usual and customary in industrial applications as defined in any codes or standards which apply.

Note: The programming examples shown in this manual are for illustrative purposes only. Proper machine operation is the sole responsibility of the system integrator.

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CHAPTER 1: INTRODUCTION

What does the NX offer YOU?

- ▪ *Low Cost*
- ▪ *High Performance*
- ▪ *Easy* to install

- ▪ *Built-In I/O Options*
- ▪ *Complete SmartStack I/O and SmartStick Remote I/O Options*
- ▪ Requires *little space.*

CsCAN Port

CsCAN uses *industry-recognized, user-friendly* **Cscape** Software**.**

RS-232 / 422 Serial Ports

Flexible **c***onnectivity* to a *wide variety* of serial devices.

Snap-On SmartStack I/O

Up to 4 option modules can be connected to an NX. Requires *little space. Easy* to install.

Web Server

Host Web pages and *FTP Sites* on NX221, NX222, NX251 and NX252 models.

CompactFlash Slot

Handy for data storage and retrieval. **Allows *simple*** program loading.

Ethernet Port

Ethernet supported on NX221, NX222, NX251 and NX252 models.

FOX Fiber Optic I/O Ports

Extends high-speed NX backplane enabling SmartStack I/O Modules to be mounted *several meters* from the NX.

Significantly increases the number of **SmartStack** I/O modules supported by *one* NX OCS.

USB Programming Port *(Future Feature.)*

Allows faster programming with newer technology

Built-in High Speed Counter (HSC) / Pulse Width Modulated (PWM) I/O (NX222 and NX252 Models)

Cost-effective Allows 2 Inputs / *2* Outputs **Convenient** – already on-board

Figure 1 – NX Features

1.1   Scope

This manual covers the specifications, installation, and configuration procedures for following products.

Table 1.1 – NX Product Descriptions						
Model	**LCD Screen**	**CompactFLASH Slot**	**Red Backlight**	**Web Server**	**Built-in Ethernet**	**Built-in HSC**
HE-NX**220**			√			
HE-NX**221**	128 x 64			√	√	
HE-NX**222**		√		√	√	√
HE-NX**250**			√			
HE-NX**251**	240 x128			√	√	
HE-NX**252**				√	√	√
All NX OCS Models	**Functions**					
	Control	*Display and Keypad*		*Network*	*I/O*	
	Yes	Yes		Yes	Yes	
SmartStack I/O Modules *	Provides a wide variety of I/O options for the NX OCS. Require little space and are easy to install. Up to <u>four</u> option modules can be connected locally to the controller. *** Note:** All NX models require the use of the plastic case version of SmartStack Modules. (When ordering a SmartStack module, use the **HE-** prefix instead of HE800, which denotes the metal case version.)					
SmartStix (HE55xxxxxxx) (Prefix denotes CsCAN version)	Is a family of remote I/O products for the NX OCS.					

1.2   NX Models

1.2.1   Product Description

The NX OCS provides controller, networking, I/O, graphical and operator interface capabilities in one unit using a highly visual, NX display screen. All NX OCS models can be used in CsCAN networks. Models are also available that can be used in Ethernet networks.

NX OCS models have Serial and CAN (Controller Area Network) communication abilities. The units contain an RS-232 port for programming/debugging, monitoring and network administration from an IBM-compatible PC.

NX OCS features include CsCAN (pronounced "see-scan") peer-to-peer network. CAN-based network hardware is used in the controllers because of **CAN's automatic error detection, ease of configuration, low-cost of design and implementation and ability to operate in harsh environments**. CsCAN networking abilities are built-in to the NX OCS and require no external or additional modules.

When several NX OCS models are networked together to achieve a specific purpose, the system acts like a large parallel-processing controller.

The NX OCS combines several desirable functions in one compact package. Each unit is a highly integrated operator interface and controller with expandable I/O and networking capabilities have standard features consisting of the following:

- 24 VDC powered
- SmartStack™ I/O Expansion
- SmartStix Remote I/O
- RS-232 / RS-485 Serial Ports
- Integrated Bezel
- Real-Time Clock
- Flash Memory for easy field upgrades.
- Compact Flash Memory for program downloads.
- System Key and Configurable Function Keys.

The NX OCS features the ability to **pass through programming commands**. When attached to an NX OCS serial port, a programming package (i.e., Cscape) can access other NX units or any other OCS unit connected to a CsCAN network by passing the programming command through the serial port to the network port. One Cscape package (connected to one NX OCS unit) can program all NX OCS or other NX units on the CsCAN network.
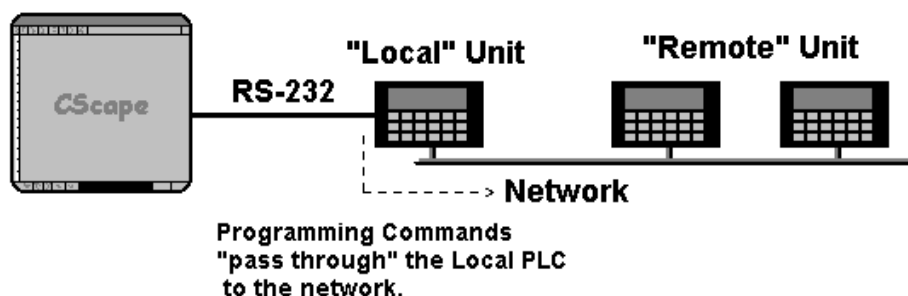
Figure 2 – Pass-Through Function (Available in CsCAN Networks Only)

After making a physical serial connection to one NX OCS, the user must indicate which node is to be connected (called the TARGET). After that, Cscape and the NX OCS automatically provide the pass through connection.

1.2.2 Cscape Software

Cscape Software (pronounced "see-scape") is used with the NX OCS products (Part # HE500OSW232). Cscape stands for **C**ontrol **S**tation **C**entral **A**pplication **P**rogramming **E**nvironment. The Windows-based software package is easy to use and aids in the integration of a CAN-based Distributed Control System. The program is used for configuring controllers. Cscape is also used for programming NX OCS ladder logic, programming user displays for the NX OCS, configuring the network for global digital and analog data, setting system-wide security and monitoring controllers in the system. Provided there is **one serial connection** to one node on the network (i.e., CsCAN Network), the operator has control over the entire system. The operator can upload, download, monitor and debug to any node on the network.

1.3   NX OCS Specifications

Table 1.2 - NX Series OCS Specifications						
	NX220	**NX221**	**NX222**	**NX250**	**NX251**	**NX252**
Input Voltage	10 to 32 VDC					
Screen Type	128x64 LCD Backlit, monochrome			240x128 LCD Backlit, monochrome		
LCD Backlighting	Green, Red, or Off (selectable)			Green or Off (selectable)		
Keypad / LEDs	20 keys (10 fn keys) plus 10 LEDs			24 keys (10 fn keys) plus 10 LEDs		
Keypad Type	Tactile Dome (1 million operations) plus defeatable Audible feedback					
Application Memory: Graphics	1 M byte					
Control Memory	256K Ladder Memory plus 32KB Register Space					
Control Scan Rate	0.1mS / K Ladder Logic (typical)*					
I/O Interfaces	Plastic SmartStack I/O – 4 modules maximum Fiber Optic Expansion (FOX) I/O – 5 bases maximum CsCAN Network Port – 252 SmartStix I/O maximum					
Built-in High Speed Counter / PWM	No	No	Yes - >1MHz max TTL or 24vdc level	No	No	Yes - >1MHz max TTL or 24vdc level
Built-in PWM Outputs	No	No	Yes 24vdc level	No	No	Yes 24vdc level
Portable Memory	Compact FLASH (CF) slot (up to 2GB)					
Battery	Replaceable 3V Lithium battery – 4.5 years (off) lifetime					
Ethernet Ports	No	10/100MHz		No	10/100MHz	
Serial Ports	1 shared port (RS-232 DE-9S** & RS-232/485 RJ45) – software selectable 1 dedicated port (RS-232/485/422 on a 10-pin terminal strip)					
Power Requirements (without I/O)	**Steady State Current:** 400mA @24VDC **Inrush Current:** 28A for 1ms @24VDC					
Temperature & Humidity	32 - 122°F (0 - 50°C), 5 to 95% Non-condensing					
UL	Please refer to Compliance Table located at					
CE	http://www.heapg.com/Pages/TechSupport/ProductCert.html					
Environment	Designed for installation in a NEMA 12 environment. Optional mounting kit HE-ACC006 allows mounting in a NEMA 4/4X or IP65 environment.					
* Total ladder scan is impacted by several factors – logic, I/O, screen and communications update. ** Denotes 9-pin, 2-row, socket. The term DB9 is widely (but erroneously) used to specify a 9-pin RS-232 connector. The correct specifier is either a DE-9S (socket) or a DE-9P (plug).						

1.4   NX OCS Resources

1.4.1   Overview

This section defines the resource limits that a programmer needs to know when writing a program using the NX OCS. The NX OCS combines operator interface (display and keypad), local and remote I/O (analog and digital), networking, and controller, into a single product. In addition, the NX OCS has graphical capabilities.

The controller portion of the NX OCS products is programmed in ladder logic via the Windows-based Cscape (Control Station Central Application Programming Environment) package. Each NX OCS provides a set of resources for use by the ladder logic control program.

1.4.2   Resource Limits

Table 1.3 shows the resources available in the NX OCS. Note that although each register type inherently consists of either 1-bit or 16-bit registers, all registers can be accessed via User Screens and/or Ladder Code as 1, 8, 16 or 32-bit values or as ASCII character strings.

Table 1.3- Resource Limits						
Resource	**NX220**	**NX221**	**NX222**	**NX250**	**NX251**	**NX252**
%S	13					
%SR	192					
%T	2048					
%M	2048					
%R	9999					
%K	10					
%D	1023					
%I	2048					
%Q	2048					
%AI	512					
%AQ	512					
%IG	64					
%QG	64					
%AIG	32					
%AQG	32					
Network Ports	CsCAN	CsCAN/ Ethernet	CsCAN/ Ethernet/HSC	CsCAN	CsCAN/ Ethernet	CsCAN/ Ethernet/HSC
Controllers Per Network	253					
SmartStack I/O Modules	4 Slots (24 with FOX)					
Keypad/ LEDs	20 keys (10 fn keys) plus 10 LEDs			24 keys (10 fn keys) plus 10 LEDs		
Display	128x64 LCD Backlit, monochrome			240x128 LCD Backlit, monochrome		
Screen Memory	1M					
User Screens	1023					
Data Fields Per User Screen	50					
Ladder Code	256K					

1.4.3   Resource Definitions

System Registers

System Registers (%S and %SR) are used to store general NX OCS status information. This information is used internally, and is also available to the operator via the System Menu, using the NX's display and keypad. The System Registers are also available for User Screens and can be accessed by Ladder Code.

1.   %S Registers

%S Registers are 1-bit memory locations containing system status information, which are implemented as shown in **Table 1.4**:

Table 1.4- %S Registers		
Register	**Name**	**Description**
%S1	FST_SCN	On during **first** scan after entering RUN mode
%S2	NET_OK	On if Network is functioning properly
%S3	T_10MS	On for 5 mS; Off for 5 mS
%S4	T_100MS	On for 50 mS; Off for 50 mS
%S5	T_SEC	On for 500 mS; Off for 500 mS
%S6	IO_OK	On if SmartStack I/O is configured properly
%S7	ALW_ON	Always On
%S8	ALW_OFF	Always Off
%S9	PAUSING_SCN	On during **last** scan before Pause-N-Load
%S10	RESUMED_SCN	On during **first** scan before Pause-N-Load
%S11	IO_FORCED	On if one or more I/O points are currently being forced
%S12	IO_FORCING	On if I/O forcing is enabled
%S13	NET_IO_OK	On if Network I/O (SmartStix) is functioning properly

2.   %SR Registers

%SR Registers are 16-bit memory locations, containing system status information, implemented as shown in **Table 1.5**.

Note: Where 2 %SRs are combined to make a 32-bit value, the lower numbered %SR is the low word, while the higher numbered %SR is the high word.

Table 1.5- %SR Registers				
Register	**Name**	**Description**	**Min**	**Max**
%SR1	USER_SCR	Current User Screen Number (0=none)	0	1023
%SR2	ALRM_SCR	Current Alarm Screen Number (0=none)	0	1023
%SR3	SYS_SCR	Current System Screen Number (0=none)	0	14
%SR4	SELF_TEST	Bit-Mapped Self-Test Result	0	65535
%SR5	CS_MODE	Control Station Mode (0=Idle, 1=Do I/O, 2=Run)	0	2
%SR6	SCAN_RATE	Average Scan Rate (in tenths of mS)	-	1000
%SR7	MIN_RATE	Minimum Scan Rate (in tenths of mS)	-	1000
%SR8	MAX_RATE	Maximum Scan Rate (in tenths of mS)	-	1000
%SR9-10	EDIT_BUF	Data Field Edit Buffer	0	2^{32}-1
%SR11-12	LADDER_SIZE	Ladder Code Size	2	256K
%SR13-14	Reserved	-	-	-
%SR15-16	Reserved	-	-	-
%SR17-18	IO_SIZE	I/O Configuration Table Size	16	127K
%SR19-20	NET_SIZE	Network Configuration Table Size	34	1K
%SR21-22	SD_SIZE	Security Data Table Size	-	-
%SR23	LADDER_CRC	Ladder Code CRC	0	65535
%SR24	Reserved	-	-	-
%SR25	Reserved	-	-	-
%SR26	IO_CRC	I/O Configuration Table CRC	0	65535
%SR27	NET_CRC	Network Configuration Table CRC	0	65535
%SR28	SD_CRC	Security Data Table CRC	0	65535
%SR29	NET_ID	This Station's Primary Network ID (CsCAN)	1	253
%SR30	NET_BAUD	Network Baud Rate (CsCAN) (0=125KB; 1=250KB; 2=500KB; 3=1MB)	0	3
%SR31	NET_MODE	Network Mode (0=network not required; 1=network required; 2=network optimized;	0	3

Table 1.5- %SR Registers				
Register	**Name**	**Description**	**Min**	**Max**
		3=network required and optimized)		
%SR32	LCD_CONT	LCD Display Contrast Setting	0	255
%SR33	FKEY_MODE	Function Key Mode (0=Momentary; 1=Toggle)	0	1
%SR34	SERIAL_PROT	RS232 Serial Protocol Mode (0=Firmware Update (RISM); 1=CsCAN; 2=Generic (Ladder- Controlled); 3=Modbus RTU; 4=Modbus ASCII)	0	4
%SR35-36	SERIAL_NUM	This Station's 32-bit Serial Number	0	2^{32}-1
%SR37	MODEL_NUM	This Station's Binary Model Number	0	65535
%SR38	ENG_REV	CPLD Engine Firmware Rev Number x 100	0000	9999
%SR39	CPLD_REV	Main CPU Firmware Rev Number x 10	000	255
%SR40	FPGA_REV	FPGA Image Rev Number x 10	000	255
%SR41	LCD_COLS	LCD Graphics Display Number of Columns NX-25x NX-22x	240 128	240 128
%SR42	LCD_ROWS	LCD Graphics Display Number of Rows NX-25x NX-22x	128 64	128 64
%SR43	KEY_TYPE	Keypad Type (0=20 keys; 1=24 keys;) NX-25x NX-22x	1 0	1 0
%SR44	RTC_SEC	Real-Time-Clock Second	0	59
%SR45	RTC_MIN	Real-Time-Clock Minute	0	59
%SR46	RTC_HOUR	Real-Time-Clock Hour	0	23
%SR47	RTC_DATE	Real-Time-Clock Date	1	31
%SR48	RTC_MON	Real-Time-Clock Month	1	12
%SR49	RTC_YEAR	Real-Time-Clock Year	1996	2095
%SR50	RTC_DAY	Real-Time-Clock Day (1=Sunday)	1	7
%SR51	NET_CNT	Network Error Count	0	65535
%SR52	WDOG_CNT	Watchdog-Tripped Error Count	0	65535
%SR53-54	BAD_LADDER	Bad Ladder Code Error Index	0	65534
%SR55	F_SELF_TEST	Filtered Bit-Mapped Self-Test Result	0	65535
%SR56	LAST_KEY	Key Code of Last Key Press or Release	0	255
%SR57	BAK_LITE	LCD Backlight On/Off Switch All models: (0 = Off; 1 = Green) NX22x also has: (2 = Red)	0	2
%SR58	USER_LEDS	User LED Control / Status	0	65535
%SR59	Reserved	-	-	-
%SR60	Reserved	-	-	-
%SR61	NUM_IDS	This Station's Number of Network IDs	1	253
%SR62	Reserved	-	-	-
%SR63	SS_BASE	SmartStack I/O Base Selector	0	7
%SR64	SS_STATUS	SmartStack I/O Base Status	0	2
%SR65-76	SS_INFO_1	SmartStack I/O Module #1 Information Structure	-	-
%SR77-88	SS_INFO_2	SmartStack I/O Module #2 Information Structure	-	-
%SR89-100	SS_INFO_3	SmartStack I/O Module #3 Information Structure	-	-
%SR101-112	SS_INFO_4	SmartStack I/O Module #4 Information Structure	-	-
%SR113-114	GOBJ_SIZE	Graphics Object Table Size	8	256K
%SR115-116	GSTR_SIZE	Graphics String Table Size	8	128K
%SR117-118	GBMP_SIZE	Graphics Bitmap Table Size	4	256K

Table 1.5- %SR Registers				
Register	**Name**	**Description**	**Min**	**Max**
%SR119-120	GTXT_SIZE	Graphics Text Table Size	8	128K
%SR121-122	GFNT_SIZE	Graphics Font Table Size	8	256K
%SR123-124	PROT_SIZE	Protocol Table Size	16	64K
%SR125	GOBJ_CRC	Graphics Object Table CRC	0	65535
%SR126	GSTR_CRC	Graphics String Table CRC	0	65535
%SR127	GBMP_CRC	Graphics Bitmap Table CRC	0	65535
%SR128	GTXT_CRC	Graphics Text Table CRC	0	65535
%SR129	GFNT_CRC	Graphics Font Table CRC	0	65535
%SR130	PROT_CRC	Protocol Table CRC	0	65535
%SR131-163	Reserved	-	-	-
%SR164.3		Enable Automatic Restore Operation (Fail Safe)	0	1
%SR164.4		Enable Backup (Fail Safe System)	0	1
%SR164.5		Enable AUTORUN (Fail Safe)	0	1
%SR164.6		Enable AUTOLOAD (Fail Safe)	0	1
%SR164.7		Clear Backup trigger bit	0	1
%SR164.8		Create Backup trigger bit	0	1
%SR164.9		MAKE_CLONE trigger bit	0	1
%SR164.10		LOAD_CLONE trigger bit	0	1
%SR165-174	Reserved	-	-	-
%SR175	CompactFlash	Current CompactFlash interface status (See **Table 7.2**.)	0	6
%SR176-177	CompactFlash	This 32-bit register shows the free space on the CompactFlash card in bytes.	0	2^{31}
%SR178-179	CompactFlash	This 32-bit register shows the total card capacity in bytes.	0	2^{31}
%SR180-192	Reserved	-	-	-

User Registers

User Registers (%T, %M and %R) are used to store application-specific OCS or RCS data. This data can be accessed via User Screens and/or by Ladder Code.

a.   %T Register

A %T Register is a non-retentive 1-bit memory location used to store application-specific state information.

b.   %M Registers

A %M Register is a retentive 1-bit memory location used to store application-specific state information.

c.   %R Registers

A %R Register is a retentive 16-bit memory location used to store application-specific values.

HMI Registers

HMI Registers (%K and %D) give the user access to the OCS or RCS keypad and display.

The MiniOCS, OCS1XX and OCS2XX have membrane keypads and text-based LCD displays, allowing the operator to enter and display general and application-specific information. This same information can be entered and displayed via a remote PC, using Cscape's Remote Display Terminal function, if the PC is connected as a CsCAN Host device. The RCS does <u>not</u> have a local keypad or display, but it still supports Cscape's Remote Display Terminal function. The OCS250 has a membrane keypad and a graphics-based LCD display, but it does <u>not</u> yet support the Cscape Remote Display Terminal function.

a.   %K Registers

A %K Register is a non-retentive 1-bit memory location (contact), used to store the state of a function key on the NX's keypad. If the function keys are set for momentary mode, a function key's associated %K register will be ON as long as the function key is pressed. If the function keys are set for toggle mode, a function key's associated %K register will toggle each time the function key is pressed.

b.   %D Registers

A %D Register is a non-retentive 1-bit memory location (coil), which can be turned ON by Ladder Code to cause the corresponding User or Alarm Screen to be displayed.

c.   User Screens

A User Screen is a combination of fixed text or graphics, along with variable Data Fields (called Graphics Objects in the OCS250), which together fill the LCD display screen. These screens are defined via Cscape dialogs and are then downloaded and stored into the NX's Flash memory. User Screens can be selected for display by operator entries on the keypad or by Ladder Code.

d.   Data Fields

A Data Field is an area on a User Screen where variable data is displayed and edited. The source data for a Data Field can be any of the NX's Register resources as defined above. The field size and display format is programmable via Cscape dialogs.

e.   Text Tables

A Text Table is a list of Text Items, which can be used in a Data Field, to display descriptive words and phrases to describe the value of a Register, instead of displaying numeric values. A simple example of this, would allow the strings "OFF" and "ON" to be displayed, instead of 0 and 1, to describe the state of the %I4 digital input. The maximum number of Text Tables and Text Items per Text Table is shown in Table 1, but the number can be further limited by overall User Screen memory usage.

SmartStack I/O Registers

Note: If using an **NX model with built-in HSC and PWM** functionality (NX222 or NX252), refer to   for register information related to those functions.

SmartStack I/O Registers (%I, %Q, %AI and %AQ) give the user access to the SmartStack I/O Module data. This data can be accessed via User Screens and/or by Ladder Code.

a.   %I Registers

A %I Register is a 1-bit memory location, which is normally used to store the state of one of the digital inputs associated with a SmartStack I/O module. When used in this way, %I registers are non-retentive. All extra %I registers, which are not associated with SmartStack inputs, are retentive, and can be used just like %M registers.

b.   %Q Registers

A %Q Register is a non-retentive 1-bit memory location, which is normally used to store the state of one of the digital outputs associated with a SmartStack I/O module.

c.   %AI Registers

A %AI Register is a 16-bit memory location, which is normally used to store the value of one of analog inputs associated with a SmartStack I/O module. When used in this way, %AI registers are non-retentive. All extra %AI registers (which are not associated with SmartStack inputs) are retentive and can be used just like %R registers.

d.   %AQ Registers

A %AQ Register is a non-retentive 16-bit memory location, which is normally used to store the value of one of the analog outputs associated with a SmartStack I/O module.

e.   SmartStack I/O Modules

Local: Up to 4 SmartStack I/O Modules can be plugged into an OCS or RCS, to provide local digital and analog I/O, and/or intelligent I/O, such as ASCII-Basic, High-Speed Counter, Stepper Motor Indexer, Power Monitor and Ethernet communication.

Remote: In addition to local I/O modules, up to 20 remote SmartStack I/O Modules can be connected to an OCS or RCS using five Fiber Optic Bases, which each contain four I/O slots. If a remote I/O connection is desired, the SmartStack FOX100 module must occupy the local OCS110 / 210/ 250 / or RCS250 Slot 1 position.

          Note: Fiber Optic Base modules include the FOX104 and FOX404.

Global Data I/O Registers

Global Data I/O Registers (%IG, %QG, %AIG and %AQG) give the user access to the Network Port's Global I/O data. This data can be accessed via User Screens and/or by Ladder Code.

a.   %IG Registers

A %IG Register is a retentive 1-bit memory location, which is normally used to store a global digital state obtained from another NX/controller on the network.

b.   %QG Registers

A %QG Register is a retentive 1-bit memory location, which is normally used to store a digital state to be sent as global data to the other NX on the network.

c.   %AIG Registers

A %AIG Register is a retentive 16-bit memory location, which is normally used to store a global analog value obtained from another NX/controller on the network.

d.   %AQG Registers

A %AQG Register is a retentive 16-bit memory location, which is normally used to store an analog value to be sent as global data to the other NX/controllers on the network.

e.   Network Port

The CsCAN Network is based on the Bosch Control Area Network (CAN), and implements the CsCAN Protocol which is designed to take maximum advantage of the global data broadcasting capability of CAN. Using this network protocol, up to 64 NX/controllers can be linked without repeaters, and up to 253 NX/controllers can be linked by using 3 repeaters.   For more information regarding CsCAN Protocol, refer to the **CsCAN Protocol Specification** document.

Ladder Code

The Ladder Code, stores ladder instructions generated by Cscape. This Ladder Code is downloaded and stored into the NX's Flash memory, to be executed each controller scan, when the controller is in RUN mode.

1.5   References

The following information serves as a *general* listing of Horner controller products and other references of interest and their corresponding manuals numbers. Visit our website listed in the **Technical Support** section to obtain user documentation and updates.

Note: This list is <u>not</u> intended for users to determine products that are appropriate for their application; controller products differ in the features that they support. If assistance is required, see the **Technical Support** section in this document.	
Controller	**Manual Number**
XLe/t Series (e.g., HE-XExxx)	MAN0878
QX Series (e.g., HE-QXxxx)	MAN0798
NX Series (e.g., HE-NXxxx)	MAN0781
LX Series (e.g., LX-xxx; also covers RCS116)	MAN0755
Color Touch OCS (e.g., OCSxxx)	MAN0465
OCS (Operator Control Station) (e.g., OCS1xx / 2xx; Graphic OCS250)	MAN0227
Remote Control Station (e.g., RCS2x0)	
MiniOCS (e.g., HE500OCSxxx, HE500RCSxxx)	MAN0305
Other Useful References	
CAN Networks	MAN0799
Cscape Programming and Reference	MAN0313
Wiring Accessories and Spare Parts Manual	MAN0347

1.6   Technical Support

For assistance and manual updates, contact Technical Support at the following locations:

North America: **Europe:**
Tel: (+) (317) 916-4274   Tel: (+) 353-21-4321-266
Fax: (+) (317) 639-4279   Fax: (+) 353-21-4321-826
Web: www.heapg.com   Web: www.horner-apg.com
Email: techsppt@heapg.com   Email: tech.support@hornerapg.com

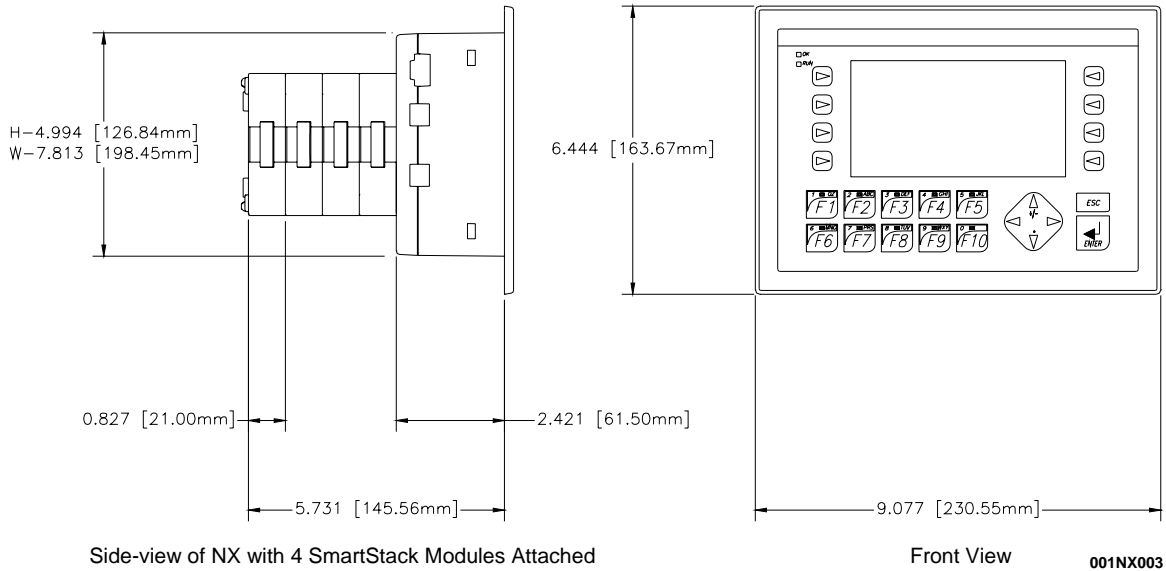# CHAPTER 2: INSTALLATION / SAFETY (NX OCS)

2.1 Dimensions and Panel Cut-Out

Side-view of NX with 4 SmartStack Modules Attached   Front View   **001NX003**

Figure 3 – Dimensions for the NX (NX25x is shown but dimensions apply to all NX Models)

Note: *For NEMA 4/4X washdown applications, the optional accessory kit HEACC006 is required.* (See *Mounting Procedures in Chapter 2*.)

The kit includes six additional mounting clips so that all mounting locations can be secured to provide an optimum seal against leaking.
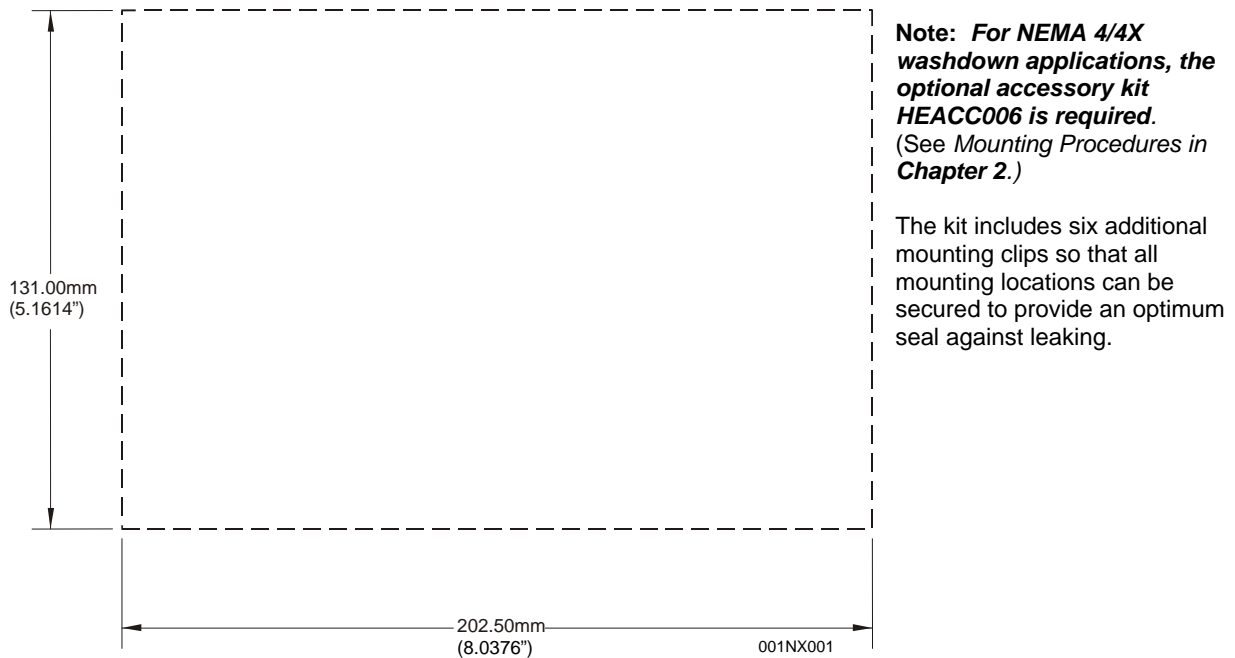
Figure 4 - Panel Cut-Out for the NX

2.2   Mounting Requirements

2.2.1   *Mounting Procedures (Installed in a Panel Door)*

Note: The following instructions apply to all NX OCS models. The NX25x is depicted as an example.

The NX OCS is designed for permanent panel mounting. To install the NX OCS, follow the instructions below.

1.   Prior to mounting the NX OCS, observe requirements for the panel layout design and adequate clearances. (A checklist is provided on page 24.)

2.   Cut the host panel. Per the specifications of Figure 5 and Figure 5 – carefully prepare the panel cutout. Make sure the corners of the cutout are square and free from burrs. (Panel cut-outs and dimensions are found **Chapter 3**.)

3.   Insert the NX OCS through the panel cutout (from the front). The gasket material needs to lie between the host panel and the NX OCS panel.

> **Caution: Do not force the OCS into the panel cutout. An incorrectly sized panel cutout damages the unit.**

4.   Install and tighten the mounting clips (provided with the NX OCS) until the gasket material forms a tight seal. Place the OCS in the panel cutout. Secure the unit as shown in Figure 7 using the four (4) supplied mounting clips. Figure 8 shows the possible clamping locations (10 possible), and the locations recommended for most applications. ***For NEMA 4/4X washdown applications, the optional accessory kit HEACC006 is required***. This kit includes six additional mounting clips so that all mounting locations can be secured to provide an optimum seal against leaking.

> **Caution: Do not over-tighten. Over-tightening damages the case.**

4.   Before commissioning, carefully remove the protective, plastic sheet from the front of the unit and discard it. The protective, transparent sheet is only provided to protect the display window until installed.

5.   Connect cables as needed such as communications, programming, power and fiber optic cables to the NX OCS ports using the provided connectors.

6.   Begin configuration procedures for the NX OCS models.

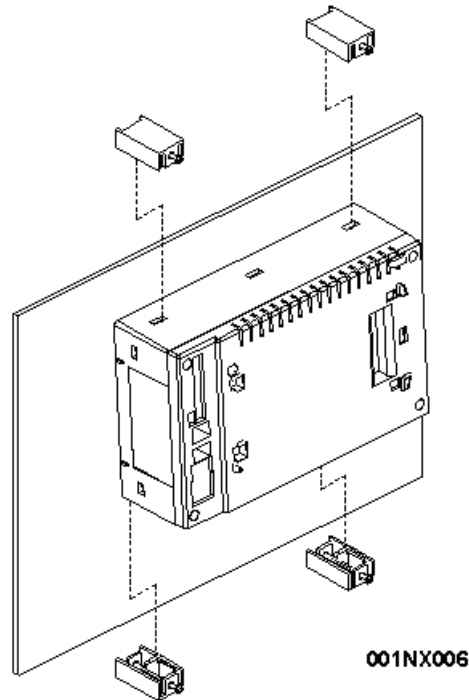*2.2.2   NX OCS Mounting Clips (Standard and NEMA and IP65 Washdown)*

001NX006

Figure 5 – **Back View of NX OCS with 4 Standard Mounting Clips**

Figure 6 shows locations for four standard mounting clips and also six additional clips contained in **optional accessory kit HEACC006**, which is required for **NEMA 4/4X or IP65 washdown applications**.
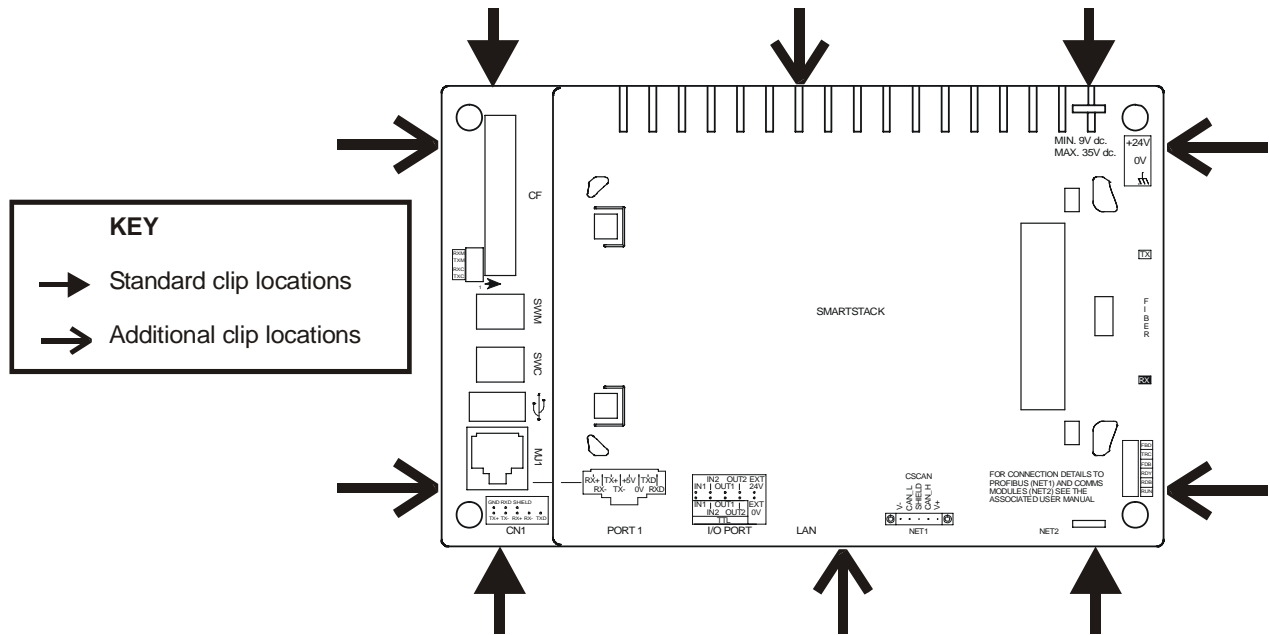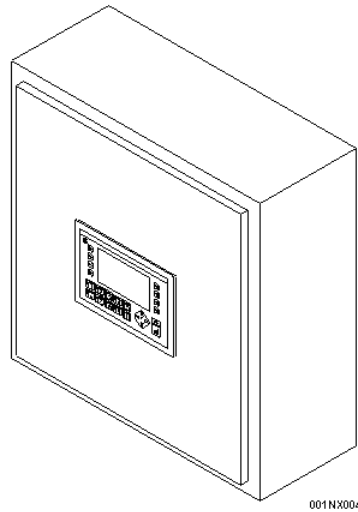

Figure 6 – Locations for 10 Mounting Clips for Optimum Seal Against Leaking
(Optional accessory kit HEACC006 required for NEMA 4/4X or IP65 washdown applications)

2.2.3   NX OCS Mounting Orientation

001NX004

NOTE: There are <u>NO </u>orientation restrictions on the NX OCS. *However, the above orientation provides for <u>optimum</u> <u>readability </u>of the screen and <u>ease of use</u> of the keypad.*

Figure 7 – **Orientation of NX OCS**

2.3   Factors Affecting Panel Layout Design and Clearances

Warning: It is important to follow the requirements of the panel manufacturer and to follow applicable electrical codes and standards.

The designer of a panel layout needs to assess the requirements of a particular system and to consider the following design factors*. A convenient checklist is provided on page 24.*

001NX005
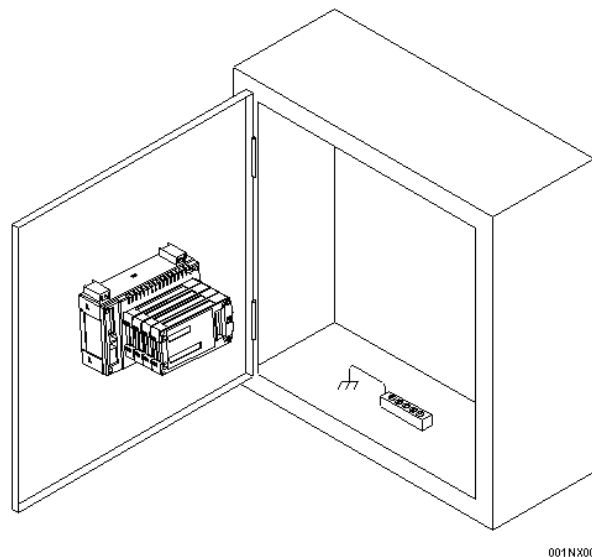
Figure 8 – **Back view of NX OCS (Shown On Panel Door)**
(NX25xxx Shown as an Example.)

a.   Clearance / Adequate Space

Install devices to allow sufficient clearance to open and close the panel door. Note that the NX OCS is mounted on a panel door and the NX OCS is mounted in a panel box.

Table 2.1 – Minimum Clearance Requirements for Panel Box and Door	
Minimum Distance between base of device and sides of cabinet	2 inches (50.80mm)
Minimum Distance between base of device and wiring ducts	1.5 inches (38.10mm)
If more than one device installed in panel box (or on door): Minimum Distance between bases of each device	4 inches between bases of each device (101.60mm)
When door is closed: Minimum distance between device and closed door (Be sure to allow enough depth for NX OCS.)	2 inches (50.80mm)

b.   Grounding

Warning: Be sure to meet the ground requirements of the panel manufacturer and also meet applicable electrical codes and standards.

Panel box: The panel box needs to be properly connected to earth ground to provide a good common ground reference.

Panel door: Tie a low impedance ground strap between the panel box and the panel door to ensure that they have the same ground reference.

c.   Temperature / Ventilation

Ensure that the panel layout design allows for adequate ventilation and maintains the specified ambient temperature range. Consider the impact on the design of the panel layout if operating at the extreme ends of the ambient temperature range. For example, if it is determined that a cooling device is required, allow adequate space and clearances for the device in the panel box or on the panel door.

d.   Orientation

There are no orientation restrictions on the NX OCS. However, the orientation shown in Figure 7 provides for optimum readability of the screen and ease of use of the keypad.

e.   Noise

Consider the impact on the panel layout design and clearance requirements if noise suppression devices are needed. Be sure to maintain an adequate distance between the NX OCS and noisy devices such as relays, motor starters, etc.

Note: Fiber Cables can be routed in the same conduit as the power wires.

2.3.1   Panel Layout Design and Clearance Checklist:

The following list provides highlights of panel layout design factors.

____Meets the electrical code and applicable standards for proper grounding, etc.?
____Meets the panel manufacturer's requirements for grounding, etc.?
____Is the panel box properly connected to earth ground? Is the panel door properly grounded? Has the appropriate procedure been followed to properly ground the devices in the panel box and on the panel door?
____Are minimum clearance requirements met? (See **Table 2.1**.) Can the panel door be easily opened and closed? Is there adequate space between device bases as well as the sides of the panel and wiring ducts?
____Is the panel box deep enough to accommodate the NX OCS?
____Is there adequate ventilation? Is the ambient temperature range maintained? Are cooling or heating devices required?
____Are noise suppression devices or isolation transformers required?   Is there adequate distance between the base of the NX OCS and noisy devices such as relays or motor starters? Ensure that power and signal wires are not routed in the same conduit.
____Are there other requirements that impact the particular system, which need to be considered?

2.4   Ports, Connectors, Cables, and Wiring

2.4.1   Primary Power Port / Grounding

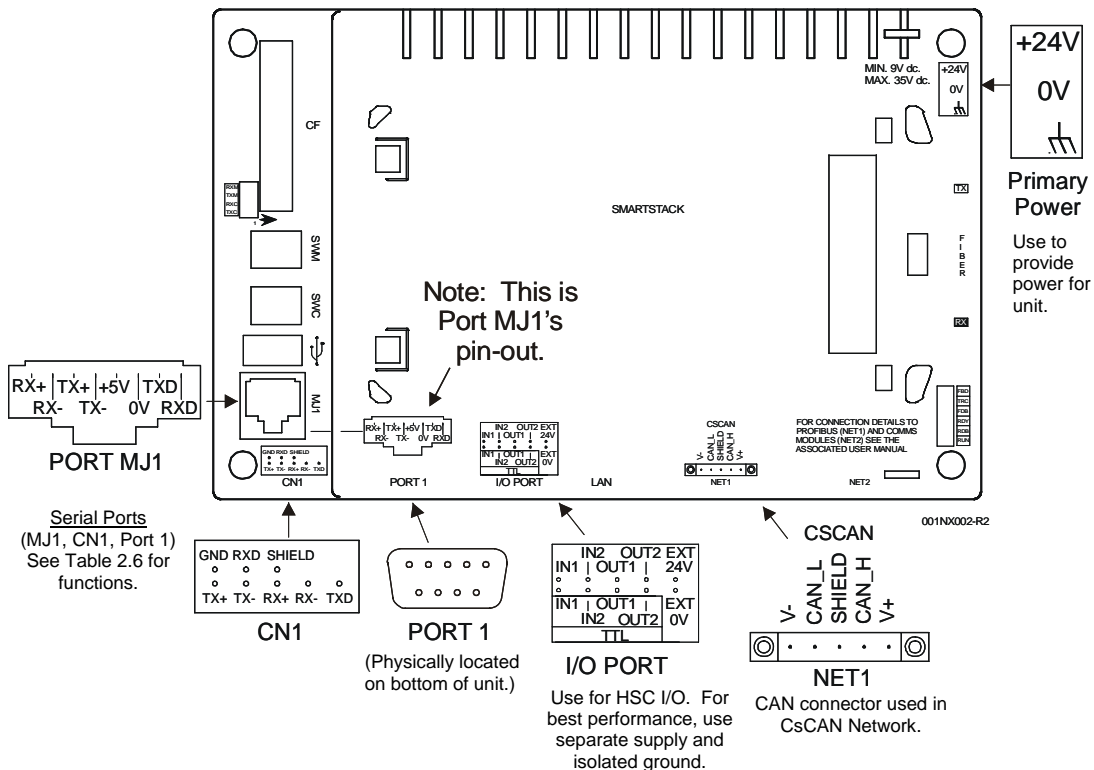Figure 9 shows the locations of the most commonly used connectors used during installation.

Figure 9 – NX Connectors and Ports

2.4.2   Primary Power Port

Table 2.2 – Primary Power Port Pins		
Pin	**Signal**	**Description**
1	⏚	Frame Ground
2	0V	Input power supply ground
3	+24V	Input power supply ground voltage

Note: The included ferrite must be installed as shown to maintain CE levels of noise immunity.

9-36vdc supply

Supplied ferrite

Wiring to be run through the ferrite twice (one loop).
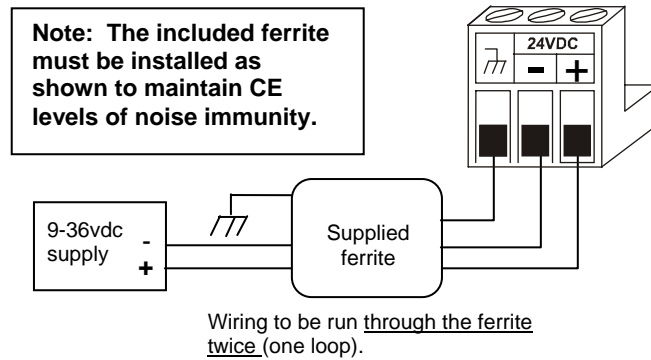
Figure 10 - Power Connector (Primary Power Port)

PIN 1
PIN 2
PIN 3

001NX002
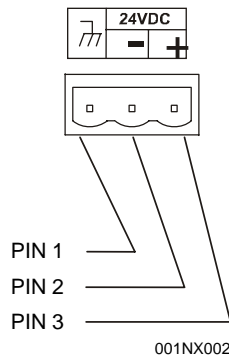
Figure 11 - As viewed looking at the NX

2.4.3   CAN Network Port and Wiring

a.   Network Connector

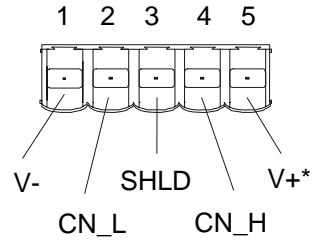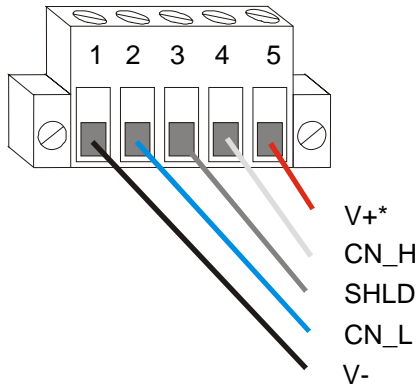| Table 2.3 – CAN Port Pins		
Pin	**Signal**	**Description**
1	V-	CAN Ground
2	CN_L	CAN Signal -
3	SHLD	CAN Shield
4	CN_H	CAN Signal +
5	V+*	N/C
* V+ is not required, because the NX CsCAN port is self-powered.		

Figure 12 – Network Connector (CAN Port)   Figure 13– As viewed looking at the NX

Note: To optimize CAN network reliability in electrically noisy environments, the V- CAN Ground needs to be isolated from the primary input power supply ground.
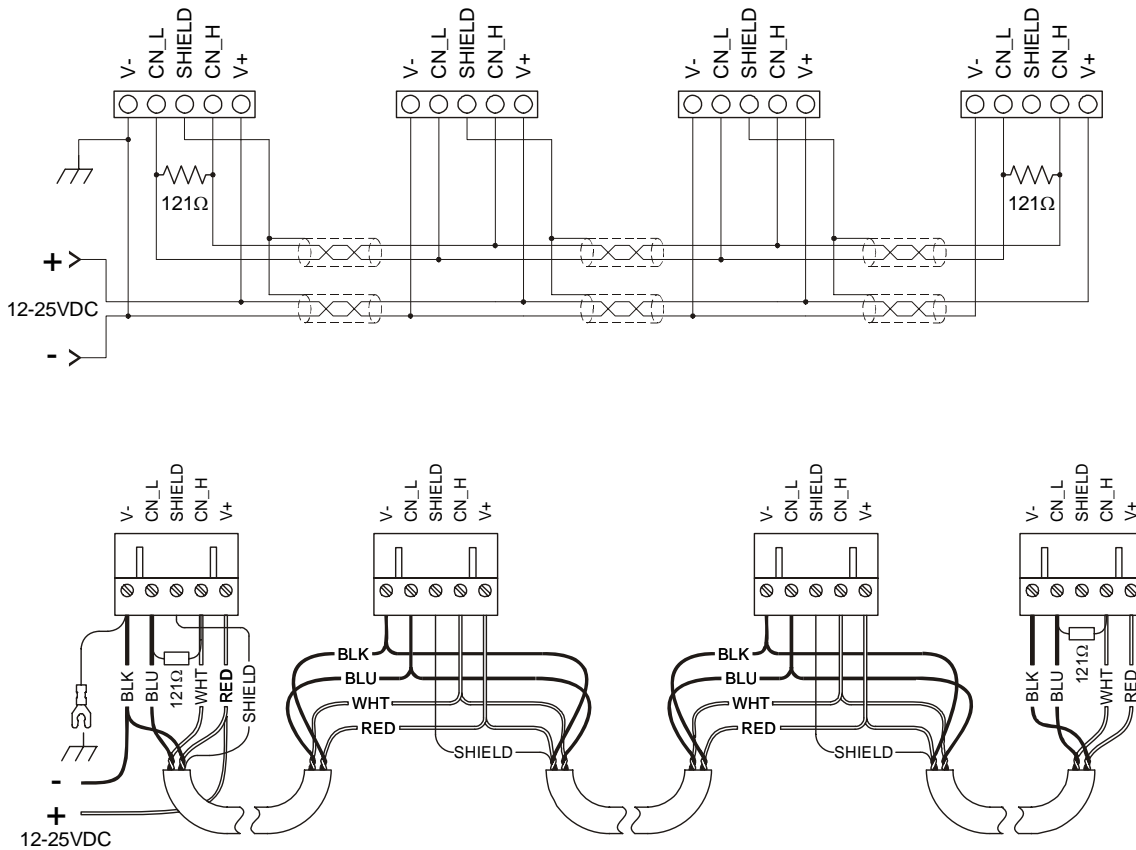
b.   Wiring

Figure 14 – CAN Wiring

c.   **CAN Wiring Rules** (See Figure 14)

Note: To optimize CAN network reliability in electrically noisy environments, the CAN power supply needs to be isolated (dedicated) from the primary power.

1.   Wire the CAN network in a daisy-chained fashion such that there are exactly two physical end-points on the network.
2.   The two nodes at the physical end-points need to have 121 ohm 1% terminating resistors connected across the CN_L and CN_H terminals.
3.   Use data conductors (CN_L and CN_H) that are 24 AWG shielded twisted pair for "thin cable" and 22 AWG shielded twisted pair for "thick cable."   They must also have 120-ohm characteristic impedance. In typical industrial environments, use a Belden wire #3084A ("thin"). Use #3082A ("thick") for network cable lengths greater than 100 meters environments where noise is a concern. Place data conductors (CN_L and CN_H) into a twisted pair together.
4.   Use power conductors (V- and V+) that are 18 AWG twisted-pair for "thin cable" and 15 AWG twisted-pair for "thick cable." Place power conductors (V- and V+) into a twisted pair together.
5.   If local codes require the local CAN power supply to be earth grounded, connect the V- power conductor to a good earth ground **at one place only** on the network, preferably at a physical endpoint. If multiple power supplies are used, only one power supply must have V- connected to earth ground. The remaining power supplies need to be isolated.
6.   For a section of cable between two nodes, the cable shield is connected to the cable shield input at *one end of the cable only.*
7.   A CAN network (without repeaters) is limited to 64 nodes (with 63 cable segments) with a maximum combined cable length of 1500 ft. at 125KBaud.
8.   Up to four CAN network segments, which adhere to the above rules, may be connected together using three CAN repeaters. In this manner, a CAN network may be extended to 253 nodes with a total cable distance of 6000 ft. at 125KBaud.

d.   **CsCAN Cable**

The 5-wire, multi-conductor copper cable used in CsCAN network include:

1. Two wires used as a transmission line for network communications.
2. Two wires used to transmit network power.
3. One conductor used as an electromagnetic shield.

Cabling is available in a variety of current-carrying capacities. On a CsCAN fieldbus every device must, at least, power its network transceivers from the network power supply. Some devices draw all of their power from the network supply. In CsCAN thick and thin cable is used as indicated:

1. **Thick cable:** Use for long distances and more power. Usually used for Trunk cable.
2. **Thin cable:** Use for shorter distances. Usually used for drop cables or where cable flexibility is needed.

Table 2.4-CsCAN Cable Specifications	
Thick Cable – general specifications (e.g., Belden 3082A)	Two twisted shielded pairs –Common axis with drain wire in center. One signal pair (#18), blue/white; One power power pair (#15) black/red. Separate aluminized mylar shields around power pair and signal pair.
	Overall foil/braid shield with drain wire (#18), bare*. High Speed (Vp=75% min), low loss, low distortion, data pair (to keep propagation delays to a minimum). 8 amp maximum current capacity. PVC insulation on power pair. Industrial temperature range. High flexibility.
Thin Cable – general specifications (e.g., Belden 3084A)	Two twisted shielded pairs –Common axis with drain wire in center. One signal pair (#24), blue/white; One power power pair (#22) black/red. Separate aluminized mylar shields around power pair and signal pair.
	Overall foil/braid shield with drain wire (#22), bare*. High Speed (Vp=75% min), low loss, low distortion, data pair (to keep propagation delays to a minimum). 3 amp maximum current capacity. PVC insulation on power pair. Industrial temperature range. High flexibility
Network Topology	Bus with limited branching (truckline / dropline)
Redundancy	Not Supported
Network Power for Node devices	Nominal 24 VDC ±4%
Allowed Nodes (Bridging excluded)	64 nodes
Data Packet Size	0-8 bytes with allowance for message fragmentation
Duplicate Address Detection	Addresses verified at power-up
Error Detection / Correction	CRC – retransmission of message if validity not acknowledged byrecipient.
* The drain wire connects shields within the cable and serves as a means to terminate the shield into the connector.	

e.   Bus Length

Several factors affect the maximum length of the bus including the accumulated length of drop lines, cable type, transfer rate and the number of drop lines. Although a branch is limited to one network per drop, it can have multiple ports. A branch can not exceed 6 meters.

Table 2.5 - CAN Network Baudrate vs. Total Cable Length Note: The following values apply to both CsCAN except as indicated.	
Thick Cable: Network Data Rate	**Maximum Total Cable Length**
1Mbit / sec.	40m (131 feet)
500Kbit / sec.	100m (328 feet)
250Kbit / sec.	200m (656 feet)
125Kbit / sec.	500m (1,640 feet)

f. Bus Power and Grounding

When using CsCAN

1. A power supply of 24VDC (±4%) at 16A maximum is required for use in a CsCAN network
2. With thick cable, a single network segment can have a maximum of 8A. To do this, the power supply needs to be located in the center of two network segments.
3. Thin cable has maximum of 3A.
4. To ground the cable shield, connect to pin 3 as shown in Figure 14.
5. If local codes require the local CAN power supply to be earth grounded, connect the V- power conductor to a good earth ground **at one place only** on the network, preferably at a physical endpoint. If multiple power supplies are used, only one power supply must have V- connected to earth ground. The remaining power supplies need to be isolated.

g. CAN Repeater (Using the HE200CGM100)

The HE200CGM100 (CGM100) is an intelligent CAN network isolating repeater. The following guidelines are provided for using the CGM100. For additional information, refer to **MAN0008.** In a typical CAN network, each device is assigned a unique CAN node address (ID) to arbitrate network communication. Depending on the application protocol used, these IDs are assigned in the range of 0 to 253. Therefore, up to 254 devices may be logically attached to a CAN network.

However, the use of standard CAN transceiver chips limits the number of physically attached devices to 64. Thus, to reach the logical limit of 254 devices, up to three smart CAN repeaters are used to connect groups of devices together. A CAN network (without repeaters) is usually limited to a maximum cable length of 1,500 feet (assuming a Baud rate of 125 kHz). With repeaters, this limit can be extended to 6,000 ft.

Using CGM100's 1000V isolation virtually eliminates problems associated with ground potential differences that are inherent in long cable drops on many local area networks.

2.4.4 RS-232 Port / RS-485 Serial Ports

The NX features two active serial ports, accessible through three connectors. Port 1 and MJ1 share internal OCS circuitry. These two ports can NOT be used simultaneously. Port CN1 has independent circuitry, and can be used simultaneously to either Port 1 or MJ1.

Note: In certain applications, both Port 1 and MJ1 can be used, but the OCS application program must select the port which is active at any given time. **Table 2.6** shows the three port connectors and the functions supported by each.

Table 2.6 – Serial Ports and Functions (Port 1, MJ1 and CN1)										
Port	Connector	RS-232	RS-422	RS-485	Cscape Programming	Full Modem Support	ASCII	RTU Slave	RTU Master	3rd Party Protocols
Port 1	DE-9S*	x			x	x	x	x	x	x
MJ1	RJ45	x	x	x	x	**	x	x	x	x
CN1	10-pin Terminal	x	x	x		**	x	x	x	x

* Denotes 9-pin, 2-row, socket. The term DB9 is widely (but erroneously) used to specify a 9-pin RS-232 connector. The correct specifier is either a DE-9S (socket) or a DE-9P (plug).
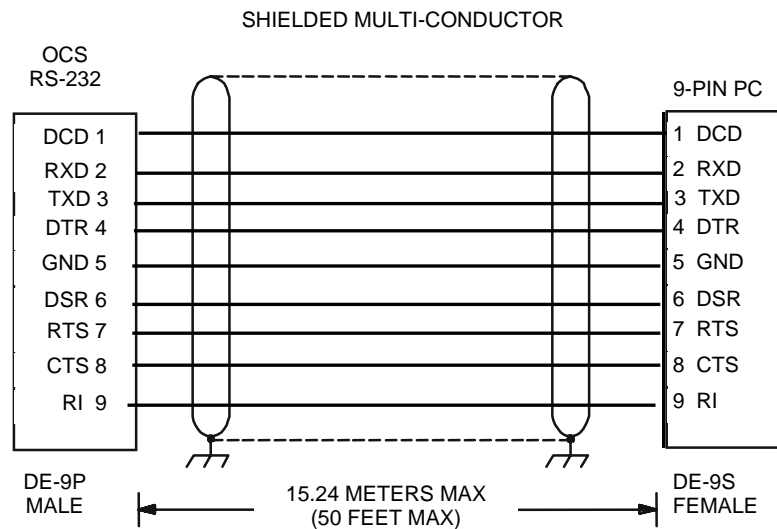** Does <u>not</u> support handshaking.

a. PORT 1 – 9-pin D-subminiature Jack

Pin 1

Pin 9
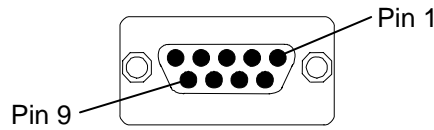
Note: The term DB9 is widely (but erroneously) used to specify a 9-pin RS-232 connector. The correct specifier is either a DE-9S (socket) or a DE-9P (plug).

Figure 15 – PORT 1 (RS-232) DE-9S Connector.

Table 2.7– PORT 1 (RS-232) Pins			
Pin	**Signal**	**Description**	**Dir**
1	DCD	Always high	Out
2	RXD	Received Data	Out
3	TXD	Transmitted Data	In
4	DTR	Data Terminal Ready	In
5	GND	Ground	-
6	DSR	Data Set Ready	Out
7	RTS	Request to Send	In
8	CTS	Clear to Send	Out
9	RI	Ring Indicate	Out

SHIELDED MULTI-CONDUCTOR

OCS
RS-232

9-PIN PC

DCD 1		1 DCD
RXD 2		2 RXD
TXD 3		3 TXD
DTR 4		4 DTR
GND 5		5 GND
DSR 6		6 DSR
RTS 7		7 RTS
CTS 8		8 CTS
RI 9		9 RI

DE-9P
MALE

15.24 METERS MAX
(50 FEET MAX)

DE-9S
FEMALE

Note: For baud rates greater than 9600 baud, a shorter cable may be required.

Figure 16 – Programming Cable (9-pin)

b. MJ1 Modular Jack

Figure 17 – **Port MJ1 RJ-45 Jack**

Note: See Table 2.6 for a list of serial port functions.

Table 2.8 – MJ1 Pins		
Pin	**Signal**	**Direction**
1	RX+	IN
2	RX-	IN
3	TX+	OUT
4	TX-	OUT
5	+5V	OUT
6	0V	-
7	RXD	IN
8	TXD	OUT

c. CN1 -   10-pin Terminal Header

001NX008
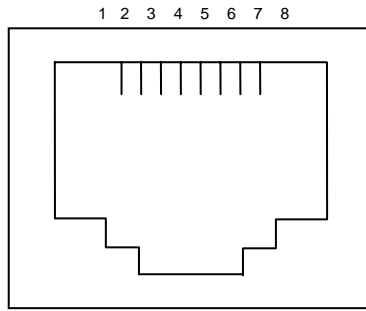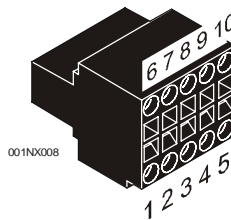
Note: See Table 2.6 for a list of serial port functions.

Figure 18 – CN1 Terminal Connector

Table 2.9 – **CN1 Pins** (Black Connector)		
Pin	**Signal**	**Direction**
1	TX+	OUT
2	TX-	OUT
3	RX+	IN
4	RX-	IN
5	TXD	OUT
6	GND	-
7	RXD	IN
8	SHIELD	-
9	+5V	OUT
10	N/C	-

2.4.5   I/O Port (HSC)

If using an NX model with built-in HSC, refer to the I/O Port connector section in CHAPTER 8: Built-in High Speed I/O.

2.4.6   Modem Setup

A modem can be used for remote communications between a computer (using Cscape Software) and the NX OCS. The modem must operate at 9600 baud or higher.
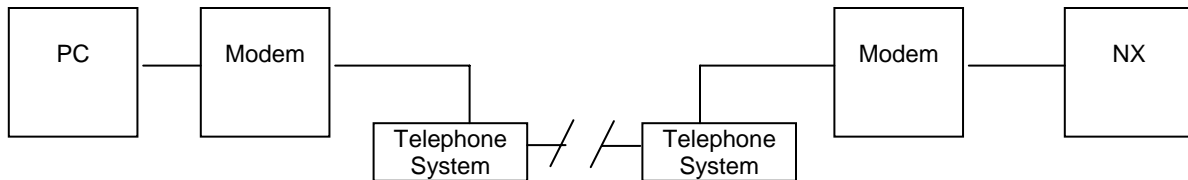
Figure 19 – Modem Setup

a. Setup

Setup the modems to match the default serial port characteristics of the NX OCS.

9600 baud
8 data bits
No parity
1 stop bit
disable error checking
disable compression

b. Cable Wiring

Figure 20 – Modem Wiring

The wire type used is not overly critical except where the length of the cable must be between 30 and 50 feet (10 to 15 meters). In all cases, the cable must be shielded multi-conductor with conductors of at least 20 gauge. The length of the cable must be as short as possible, and in no case, longer than 50 feet (15 meters).

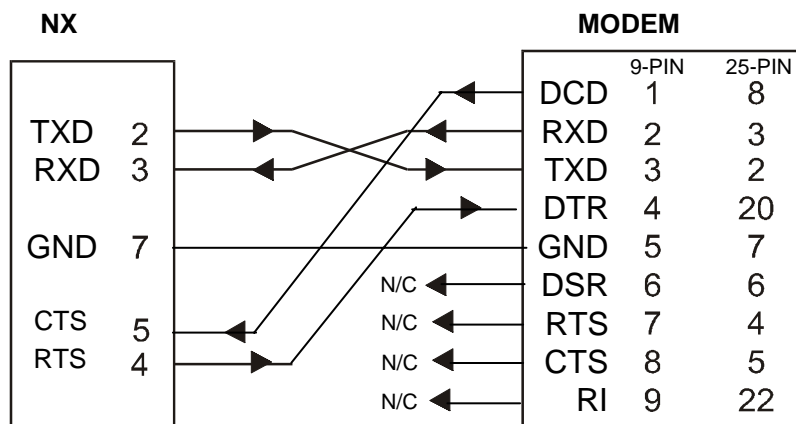The modem must be located as close as possible to the NX OCS, preferably less than one meter. However, EIA-232 specifications allow for cable runs up to 50 feet (15 meters). If cable lengths longer than 30 feet (10 meters) are required, a special low capacitance cable must be used.

> **Warning:** To connect a modem to the NX OCS the controller to modem cable must be constructed or purchased. Using a Null Modem cable can cause damage to the NX OCS, modem or both.

c. Recommended Modem

Selection of a telephone modem for use with the OCS is highly dependent on environment. For a relatively benign, low-noise environment, an off-the shelf external modem like a U.S. Robotics Sportster Modem may work well. For a more industrial environment, however, it is appropriate to use a telephone modem designed for that environment. Check with Technical Support for the availability of an industrial modem from Horner APG (page 17). Other manufacturers such as Datalinc have models, which have been known to work in more harsh environments at a higher cost. *If a modem is used which is not appropriate for the environment, there may be little that can be done to correct the situation other than change to a more appropriate model.*

For detailed information regarding the use of modems with NX products, contact Technical Support (page 17). You can also find specific application information (cabling, modem commands, etc.) in the Cscape Help file as well.

2.5 NX LEDs

2.5.1 *LEDs*

RUN and **OK** LEDS are physically located on the front panel of the NX OCS. (Refer to Figure 21.) Physical **CAN OK**, and **FIBER OK** LEDs can be viewed on the back of the NX OCS next to the fiber optic connectors.

Table 2.10 – NX OCS LEDs	
RUN	• OFF indicates OCS is in IDLE/STOP mode. • Flashing indicates DO / IO mode or RUN with no ladder program. • ON indicates ladder code running.
OK	• OFF indicates one or more self-tests failed. • ON indicates all self-tests passed.
CAN OK	Randomly flashes during CAN communications.
FIBER OK	ON indicates NX OCS's fiber input cable is properly connected and is receiving a carrier.

2.6 Battery Replacement

NX has two different types of battery assemblies depending on the model used.

Model number	Battery Assembly
220, 221, 250, 251	CBL00042R1.1
222, 252	CBL00042R1.1-105

NOTE: Use appropriate ESD precautions before handling the device.

Procedure for CBL00042R1.1 assembly
1. Make sure the user program and any data stored in retentive memory is backed up.
2. Disconnect all power from the NX OCS unit including I/O power.
3. Unscrew the (4 screws) back cover and remove it.
4. Remove the X25 connector (Figure 21).
5. Unscrew the 4 PCB corner screws

6. Note there are two connectors (J15A & J15B) on the PCB near the 'BATTERY' that can accommodate the battery connector (Figure 22).
7. Plug the new battery into the empty connector before removal of the old battery assembly
8. Remove the old battery assembly and insert the new assembly (Figure 23).
9. Dispose of the old battery assembly properly (see warning on disposal regulations)
10. Screw (4 screws) the PCB and connect the X25 connector.
11. Replace the back cover and screw (4 screws).
12. Apply power to the unit. Check that the battery error is no longer reported. If the unit still reports the error, remove the battery immediately and contact Technical Support.

Figure 21

Figure 22
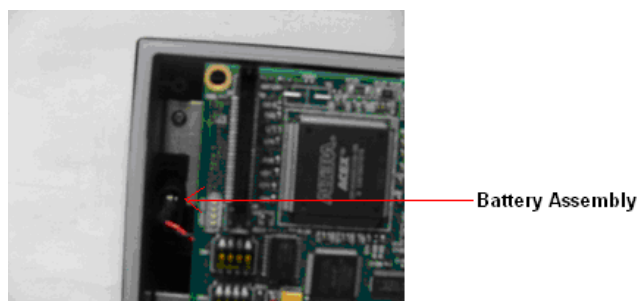
Figure 23

Procedure for CBL00042R1.1-105 assembly
1. Make sure the user program and any data stored in retentive memory is backed up.
2. Disconnect all power from the NX OCS unit including I/O power.
3. Unscrew the (4 screws) back cover and remove it.
4. Remove the X25 connector (Figure 24).
5. Note there are two connectors (Battery Connectors in Figure 24) on the PCB that can accommodate the battery connector.
6. Plug the new battery into the empty connector before removal of the old battery.
7. Remove the old battery assembly.
8. Dispose of the old battery properly; see the above warning on disposal regulations.
9. Connect the X25 connector and replace the back cover and screw (4 screws).
10. Apply power to the unit. Check that the battery error is no longer reported. If the unit still reports the error, remove the battery immediately and contact Technical Support.
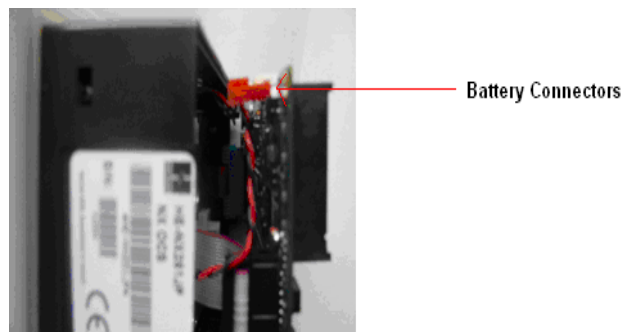
Figure 24

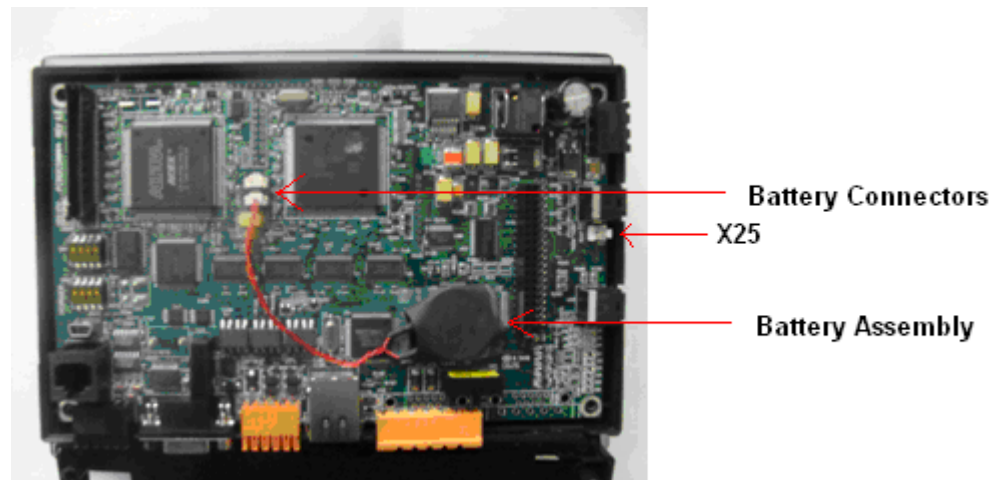> **Warning:** Disposal of lithium batteries must be done in accordance with federal, state, and local regulations. Be sure to consult with the appropriate regulatory agencies *before* disposing batteries. In addition, do <u>not</u> re-charge, disassemble, heat or incinerate lithium batteries.

> **Warning:** Do <u>not</u> make substitutions for the battery. Be sure to only use the authorized part number to replace the battery.

The NX uses a replaceable 3V Lithium battery – 4.5 years (off) lifetime.

2.7   Safety

When found on the product, the following symbols specify:

| ⚠ | **Warning:** Consult user documentation. | ⚡ | **Warning:** Electrical Shock Hazard. |

> **WARNING: To avoid the risk of electric shock or burns, always connect the safety (or earth) ground before making any other connections.**
>
> **WARNING: To reduce the risk of fire, electrical shock, or physical injury it is strongly recommended to fuse the voltage measurement inputs. Be sure to locate fuses as close to the source as possible.**
>
> **WARNING: Replace fuse with the same type and rating to provide protection against risk of fire and shock hazards.**
>
> **WARNING: In the event of repeated failure, do <u>not</u> replace the fuse again as a repeated failure indicates a defective condition that will <u>not</u> clear by replacing the fuse.**
>
> **WARNING: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.**

- All applicable codes and standards need to be followed in the installation of this product.
- For I/O wiring (discrete), use the following wire type or equivalent: Belden 9918, 18 AWG or larger.

Adhere to the following safety precautions whenever any type of connection is made to the module.

- Connect the green safety (earth) ground first before making any other connections.
- When connecting to electric circuits or pulse-initiating equipment, open their related breakers. Do not make connections to live power lines.
- Make connections to the module first; then connect to the circuit to be monitored.
- Route power wires in a safe manner in accordance with good practice and local codes.
- Wear proper personal protective equipment including safety glasses and insulated gloves when making connections to power circuits.
- Ensure hands, shoes, and floor are dry before making any connection to a power line.
- Make sure the unit is turned OFF before making connection to terminals. Make sure all circuits are de-energized before making connections.
- Before each use, inspect all cables for breaks or cracks in the insulation. Replace immediately if defective.

CHAPTER 3: CONFIGURATION - SYSTEM MENU (NX)

3.1   General

Chapter Three describes the System Menu.

The System Menu is used to access and edit information using the NX front panel.

3.2   Navigating Through the System Menu

Prior to configuration, it is important to understand how to navigate through the System Menu using the following guidelines. After performing the **System** key sequence (press up and down arrows simultaneously) on the front panel of the NX, the System Menu main screen appears. It contains a list of options. **(See Figure 21.)**

1.   Press the ↑ and ↓ keys to scroll up or down through the menu options. Press **Enter**.
2.   A screen appears containing one or more parameter names. If the parameter is editable, the parameter name is highlighted. Press **Enter**.
3.   The parameter value field is highlighted. Use the ↑ and ↓ keys or numeric keys to edit the parameter value.
4.   If multiple parameters are available for editing, use the ↑ and ↓ keys to scroll through parameters.
5.   While in a system screen, press **ESC** (if not currently modifying a field) to return to the main System Menu. It may be necessary to press **ESC** more than one time to return to the main System Menu screen.

3.3   Editing System Menu Screen Fields

Prior to configuration, it is important to know how to edit the System Menu screen fields using the following guidelines.

1.   There are two types of fields; Property Fields and Value Fields.

A **Property Field** is highlighted when selected using the arrow keys. A Property Field indicates the name of a property - it is not editable.

Saver Enable	No
Timeout (min)	15

Value Fields allow a property value to be edited.

2.   To change a value in an editable field, press the **Enter** key to select **Edit Mode**.   The NX indicates Edit Mode by highlighting the value field *.
3.   In Edit Mode, the fields require one of the following methods for modifying the value. Refer to the field description to determine which method to use.

Enumerated entry   - use ↑ and ↓ keys to select appropriate value.
Numeric entry   - use Numeric keys or ↑ and ↓ keys on the appropriate digit.
Bar graph entry   - use ← and → keys to adjust value.

4.   After the value is correctly entered, press the **Enter** key to accept the value.
5.   Should the user not wish to accept the value before the **Enter** key is pressed, the **ESC** key can be pressed instead. This action restores the original value to the display.   The NX also immediately exits Edit Mode.

3.4   Initial System Menu Screens and Self-Test

1.   After turning on the power to the NX, the following example screen appears indicating that Self-Test is running. (OCS3xx is shown as an example.)

```
NX 2xx - CsCAN
        Self-Test running
```

   xx = indicates the model.

a.   If the Self-Test passes, the following example screen appears:

```
NX 2xx - CsCAN
        ***Self-Test Passed***
```

b.   If the Self-Test fails, a message briefly flashes on the screen for each error that occurs.

   To view a summary screen of Self-Tests, see **Section 4.6.**

3.5   Entering the System Menu

To enter the System Menu, alternately press the **Up arrow** key and **Down arrow** key on the front panel of the NX. The System Menu main screen appears. It contains a virtual keypad and a list of options **(**Figure 21**).**

3.6   System Menu Option Screens

In addition to providing access to configuration parameters, the System Menu also provides power-up and runtime status. For brevity, both configuration and status fields are covered in this section.

•	Set Network ID
•	Set Network Baud
•	Set Contrast
•	View OCS Status
•	View OCS Diags
•	View I/O Slots
•	View Protocols
•	Set Fkeys Mode
•	Set RS232 Mode
•	Set Time/Date
•	Set Beeper
•	Set Screen
•	CompactFlash
•	Fail-Safe System
•	Clone Unit

Figure 21 – System Main Menu Screen

- **Set Network ID**

This screen contains two parameters. The first parameter (Network OK?) contains the current network status. The second parameter (Network ID) contains the current Network ID of the model. The second parameter is numerically editable and is used to configure the Network ID.

Each unit on the network **needs a unique ID number**.   Using the virtual keypad, the correct ID number is entered here before physically attaching the unit to the network.

       Cscan model: [1 - 253]

To edit the Network ID:

1.   Press the **Enter** key until the Network ID parameter value field is highlighted.
2.   Then type in the desired Network ID number by touching the virtual keypad and press **Enter**.
       Note: If the **Enter** key is <u>not</u> pressed, the desired Network ID number does <u>not</u> take effect.

Note: If the Network ID setting is changed, the unit stops executing the ladder code (for up to 1 second) while the network is re-tested. If the "Network OK?" status changes from "Yes" to "No," the new Network ID is a duplicate, and another ID needs to be selected.

- **Set Network Baud**

This screen contains an editable enumerated parameter allowing the user to select the current baud rate of the network.

       Cscan model: [125K, 250K, 500K, 1M]

Note: All devices on the network must be at the same baud rate. A device configured for the wrong baud rate can shut down the network entirely.

- **Set Contrast**

This menu contains an editable bar graph entry allowing the user to set the contrast of the LCD display.

- **View OCS (RCS) Status**

This screen contains one enumerated editable parameter that sets the NX scan mode **and** several non-editable status parameters that display information about the internal state of the NX. Press the ↑ and ↓ keys to scroll through the different items. Pressing **ESC** returns to the System Menu.

<u>Parameter</u>	<u>Description</u>
Mode:	Displays the current scanning mode. Allows the user to choose a scanning mode to view (**Idle**, **Run**, **DoIO**) by highlighting the mode parameter and using the ↑ and ↓ to change modes. In *Idle* mode, the I/O is <u>not</u> scanned and the OCS ladder program does <u>not</u> execute. The green "RUN" LED is OFF. In *Run* mode, the ladder program executes and the green "RUN" LED illuminates. *DoIO* mode is similar to *Run* mode, except the ladder logic is not solved. When the OCS is in *DoIO* mode, the user is able to exercise all of the I/O from Cscape, without interference from the ladder program. In this mode the green "RUN" LED flashes. This feature is a valuable troubleshooting tool.

`Scan-Rate (ms.):`   Shows the number of milliseconds for the scan. The scan-rate is the sum of the time required to execute the following items:

> a. Scan inputs
> b. Solve logic
> c. Write outputs
> d. Handle network communications
> e. Handle host communications request
> f. Process data for operator interface

`OCS Net Use (%):`   Shows the percentage of the network used by the NX.
`All Net Use (%):`   Shows the percentage of the network used by all devices on the network.

`Ladder Size:`   Shows the number of bytes used by the ladder program.
`Config Size:`   Shows the number of bytes used by the I/O configuration

`Graphics Size:`   Shows the total size of the file containing graphics.
`String Size:`   Shows the total size of the text stored in the String Table.
`Bitmap Size:`   Shows the total size of the file containing bitmaps.

`Text Tbl Size:`   Shows the number of bytes used by the text tables.
`Font Tbl Size`   Shows the number of bytes used by the downloadable font table.
`Protocol Size`   Shows the number of bytes used by the protocol table.
`Firmware Rev:`   Shows the execution engine firmware version.
`CPLD Rev:`   Shows the CPLD revision.
`FPGA Rev:`   Shows the FPGA Image version.
`Self-Test:`   Shows if the power-up self-test passed or failed by displaying **Ok** or **Fault**.

- **View OCS Diags**

This screen displays a list of self-test diagnostics results (no editable parameters). Each item describes a test and shows a result of **Ok** if the test passed or **Fault/Warn** if an error was found while running the test. **Fault** indications will prevent the loaded application from running.   Warn**(**ing) indications allow the application to run but inform the user that a condition exists that needs correction.

System RAM - This test checks the functionality of the controller RAM at power up.
> **Ok**   The RAM is functioning correctly.
> **Fault** The RAM is not functioning correctly.

System BIOS - This test checks for a valid BIOS portion of the controller firmware.
> **Ok**   The loaded BIOS firmware is valid
> **Fault** The loaded BIOS is invalid.

Firmware - This test validates the controller firmware.
> **Ok**   The firmware is valid.
> **Fault** The controller firmware is invalid.

Logic Error -   This test checks for problems with the user program while running.
> **Ok**   No errors have been encountered while running a user program.
> **Fault** Indicates the user program contained an instruction that was invalid or unsupported.

User Program - This tests for a valid user program and configuration data.
> **Ok**   The user program and configuration is valid.
> **Fault** The user program and/or configuration are not valid.

User Graphics - This test validates the user graphics.
   Ok Graphics are valid.
   Fault The graphics are invalid.

W-Dog Trips - This test checks for resets caused by hardware faults, power brownouts or large amounts of electrical interference.
   0   No unintentional resets have occurred.
   xx Indicates a fault with xx showing the number of occurrences.

Net Errors - This test checks for abnormal network operations while running.
   0   No network errors were counted
   xx Indicate serious networking problems exist, xx indicates the number of occurrences.

Network State - This test checks that the network sub-system is powered and operating correctly.
   Ok The network system is receiving power and has determined other devices are communicating on the network.
   Warn Power is not being applied to the network or no other devices were found to be communicating on the network.

Network ID - This test checks that the network ID is valid.
   Ok The network ID is valid.
   Warn The network ID is not valid for the selected protocol.

Dup Net ID - This test checks for duplicate IDs on a network.
   Ok This controller's ID was not found to be a duplicate.
   Warn Another controller on the network was found with the same ID as this controller.

Clock Error - This test checks that the real time clock contains valid data.
   Ok The real time clock contains valid data.
   Warn Indicates invalid data in the real time clock.

I/O System - This test checks that the I/O configuration downloaded and the physical devices (SmartStack) attached to the controller match.
   Ok The I/O configuration matched the installed modules.
   Warn Indicates the downloaded configuration and attached modules do not match.
      (See View I/O Slot system screen for more information.)

Battery - This test checks battery.
   Ok Battery level tested OK at power-up.
   Warn Battery level did <u>not</u> test OK at power-up.

- **View I/O Slots**

The View I/O Slots screen displays information about SmartStack modules (if any) that are currently connected to the NX. Some models support multiple I/O bases using a FOX (Fiber Optic eXpansion) interface. For these models, the View I/O Slots screen also allows selection of the I/O base to be displayed and indicates whether the I/O base is online, offline, or duplicated.

When viewing I/O slots, the following status screens are possible. Note that in the I/O slot display descriptions, the term **ModNum** refers to a SmartStack I/O module number such as DIQ611 or THM100.

a.   If an OCS slot has <u>no</u> configured I/O module <u>and</u> <u>no</u> module is physically attached, the message **" I/O: Empty"** is displayed for the appropriate slot.
b.   If an OCS slot has <u>no</u> configured I/O module <u>and</u> a module is physically attached, the message **"+I/O: ModNum"** is displayed for the appropriate slot.

c.   If an OCS slot has a configured I/O module <u>and</u> no module is physically attached, the message **"-I/O Missing"** is displayed for the appropriate slot.

d.   If an OCS slot is configured for a <u>different</u> module than what is physically attached, the message **"?I/O: ModNum"** is displayed for the appropriate slot.

e.   If an attached module is <u>not</u> supported by the OCS firmware, the message **"*Unsupported"** is displayed for the appropriate slot. The module is either defective or an Engine firmware upgrade is required to support the module.

f.   If an attached I/O module has erroneous or outdated firmware in it, the message **"fI/O: ModNum"** is displayed for the appropriate slot The module is either defective or a Module firmware upgrade is required.

g.   If an attached module has a configuration error, the message **"cI/O: ModNum"** is displayed for the appropriate slot. The configuration data for that module is incorrect.

h.   If an OCS slot configuration matches the attached I/O module, the message **" I/O: ModNum"** is displayed for the appropriate slot.

- **View Protocols**

This screen displays protocol drivers loaded by the applications and their current revisions.

- **Set FKeys Mode**

This screen contains an editable enumerated field that allows the Function keys to be configured to operate in one of two modes. When a function key is pressed, it can TOGGLE the %K register associated with the key <u>or</u> it can MOMENTARILY turn the %K register ON when the key is pressed.

- **Set RS232 Mode**

This screen contains an editable enumerated parameter that allows the mode of the serial port to be set to one of two modes. The **CsCAN** mode allows Csape to connect to the serial port for uploads, downloads, monitoring and control. The **Update** mode allows a firmware update and factory test utility to be used. When Update mode is selected, the firmware is ready to download when the OK LED flashes. When using Cscape to perform firmware updates, the "Update" mode is <u>not</u> necessary.

- **Set Time/Date**

This screen contains two editable enumerated fields for displaying and modifying the NX's time and date. Each field is subdivided and allows the ↑ and ↓ key to modify the value.

- **Set Beeper**

This screen allows the Beeper to be enabled or disabled by pressing the ↑ and ↓ keys. When enabled, there are two types of beeps.

> **Short Beep** - beeps when a key is pressed.
> **Long Beep** – beeps when a parameter field is disabled.

It is also possible to have the Ladder Program write to the %SR184 Register, which causes beeps to occur. Any value higher than zero enables the beeper. The beeper remains enabled until the value is zero.

- **Set Screen**

This screen allows a screen saver to be enabled or disabled and the timeout for the screen saver to be set. To enable the screen saver, change **Saver Enable** to **Yes**. Edit the **Timeout (min)** to determine the

number of minutes before the screen saver becomes active. This screen also specifies the amount of additional scan added to each logic scan to update graphics. Lower values have less effect on ladder scan time but will affect response time of graphics.

- **Fail – Safe System**

The Fail-Safe System is a set of features that allow an application to continue running in the event of certain types of "soft" failures. These "soft" failures include:
- Battery power loss
- Battery-Backed Register RAM or Application Flash corruption due to, for example, an excessive EMI event.

"Fail-Safe System" menu will open the following menus on the screen:

```
Backup/Restore Data
Enable AutoRun
Enable AutoLoad

(ESC to exit)
```

Backup/Restore Data displays the following options on the screen:

```
 Backup/Restore Data
F1 Backup  F2 Restore
    F3 Clear Backup
     Esc  Exit
```

Backup   Copies Battery Backed RAM contents on to the onboard FLASH memory of the OCS.
Restore   Copies the backed up data from onboard FLASH to the battery backed RAM.
Clear Backup   The backup data will be erased from the onboard FLASH.
Exit   Goes back to previous menu.

"Enable AutoRun" displays the following options which can be selected:

```
Enable AutoRun     No

(******CAUTION******)
( Auto Enters RUN   )
( after AutoLoad    )
( or Battery Fail   )
```

Enable AutoRun   No   OCS will be in IDLE mode after AutoLoad or Automatic Restore.
                        Yes   OCS will be automatically placed into RUN mode after AutoLoad or Automatic Restore.

 "Enable AutoLoad" displays the following options which can be selected:

```
Enable AutoLoad    No

( AutoLoad from     )
( Removable Media's )
( AUTOLOAD.PGM file )
( when triggered    )
```

Enable AutoLoad   No   Does not load AUTOLOAD.PGM automatically when application program is absent or corrupted.
                        Yes   Loads AUTOLOAD.PGM file automatically from RM when application program is absent or corrupted.
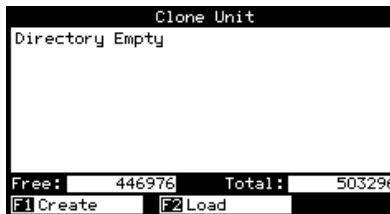
- **Clone Unit**

'Clone Unit' feature allows the user to "clone" the OCS of the exact same model. This feature "clones" application program and unit settings stored in Battery backed RAM of an OCS into the RM (refer Removable Media Chapter 7 for details on using RM). It can then be used to clone a different OCS (exact same model).
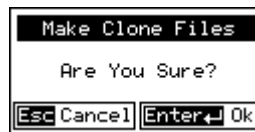
This feature can be used for:

- Replacing an OCS by another unit of the same model.
- Duplicating or "clone" units without a PC.

Clone

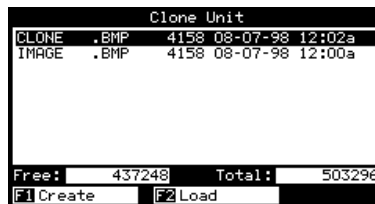Selecting "Clone Unit" menu will open the following menu screen:

```
            Clone Unit
Directory Empty




Free:      446976    Total:      503296
F1 Create      F2 Load
```

Selecting Create Clone brings up the screen below for the user:

```
  Make Clone Files
    Are You Sure?
Esc Cancel  Enter↵ Ok
```

After confirmation, the OCS will create two new files in the root directory of the Removable Media Drive as shown below:

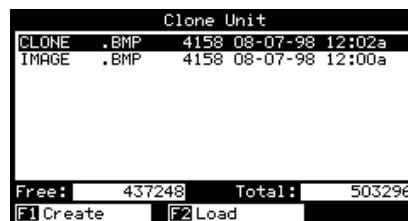**AUTOLOAD.PGM**   Application file
CLONE.DAT   File having all unit settings and register values from Battery Backed RAM

```
            Clone Unit
CLONE  .BMP    4158 08-07-98 12:02a
IMAGE  .BMP    4158 08-07-98 12:00a




Free:      437248    Total:      503296
F1 Create      F2 Load
```

Load Clone

Selecting "Clone Unit" menu will open the following menu screen. Select "Load Clone".

```
            Clone Unit
CLONE  .BMP    4158 08-07-98 12:02a
IMAGE  .BMP    4158 08-07-98 12:00a




Free:      437248    Total:      503296
F1 Create      F2 Load
```

NOTE: For security enabled files, Load clone asks for password validation before loading the application.

CHAPTER 4: KEYPAD AND SCREEN

## 4.1 Remote Screen and Keypad Capability

4.1.1 Cscape Status Bar

When the NX is connected to a PC using Cscape software, *and* the Remote Text Terminal feature is selected, a Cscape Status Bar appears at the bottom of the screen. The Cscape Status Bar can be used to determine if communications have been established between the NX and the Cscape program. Components of the Cscape Status Bar are explained in Figure 5.1.

Message Line - The contents of these messages are context sensitive. The Message line can be empty.

Equal Indicator – indicates whether the current program in Cscape is equal to the program stored in the Target Controller.
- If *Equal*, the program in Cscape is the same as the program stored in the Target Controller.
- If *Not Equal*, the program in Cscape is <u>not</u> the same as the program stored in the Target Controller.
- If **Unknown**, there may have been a change since the last time the program in Cscape was compared to the Target Controller.
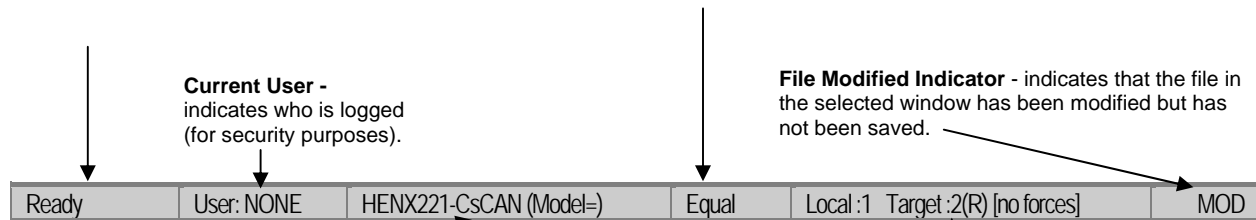
Current User - indicates who is logged (for security purposes).

File Modified Indicator - indicates that the file in the selected window has been modified but has not been saved.

| Ready | User: NONE | HENX221-CsCAN (Model=) | Equal | Local :1 Target :2(R) [no forces] | MOD |

Controller Model - Network (Model Confirmation)

- *Controller Model* indicates the NXfor which the program in Cscape is configured.

- *Network* indicates the type of network that the program in Cscape expects to use (e.g., CsCAN).

- *(Model Confirmation)* provides the following indications:

- **(Model=)** - the actual Target Controller matches the configured Controller Model and Network.

- **(Model Not=)** – the actual Target Controller does <u>not</u> match the configured Controller Model and Network.

- **(Model ?)** – there may have been a change since the last time the Target Controller was compared to the configured Controller Model and Network.

Communications Status - indicates the current status of the "pass through" Connector.

- **Local: xx** – indicates the Network ID of the NX to which the Cscape program is physically connected through its serial port. It can serve as a "pass through" device to other nodes on the network.

- **Target: yy(R)** – indicates the Network ID of the NX with which the Cscape program is exchanging data.
 **Note:** The **Local** unit and **Target** unit can be the same unit or they can be separate units.

  The following are status indicators:

  (R) – Running
  (D) - Do I/o
  (I) – Idle
  (?) – Cscape is not communicating with the remote unit.
  [no forces] – indicates no I/O has been forced.

4.1.2   Establishing Communications using the Remote Text Terminal

1.   Start Cscape software. Press **Screens, Remote Text Terminal**.
2.   Establish communications between the Cscape program and NX by pressing **Controller, Set Network Target ID**.   Set the Target ID.
3.   Again, select **Controller**, **Configure I/O**.   Follow the procedures specified in Chapter 8: I/O Configuration.
4.   Download the program from Cscape to the NX by pressing **Program, Download**.
5.   Check the **Cscape Status Bar** as described in Section 5.1.1 to ensure that the program in Cscape matches the program downloaded to the NX. Be sure to check the Status Bar often. Another way to check that the download occurred is to press **Program, Verify**.
6.   Click on the **System Key** in the display representation and continue the procedures to enter the system menu described in Chapter Four.

4.2   NX Description
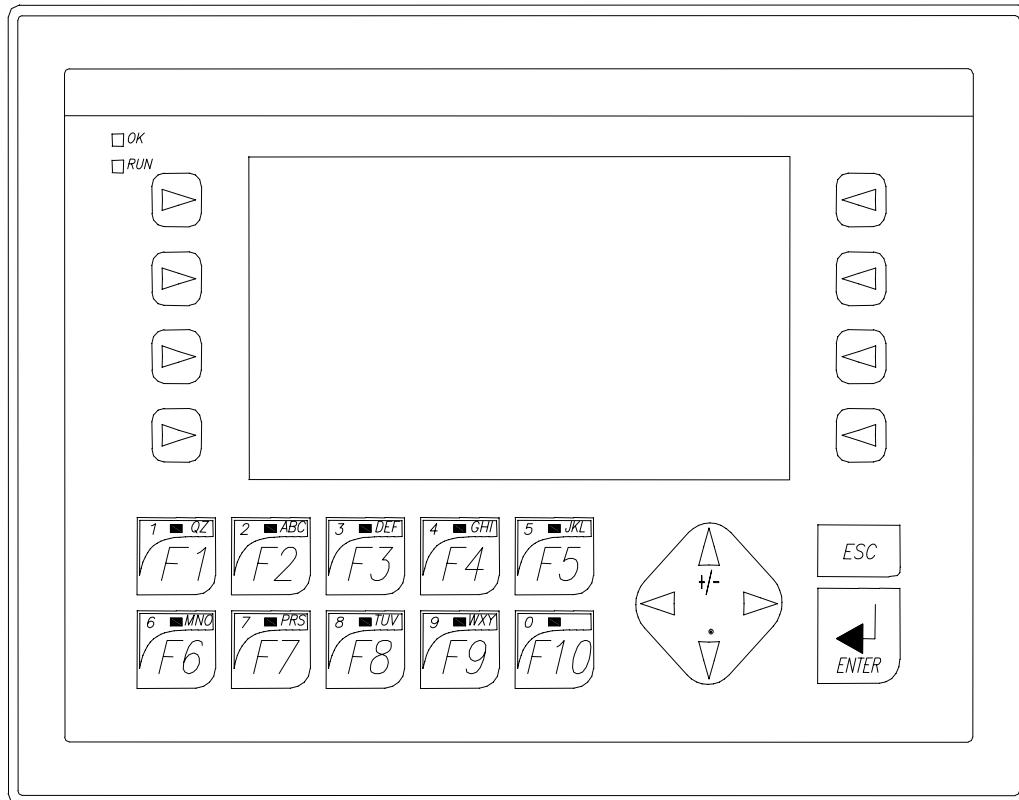
Figure 22 - NX Keypad
(NX25x shown as an Example.)

4.3   User Screens

The NX uses a jump screen object to navigate through screens.

If the ladder program energizes a text coil, the screen associated with this coil is displayed and overrides the normal user screens. This is designed to show alarm conditions or to display other ladder-detected events. When the text coil is de-energized, the previous screen that was being viewed before the alarm is returned.

If the screen contains an editable field, the user can press the **Enter** key to enter the edit mode. When in edit mode, a cursor appears on one digit of the editable field. Use the direction keys ($\leftarrow$ and $\rightarrow$) to move to the cursor to the desired position. Use the $\uparrow$ and $\downarrow$ keys to increment or decrement the digit or enter the number/data with the alphanumeric keys.

If there is more than one field on the screen needing to be edited, use the direction keys ($\leftarrow$ and $\rightarrow$) to move the cursor to the desired location.

The value chosen by the user can <u>not</u> exceed the minimum or maximum set by the user program. If the user tries to exceed the maximum point or enter a value below the minimum point, the value does <u>not</u> change.

Note: If the NX displays >>>>>> in a text field, the value is too big to display in the field or is above the maximum for an editable field. If the NX displays <<<< in a text field, the value is too small to display or is below the minimum for an editable field.

NOTES

CHAPTER 5: SMARTSTACK

5.1   General

Chapter Five provides preliminary configuration procedures, which are common to <u>all</u> SmartStack Modules.

Note: Because the configuration parameters are different for each SmartStack Module, refer to the data sheet that is <u>specific</u> to the selected module.

5.2   Preliminary Configuration Procedures

Note: SmartStack Modules use Cscape Software for configuration.

1.   From the Main Menu, select **Controller|I/O Configure**.
        Note: The look of the screen varies depending upon the type of controller that appears.

2.   **First, ensure that the desired controller is selected.**
        In this case, a different controller is desired than the one shown on the screen. It is necessary to select the desired controller, which is the NX22x-CcCAN/HSC. Continue with Step 2.

        However, if you are satisfied with the controller selection, press a **Base #** tab. Go to Step 3
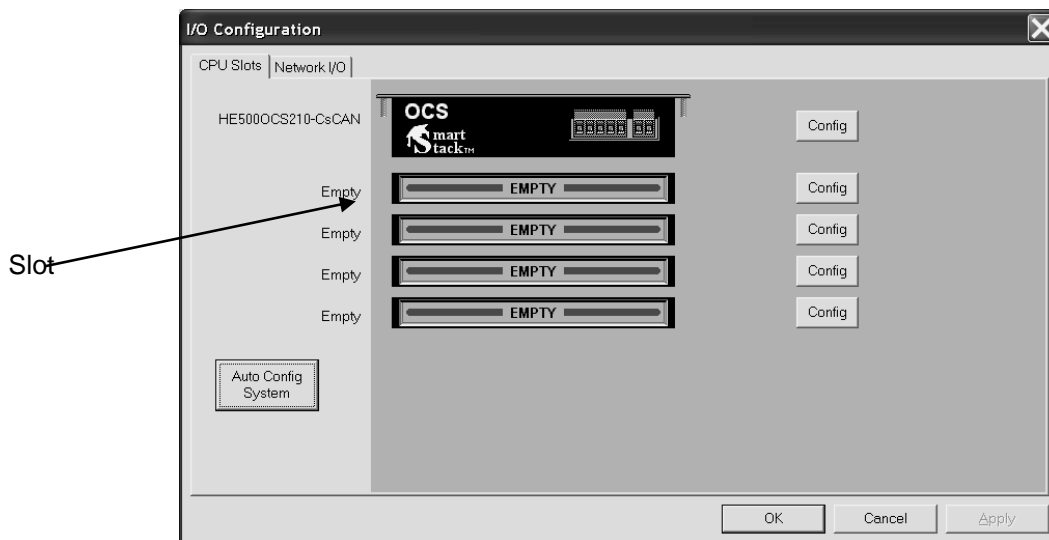

Figure 23 - Main Configuration I/O Screen

Note: The **Auto Config System** button can be pressed *prior* to selecting the desired controller *and* I/O. By pressing the button, the settings are deleted from any controller *and* I/O that is physically connected to the PC. A dialog box appears and indicates that settings will be deleted from currently configured models. If OK, press **Yes**. Then press **OK**.

Selecting a Different Controller

To select a different controller, ensure that the **CPU Slots** tab is pressed. Then, click on the slot or the **Config** button. The Configure Controller screen appears.
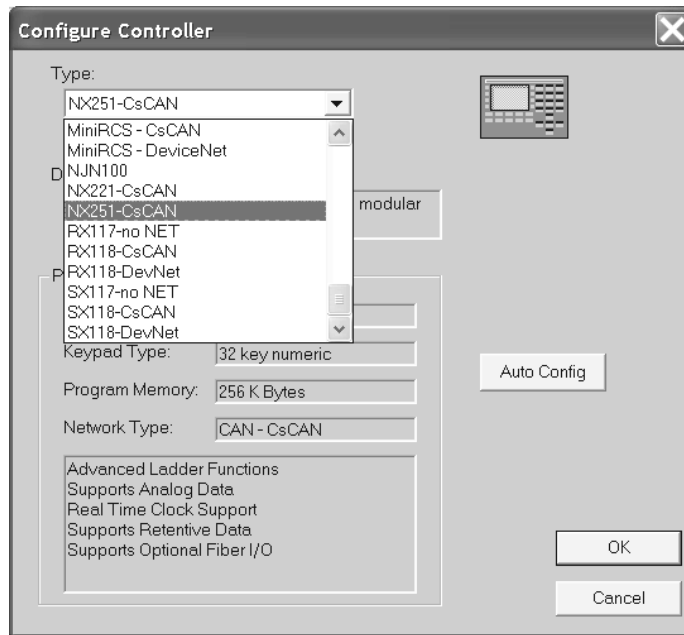

Figure 24 – Selecting a Controller

To select a different controller, click on the **Type** list box and select the desired controller. Then press OK. If satisfied with the controller now selected, press **Base #** tab at the top of the screen (similar to Figure 23 except an NX model is selected). Then, go to Step 3.

Note: The **Auto Config** button can be pressed *prior* to selecting the desired controller. By pressing the button, the settings are deleted from any controller that is physically connected to the PC.

3.   Figure 25 appears.   In this configuration example, I/O modules are going to be selected and configured for Base 2.

Any Base can be selected. It is <u>not</u> necessary to select bases in a specific order.

The **Main** base contains the slots directly located on the back of the NX.
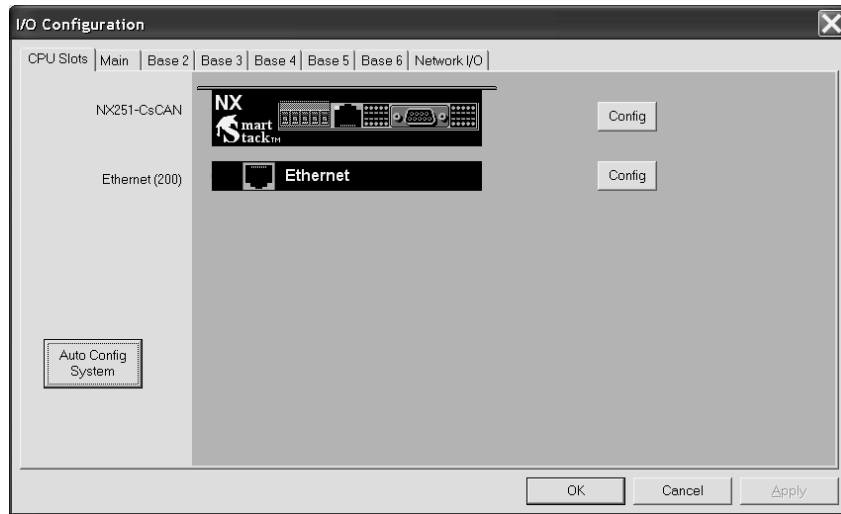
Figure 25 – Main Base Screen appears with Ethernet

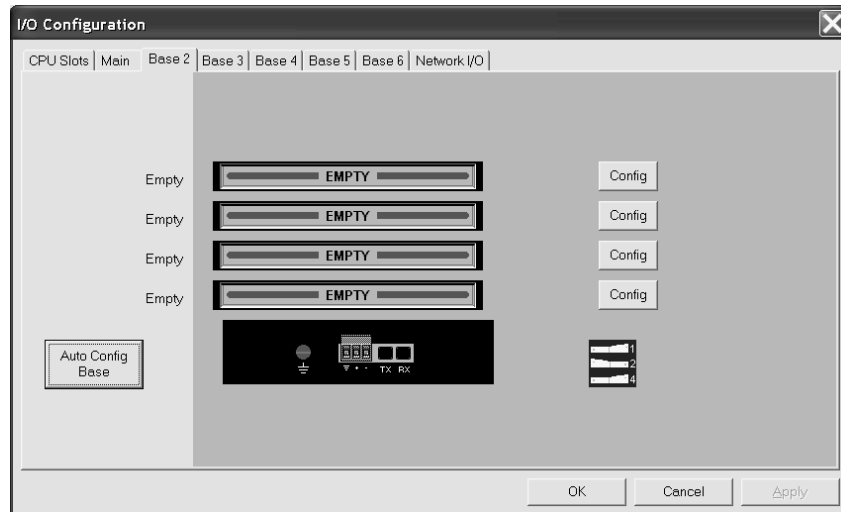Upon pressing the Base 2 tab, the following screen appears.

Figure 26 – Base 2 Selected

Double-click on a slot or press the **Config** button located next to the slot. The following screen appears. Select a tab at the top of the screen, and then select an I/O module. (For this example, the **DIQ612** is going to be selected.) Press **OK**.
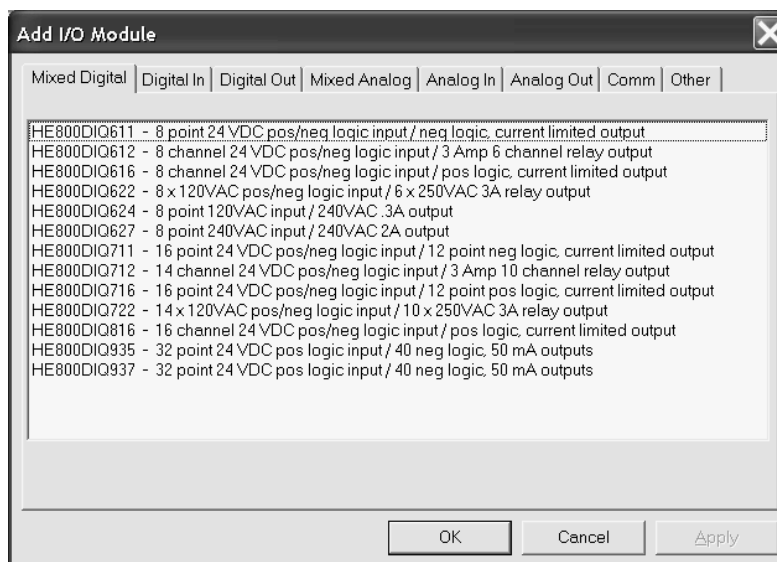
Figure 27 – Selecting an I/O Module

4.   The following screen appears.
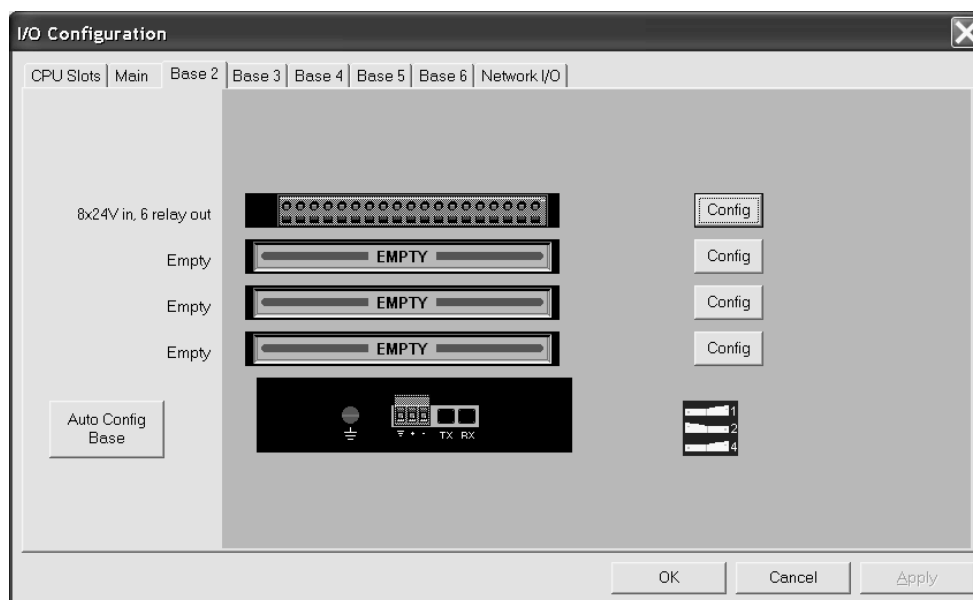
Figure 28 – Base 2 with an I/O Module Selected

The description and properties of the I/O module are provided. If satisfied with the selections, press **OK**.

> **Note:** If a module already occupies a slot and a different module is desired, right-click on the slot and press **Replace**. To leave a slot empty, right-click on the slot and press **Delete**. By right-clicking on a slot, its configuration can be **copied** into another slot on the same base (or a different base) and **pasted** into a new slot.

5.   The Module Configuration Screen appears (Figure 29). Two tabs are available for selection:
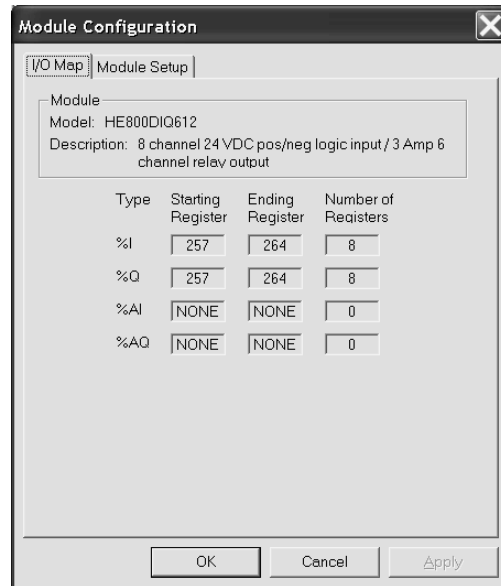
Figure 29 – I/O Map Tab

a.   I/O Map Tab

The **I/O Map** describes the I/O registers assigned to a specific I/O module. Although there are no user-defined parameters, the I/O Map can be viewed <u>after</u> the SmartStack module is configured to review the registers.

- Model number   Provides the part number.
- Description   Describes the number of input and output channels and other key characteristics of the module.
- Type: Displays the register types assigned to the module.
- Starting Location: Denotes the starting location of the register type.
- Ending Location: Denotes the ending location of the register type.
- Number: Indicates the quantity of a particular register type.

Note: Do <u>not</u> confuse the described number of input and output channels with the numbers found in the Type column (i.e., %I and %Q). The numbers do <u>not</u> necessarily match.

b.   **Module Setup Tab**

Note: The Module Setup screen varies according to the module selected. Users make selections based upon requirements. Guidelines that are specific to the module are provided in individual data sheets. **It is important to consult the datasheet for specific details pertaining to the Module Setup tab.**
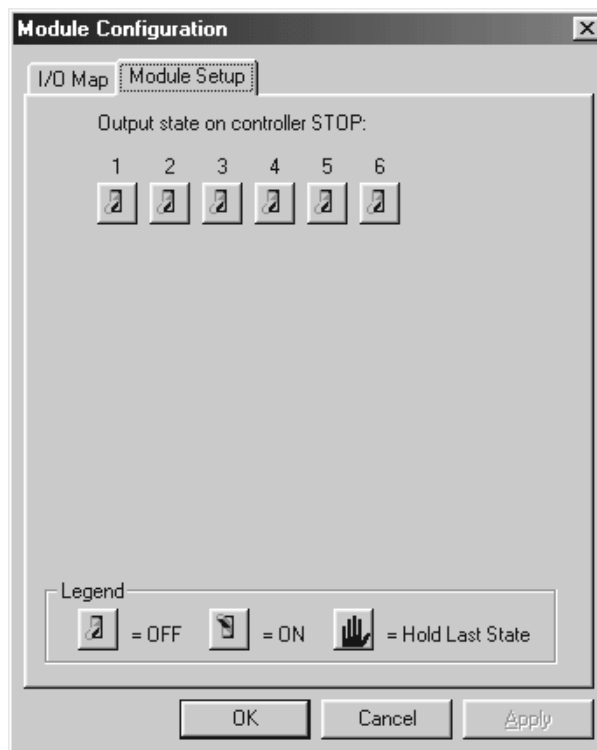
Figure 30 – Module Setup Tab Selected

The **Module Setup** is used in applications where it is necessary to change the default states of the outputs when the controller (e.g., NX) enters idle/stop mode. The default turns the outputs OFF when the controller enters idle/stop mode. By selecting the Module Setup tab, each output can be set to either turn ON, turn OFF or to hold the last state. Generally, most applications use the default settings.

Warning: The default turns the outputs OFF when the controller enters idle/stop mode. To avoid injury of personnel or damages to equipment, exercise extreme caution when changing the default setting using the **Module Setup** tab.

6.   Depending upon the I/O module selected, additional configuration procedures can be required. Be sure to consult the individual data sheet to determine if a supplement is available for the specific module. Supplements provide configuration information and cover other important topics pertaining to a specific module.

CHAPTER 6: SMARTSTIX I/O

6.1   General

Chapter Seven covers SmartStix I/O programming and configuration parameters.

6.2   SmartStix I/O Introduction

SmartStix I/O is a family of low-cost Remote I/O devices that are designed to extend the I/O capabilities of **Control Station** products, such as **NX**, **MiniOCS**, **OCS** and **RCS**. SmartStix I/O Modules connect to Control Station devices via the **CsCAN Network** and communicate using **CsCAN Protocol**.

Devices with **CsCAN Network** ports that are connected to each other for peer-to-peer communication are called **CsCAN Nodes**. A device that is connected to a CsCAN Node's programming port for master-slave supervisory communication is called a **CsCAN Host**. For example, SmartStix I/O Modules and NX are CsCAN Nodes while a PC running Cscape is a CsCAN Host.

6.3   SmartStix I/O Modules

SmartStix I/O Modules are devices that exchange data with NX over the CsCAN Network and control and monitor physical I/O points.

To control physical outputs, data is sent by an NX to the SmartStix I/O Module using CsCAN Directed Data Messages. To monitor physical inputs, an NX receives data from the SmartStix I/O Module using CsCAN Global Data Messages.

In addition to I/O control and monitoring, configuration and status data can be exchanged between an NX and a SmartStix I/O Module.

For example, an NX can send configuration data to a SmartStix I/O Module to tell it how often to expect output control data, and what to do if the NX stops sending output control data. Also, an NX can receive status data from a SmartStix I/O Module indicating if it needs configuration or if a fault has been detected.

All this is accomplished by using the PC-based Cscape programming tool to program the NX. Since the NX dynamically configures the SmartStix I/O Module, SmartStix I/O Modules can be readily deployed without having to configure them first.

6.4   BASIC SMARTSTIX PROGRAMMING

6.4.1   Using GET and PUT

6.4.1.1 Get Remote I/O Function Block

This function handles receiving data from a remote I/O device and places the received data in a set of registers specified by the user. This function passes power flow if the function is actively receiving data / heartbeat messages from the remote I/O device. This function stops passing power flow if it has <u>not</u> received data / heartbeat messages from the remote I/O device for 2000 milliseconds.

A remote I/O device consists of a CsCAN device such as a SmartStix Module that transmits global data and receives directed network data.

Figure 31 – Get Remote I/O Function Block and Parameter Screen

6.4.1.2   Get Remote Parameter Description:

ID – This is the network ID of the remote I/O from which to receive data. This can be a constant from 1 to 253 or a 16-bit register.

Digital / Analog – These radio buttons allow choosing digital or analog network data. Remote I/O devices with discrete inputs/outputs normally require digital data. Remote I/O devices such as voltage, current or thermocouple would require analog data.

Destination Data Address – This is the location to start placing data received from the remote I/O device. The number of registers used is defined by the **Num Words** parameter in this section. Any valid read/write OCS reference types can be used (%R, %AI, %I, %M, etc.).

Status – This 16-bit register is used internally.   It must <u>not</u> written by any other function block. Use the power flow from this function for the pass/fail status.

Num Words – This is the number of words to receive from the remote I/O device. Up to four words can be received from the remote I/O device. The function of these words are described in **Table 6.1**.

Table 6.1 - Consumed / Produced Parameter Descriptions		
Consumed Directed Digital Data Words	**Function**	**Affects**
Word 1 (bits 1 to 16)	Controls on/off state of digital outputs 1-16.	Relay or Digital output SmartStix
Word 2 (bits 17 to 32)	Controls on/off state of digital outputs 17-32.	Relay or Digital output SmartStix
Word 3 (bits 33 to 48)	Specifies whether SmartStix uses default configuration or values from Word 4.	Relay and Digital input and output
Word 4 (bits 49 to 64)	Sets digital inputs / heartbeat and life expectancy time data.	Relay and Digital input and output
Word 5 (bits 65 to 80)	Sets the default state of outputs 1-16.	Relay and Digital output
Word 6 (bits 81 to 96)	Sets the default state of outputs 17-32.	Relay and Digital output
Word 7 (bits 97 to 112)	Determines if default state is on or off for outputs 1-16.	Relay and Digital output
Word 8 (bits 113 to 128)	Determines if default state is on or off for outputs 17-32.	Relay and Digital output
Produced Global Digital Data Words	**Function**	**Affects**
Word 1 (bits 1 to 16)	On/off state of inputs 1-16.	Digital input SmartStix
Word 2 (bits 17 to 32)	On/off state of inputs 17-32.	Digital input SmartStix
Word 3 (bits 33 to 48)	Status bits and diagnostic data	Relay or Digital input and output
Word 4 (bits 49 to 64)	Device class number and firmware identifier sent by SmartStix module.	Relay or Digital input and output

Note: **Table 6.1** summarizes SmartStix I/O module consumed and produced data words. For advanced users, refer to page 59 - 62 for sections describing the consumed and produced words in detail.

6.4.1.3   *Put Remote I/O Function Block*

This function handles sending data to a remote I/O device block obtained from a set of registers specified by the user. This function passes power flow if the remote I/O device is behaving normally. This function does <u>not</u> pass power flow if the remote I/O device has <u>not</u> sent a heartbeat in 2000 milliseconds. This function sends heartbeat messages to the output device every 1000 milliseconds. The default remote I/O operation is to expect heartbeat messages at least every 2000 milliseconds; otherwise the outputs are turned off (or their configured default state). Data is normally transmitted on change of state or if the remote I/O device is power-cycled.

A remote I/O device consists of a CsCAN device such as SmartStix Modules that transmit global data and receive directed network data.
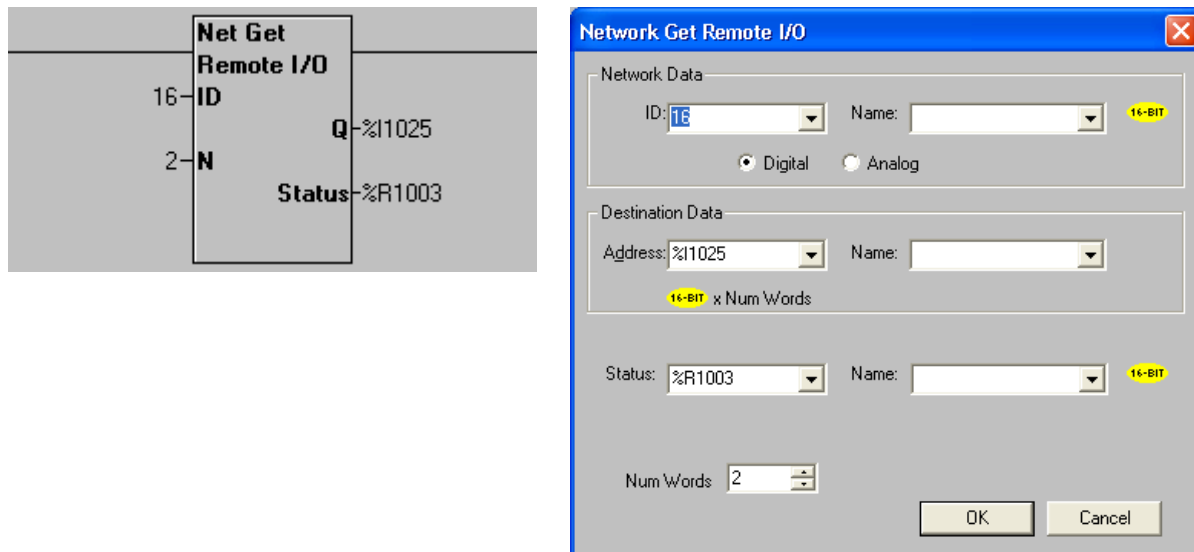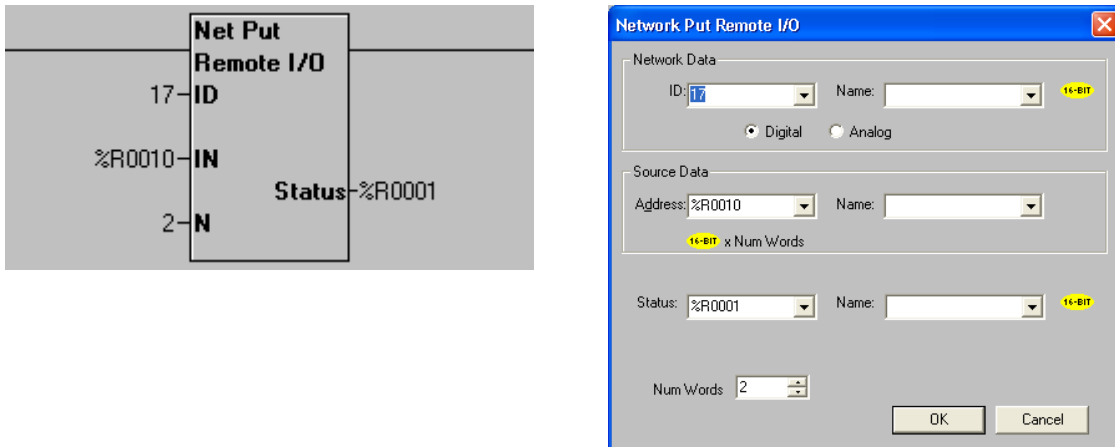

Figure 32 - Put Remote I/O Function Block and Parameter Screen

6.4.1.4   Put Remote Parameter Description:

ID – This is the network ID of the remote I/O to direct the sent data. This can be a constant from 1 to 253 or can be a 16-bit register.

Digital / Analog – These radio buttons allow choosing digital or analog network data. Remote I/O devices with discrete inputs/outputs normally require digital data. Remote I/O devices such as voltage, current or thermocouple require analog data.

Source Data Address – This is the starting location to get data to send to the remote I/O device. When this data changes state, it is sent to the remote I/O device. The number of registers used is defined by the *Num Words* parameter in this section. Any valid OCS reference types can be used (%R, %AQ, %Q, %M, etc.).

Status – this 16-bit register is used internally. It must <u>not</u> be written by any other function block.

Bit 1-12 – reserved or internal use only
Bit 13   – Remote I/O OK and in sync with supplied data
Bit 14 – the Remote I/O detected a heartbeat error
Bit 15 – the Remote I/O has just powered up
Bit 16 – the function is forcing a send (unit just power cycled or first scan)

Num Words – This is the number of words to send to the remote I/O device. Up to 8 words can be sent to the remote I/O device. The function of these words are described starting with **Table 6.1**.

6.5   SmartStix I/O Default Operation

SmartStix I/O has been designed so that its default operation satisfies the most common applications. This keeps the user interface simple and makes the product easy to use. The default operation is summarized in **Table 6.2**. To change the default operator, see *Advanced SmartStix Programming* (page 59).

Table 6.2 – SmartStix I/O Default Operation	
Digital Input Devices	
Data Reporting Method	Change of State
Heartbeat Generation Interval	1000msec.
Digital Output Devices	
Update Method (using NETPUT Remote I/O Function block)	Change of State
Heartbeat Generation Interval	1000msec.
(LET) Life Expectance Time (Receipt of Heartbeat)	2000msec.
(LET) Action Upon Expiration	Turn all outputs OFF

ADVANCED SMARTSTIX PROGRAMMING

6.6   SmartStix I/O Module Device Classes

There are currently five SmartStix I/O Module device classes (0, 1, 2, 3 and 7) that control and monitor Digital I/O points and exchange Directed and Global Data words with an NX via the CsCAN Network.

Table 6.3 shows the five device classes along with the number of Digital I/O points they contain and the number of Directed and Global Data words they exchange.

Example: Determining the class of a SmartStix module using Table 6.3:

1. Select the number of digital output points and the number of digital input points using **Table 6.3**.
2. Upon doing so, the device class is located in the same row as the digital outputs and inputs; the words consumed and produced are also shown for that device class.

Table 6.3 – SmartStix I/O Module Device Classes				
Device Class	**Digital Output Points**	**Digital Input Points**	**Directed Data Words Consumed**	**Global Data Words Produced**
0	16	0	8	4
1	0	16	8	4
2	16	16	8	4
3	0	32	8	4
7	32	0	8	4
All other device classes are reserved for future products.				

Note that although all of the above device classes can **consume** eight Directed Data Words and can **produce** four Global Data words, each device class **uses** a specific subset of this data.

The following terms are defined:
Consumed Data: Directed Data received by a SmartStix I/O Module *from* an NX
Produced Data: Global Data transmitted by a SmartStix I/O Module *to* an NX

Table 6.1 summarizes SmartStix I/O module consumed and produced data words. For advanced users, the following sections describe the consumed and produced words in detail.

6.7   SmartStix I/O Module Consumed (Received) Directed Data

Table 6.4 – Consumed Directed Data Word 1															
16-bit Word															
8-bit High Byte								8-bit Low Byte							
Digital Output Control Data – Low Word															
Q16	Q15	Q14	Q13	Q12	Q11	Q10	Q9	Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1

Q16…Q1   Controls the Off / On state of the SmartStix I/O Module's 1st 16 Digital Outputs, if any.

Table 6.5 – Consumed Directed Data Word 2															
16-bit Word															
8-bit High Byte								8-bit Low Byte							
Digital Output Control Data - High Word															
Q32	Q31	Q30	Q29	Q28	Q27	Q26	Q25	Q24	Q23	Q22	Q21	Q20	Q19	Q18	Q17

Q32…Q17 Controls the Off / On state of the SmartStix I/O Module's 2nd 16 Digital Outputs, if any.

Table 6.6 – Consumed Directed Data Word 3								
16-bit Word								
8-bit High Byte				8-bit Low Byte				
Diagnostic Command Data				Configuration Command Data				
Reserved for Future Products						CIT	CHT	CLT

CLT = 0   Command the SmartStix I/O Module to set its Life Expectancy Time to 2.0 seconds, as the maximum time to wait between NX to SmartStix I/O Module output control data messages, before setting all Digital Outputs to their default states.

CLT = 1   Command the SmartStix I/O Module to use Word 4's Life Expectancy Time. In this case, a value of 0.0 disables the Life Expectancy feature.

CHT = 0   Command the SmartStix I/O Module to set its Heartbeat Send Time to 1.0 second, as the minimum time between SmartStix I/O Module to NX Heartbeat messages.

CHT = 1   Command the SmartStix I/O Module to use Word 4's Heartbeat Send Time. In this case, a value of 0.0 disables the Heartbeat Send feature.

CIT = 0   Command the SmartStix I/O Module to send its Digital Input data to the NX, only when the Digital Inputs change state.

CIT = 1   Command the SmartStix I/O Module to use Word 4's Digital Input Send Time, to determine how often to periodically send its Digital Input data to the NX.   In this case, a value of 0.0 disables *automatic* sending of Digital Input data.

> **Note:**   Regardless of the CIT setting, Digital Inputs are always sent to the NX when the SmartStix I/O Module powers-up, and when specifically requested by the NX.

Table 6.7 – Consumed Directed Data Word 4	
16-bit Word	
8-bit High Byte	8-bit Low Byte
Digital Input / Heartbeat Send Time Data	Life Expectancy Time Data
0.0 to 25.5 seconds = Minimum Send Interval	0.0 to 25.5 seconds = Maximum Receive Interval

See Directed Data Word 3's CLT, CHT and CIT command descriptions above.

Table 6.8 – Consumed Directed Data Word 5															
16-bit Word															
8-bit High Byte								8-bit Low Byte							
0 = Force Off / On 1 = Hold-Last-State								Default Digital Output Data - Low Word							
H16	H15	H14	H13	H12	H11	H10	H9	H8	H7	H6	H5	H4	H3	H2	H1

H16…H1 Determines default state of the SmartStix I/O Module's 1st 16 Digital Outputs, if any, when the configured Life Expectancy Time expires. If an H bit is 1, its corresponding Digital Output, by default, holds its last state. If an H bit is 0, its corresponding Digital Output is forced Off or On, depending on the corresponding F bit in Word 7 (Table 6.10).

Table 6.9 – Consumed Directed Data Word 6															
16-bit Word															
8-bit High Byte								8-bit Low Byte							
0 = Force Off / On 1 = Hold-Last-State								Default Digital Output Data - High Word							
H32	H31	H30	H29	H28	H27	H26	H25	H24	H23	H22	H21	H20	H19	H18	H17

H32…H17 Determines default state of the SmartStix I/O Module's 2nd 16 Digital Outputs, if any, when the configured Life Expectancy Time expires. If an H bit is 1, its corresponding Digital Output, by default, holds its last state. If an H bit is 0, its corresponding Digital Output is forced Off or On, depending on the corresponding F bit in Word 8 (Table 6.11).

Table 6.10 – Consumed Directed Data Word 7															
16-bit Word															
8-bit High Byte								8-bit Low Byte							
0 = Force Off 1 = Force On Default Digital Output Data - Low Word															
F16	F15	F14	F13	F12	F11	F10	F9	F8	F7	F6	F5	F4	F3	F2	F1

F16…F1 Determines default Off or On state of each of the SmartStix I/O Module's 1st 16 Digital Outputs, if any, when the configured Life Expectancy Time expires, and when the corresponding H bit in Word 5 (Table 6.8) is 0.

Table 6.11 – Consumed Directed Data Word 8															
16-bit Word															
8-bit High Byte								8-bit Low Byte							
0 = Force Off 1 = Force On Default Digital Output Data - High Word															
F32	F31	F30	F29	F28	F27	F26	F25	F24	F23	F22	F21	F20	F19	F18	F17

F32…F17 Determines default Off or On state of each of the SmartStix I/O Module's 2nd 16 Digital Outputs, if any, when the configured Life Expectancy Time expires, and when the corresponding H bit in Word 6 (Table 6.9) is 0.

6.8   Consumed Directed Data Power-Up Initialization

At power-up, the SmartStix I/O Module's eight Consumed Directed Data words are all cleared to 0. Until Directed Data is actually received from an NX, the SmartStix I/O Module will exhibit the following behavior:

1. All Digital Outputs are Off, until Q data is received from an NX.
2. The device expects to receive Q data at least every two seconds.
3. The device transmits a Heartbeat every second.
4. The device transmits its Digital Input data, only when the Digital Inputs change state.
5. If Q data is received, and then not received for 2 seconds, the outputs go Off again.
6. At power-up, a request for Directed Data is transmitted to the CsCAN Network.

6.9   SmartStix I/O Module Produced (Transmitted) Global Data

Table 6.12 – Produced Global Data Word 1															
16-bit Word															
8-bit High Byte								**8-bit Low Byte**							
Digital Input Status Data - Low Word															
I16	I15	I14	I13	I12	I11	I10	I9	I8	I7	I6	I5	I4	I3	I2	I1

I16…I1   Monitors the Off / On state of the SmartStix I/O Module's 1st 16 Digital Inputs, if any.

Table 6.13 – Produced Global Data Word 2															
16-bit Word															
8-bit High Byte								**8-bit Low Byte**							
Digital Input Status Data - High Word															
I32	I31	I30	I29	I28	I27	I26	I25	I24	I23	I22	I21	I20	I19	I18	I17

I32…I17   Monitors the Off / On state of the SmartStix I/O Module's 2nd 16 Digital Inputs, if any.

Table 6.14 – Produced Global Data Word 3															
16-bit Word															
8-bit High Byte								**8-bit Low Byte**							
Module Fault Data				**Network Fault Data**				**Configuration Status Data**							
PUP	I/O	ROM	RAM	LIFE	ID	DUP	NAK						SIT	SHT	SLT

SLT   CLT command status; matches CLT when command is complete
SHT   CHT command status; matches CHT when command is complete
SIT   CIT command status; matches CIT when command is complete

NAK   Network Acknowledge test failed; found no other Network devices
DUP   Network Duplicate ID test failed; found another Network device with our Network ID
ID   Network ID test failed; Network ID rotary switches illegally set to 00, FE or FF
LIFE   Network Life Expectancy Time has expired; outputs are in default state

RAM   Module RAM test failed; found a RAM memory fault during power-up-self-test
ROM   Module ROM test failed; found a ROM memory fault during power-up-self-test
I/O   Module I/O test failed; found an I/O fault during power-up-self-test
PUP   Module just powered up; using default configuration; outputs are Off

Table 6.15 – Produced Global Data Word 4	
16-bit Word	
8-bit High Byte	**8-bit Low Byte**
Firmware Revision Status Data	**Device Identification Status Data**
0.00 to 2.55 = Version Number	0 to 255 = Device Class Number

Device Class Number   SmartStix I/O Module's numeric product identifier (see Table 6.3)
Version Number   SmartStix I/O Module's numeric firmware identifier

6.10   Produced Global Data Power-Up Initialization

At power-up, a SmartStix I/O Module's four Produced Global Data words are initialized as follows:

1.   Digital Inputs are read and loaded into Words 1 and 2.
2.   Power-up-self-test result is loaded into Word 3; if tests passed, only PUP bit is On.
3.   Module's Device Class Number and Version Number are loaded into Word 4.
4.   All four Produced Global Data words are transmitted to the CsCAN Network.

6.11 SmartStix I/O Module LED Indicators

SmartStix I/O Modules provide diagnostic and status LED indicators

6.11.1 Diagnostic LED Indicators

The MS an NS diagnostic LEDs indicate the fault status of the module and the network, respectively. Note that the diagnostic LEDs correspond directly to the Module Fault and Network Fault bits as shown in Table 6.14.

The following table shows the possible LED states and their meanings:

Table 6.16 – SmartStix I/O Module Diagnostic LED Indicators		
Diagnostic LED	**State**	**Meaning**
MS (Module Status)	Solid Red	RAM or ROM test failed (RAM or ROM bit On)
	Blinking Red	I/O test failed (I/O bit On)
	Blinking Green	Module is in power-up state (PUP bit On)
	Solid Green	Module is running normally (all Module Fault bits Off)
NS (Network Status)	Solid Red	Network Ack or Dup ID test failed (NAK or DUP bit On)
	Blinking Red	Network ID test failed (ID bit On)
	Blinking Green	Module is in Life Expectancy default state (LIFE bit On)
	Solid Green	Network is running normally (all Network Fault bits Off)

6.11.2 Status LED Indicators

In addition to the MS and NS diagnostic LED indicators described above, SmartStix I/O Modules also provide a Power Status LED, which illuminates Red when power is applied to the module.

Also, there are I/O Status LED indicators for each of the Digital I/O points, which illuminate Red when the I/O point is On.

6.12 SmartStix I/O Module Network ID

Each SmartStix I/O Module (as well as all other CsCAN Nodes on the CsCAN Network) must be assigned a unique Network ID number, to arbitrate network data exchanges.

Since a Network ID is a number in the range 1 to 253, up to 253 CsCAN Nodes can be logically connected to a CsCAN Network. However, the use of standard CAN transceiver chips, limits the number of physically attached devices to 64. Thus, to reach the logical limit of 253 devices, up to three smart CAN repeaters (HE200CGM100) are used, to connect groups of devices together.

Assigning a SmartStix I/O Module's Network ID is accomplished by setting its two hexadecimal (base 16) Network ID rotary switches, which are labeled HI and LO. Each rotary switch has 16 positions, labeled 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and F, where A through F represent the decimal values 10 through 15. The Network ID rotary switches are set as follows:

$$\text{Network ID} = (\text{Network ID}_{HI} \times 16) + \text{Network ID}_{LO}$$

This allows the Network ID to be set to any number from 0 to 255. However, since Network IDs 0, 254 and 255 (00, FE and FF) are reserved for other purposes, they are illegal settings for a SmartStix I/O Module. If a SmartStix I/O Module's rotary switches are set for an illegal Network ID, a default Network ID of 253 will be used, the ID Network Fault bit will be On, and the NS LED will blink Red.

NOTES

CHAPTER 7: USING COMPACTFLASH™ MEMORY CARDS

7.1   General

Chapter Seven provides an overview of the CompactFlash feature in NX OCS models and Cscape Software.

Note: For detailed information regarding CompactFlash function blocks and parameters, refer to the help file in Cscape Software.

7.2   Compact Flash Overview

All NX OCS models provide a slot for a CompactFlash memory card. The CompactFlash manager is a graphical object that allows viewing the filenames, size and dates of files and directories on a CompactFlash card. The operator can optionally change directories, delete files and format a new flash cards. This object also supplies status information such as color change on card OK, card full and card missing status. The file view includes total card capacity and remaining free space.

7.2.1   Accessing Files with an NX OCS

a.   Insert a CompactFlash card into the NX OCS CompactFlash slot.
b.   If not formatted, use the CompactFlash Manager object to format the card.
c.   The NX OCS ladder application program can **read** and **write** to the CompactFlash card. The file is saved as a .csv file, which is compatible with several PC applications such as Excel.

7.2.2   Accessing Files with a PC

a.   Insert or connect the CompactFlash memory card to the PC according to the manufacturer's instructions.
b.   The PC typically sees the CompactFlash card as a removable storage device like a small solid-state hard drive. Files can be read from and written to the CompactFlash card in the same way they are read/written to a standard hard disk. The only file format that can be read or written by an OCS application is a .csv (comma separated value) file.

7.3   CompactFlash Function Blocks in Cscape

Note: For detailed information regarding CompactFlash function blocks and parameters, refer to the help file in Cscape Software.

The following CompactFlash functional blocks are available in Cscape Software.

a.   Read CompactFlash csv
This function allows reading of a comma-separated value file from the CompactFlash interface into the controller register space. The file format of the value file uses commas to separate values.

b.   Write CompactFlash csv

This function allows writing of a comma-separated value file to the CompactFlash interface from the controller register space. The file format of the value file uses commas to separate values.

c.   **Rename CompactFlash csv**

This function allows renaming a file on the CompactFlash card. The data in the file is <u>not</u> changed.

d.   **Delete CompactFlash csv**

This function allows deleting a file on the CompactFlash card.

7.4   Configuring CompactFlash Manager in Cscape

The CompactFlash Manager is a graphical object that allows viewing filenames, size and dates of files, and directories on a CompactFlash card. The operator can optionally change directories, delete files, and format new flash cards. This object also supplies status information such as **Color change on card OK**, **Card full**, and **Card missing** status. For additional information, refer to **Cscape Help File**; select **Cscape Reference Manua**l, and then select ***Using Graphics Editor***.

7.5   Filenames Used with the CompactFlash Function Blocks

The OCS CompactFlash function blocks support the flash with a DOS/Windows standard FAT-16 file system. All names must be limited to the "eight dot three" format where the filename contains eight characters a period then a three-character extension.

The entire filename including any path must be less than or equal to 147 characters.

When creating filenames and directories it is sometimes desirable to include parts of the current date or time. There are six special symbols that can be entered into a filename that are replaced by the OCS with current time and date information.

Table 7.1 – Filename Special Symbols		
Symbol	**Description**	**Example**
$Y	Substitutes the current 2 digit year	2004 = 04
$M	Substitutes the current month with a 2 digit code	March = 03
$D	Substitutes the current day	22nd = 22
$h	Substitutes the current hour in 24 hour format	4 pm = 16
$m	Substitutes the current minute	
$s	Substitutes the current minute	

Note that all the symbols start with the dollar sign ($) character. Date symbols are in upper case, time symbols are in lower case.

The following are examples of the substituted time/date filenames:

Current date and time: March 1, 2004 3:45:34 PM

Filename: Data$M$D.csv = Data0301.csv

Filename: Year$Y\Month$M\aa$D_$h.csv = Year04\Month03\aa01_15.csv

Filename: Month_$M\Day_$D\$h_$m_$s.csv = Month_03\Day_01\15_45_34.csv

7.6 System Registers used with CompactFlash

%SR175 Status – This shows the current status of the CompactFlash interface.

Possible status values are shown in the table:

Table 7.2 – CompactFlash Status Values	
0	CompactFlash interface OK
1	Card present but unknown format
2	No card in slot
3	Card present, but not supported
4	Card swapped before operation was complete
5	Unknown error

%SR176 Free Space – This 32-bit register shows the free space on the ComapactFlash card in bytes.

%SR178 Card Capacity – This 32-bit register shows the total card capacity in bytes.

NOTES

CHAPTER 8: BUILT-IN HIGH SPEED I/O (HSC / PWM)

8.1 Overview

The NX models with Built-in High Speed I/O (NX222 / NX252) provide a variety of standard and complex applications as shown in **Table 8.1**.

Table 8.1 – Built-in High Speed I/O Applications and Procedural Overview			
Input Functions			
Application	**Counter 1**	**Counter 2**	**How?**
Totalizer 16 Bits (1 HSC input)		√	1. Choose up to 2 input functions. Perform Built-in High Speed Configuration Procedures using Cscape Software (page 72). Either configure Counter 1 and 2 as totalizers <u>or</u> configure Counter 1 for Frequency Measurement and Counter 2 as a totalizer <u>or</u> configure only one counter depending upon the function required.
Totalizer 32 Bits (1 HSC input)	√		2. Re-assign registers in accordance with the features chosen in the configuration.
Frequency Measurement (1 HSC input)	√		3. Wire the I/O port connector in accordance with the features chosen in the configuration.
Output Function			
Application	**Counters**		**How?**
PWM (2 PWM Outputs)	Not Applicable		1. <u>No</u> Built-in High Speed Configuration Procedures are required. 2. Assign values into the register map for Duty Cycle and frequency out. See examples on page 71 3. Wire the I/O port connector in accordance with the features chosen in the configuration.

8.2 Glossary

|	
Accumulator	Register used to accumulate or store up a sum or count of many items or events.
Clear	A special function to zero out the value in a specific register. (Not used with Frequency Counter.)
Disable	A special function to trigger counter to stop.
Encoder	A sensor or transducer for converting rotary motion or position to a series of electronic pulses
Frequency Input	The number of times an electromagnetic signal repeats an identical cycle in a unit of time, usually one second.
Latch (strobe)	A special function that uses a digital logic circuit to store one or more bits. A latch has a data input, a clock input and an output. When the clock input is active, data on the input is "latched" or stored and transferred to the output register either immediately or when the clock input goes inactive. The output retains its value until the clock goes active again.
Marker	Indicate a particular position on a display surface or a value in an instrument.
Polarity	A Polarity pull-down box is associated with each function and indicates the manner in which the trigger happens (e.g., High level, Low Level, Falling Edge, Rising Edge).
Preload (load)	A special function used to trigger loading of a value into a register upon an event. (Not used with Frequency Counter.)
Quadrature	A high speed device that expresses the phase relationship between two periodic quantities of the same period when the phase difference between them is one fourth of a period. A coupler in which the two output signals are 90° out of phase.
Totalizer	A counter that sums the total number of cycles applied to its input.

8.3   I/O Port

001NX008
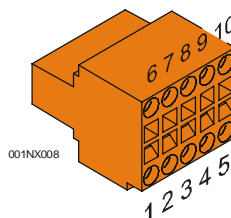
Figure 33 – I/O Port (HSC)Terminal Connector

Table 8.2 – I/O Port Pins (HSC / PWM) (Orange Connector)		
Pin	**Signal**	**Description**
1	TTL In1	HSC 1 / 5 V Input 1 (See Note*)
2	TTL In2	HSC 2 / 5 V Input 2 (See Note*)
3	TTL In3	HSC 3 / 5 V Input 3 (See Note*)
4	In3	HSC 3 / 24 V Input 3 (See Note*)
5	0 V	Ground (For best performance, use separate supply and isolated ground.)
6	In1	HSC 1 / 24 V Input 1 (See Note*)
7	In2	HSC 2 / 24 V Input 2 (See Note*)
8	Out1	Output 1 / PWM 1
9	Out2	Output 2 / PWM 2
10	+24 V	Power for Outputs
Note* - Depending on the output of the application, use 5 V (e.g., TTL In1) _or_ 24 V (e.g., In1) _per channel._		

8.4   I/O Specifications

Table 8.3 – Specifications for NX with Built-in High Speed I/O				
INPUT				
Input Voltage Ranges	TTL / 5 VDC	24 VDC	**Input Type**	Positive Logic
			Peak Voltage	5.5 VDC Max. @ 5 VDC Input 35 VDC Max. @ 24 VDC Input
ON Voltage Level	+ 2 VDC	+ 12 VDC	**Input Impedance**	4.7k ohms @ 5 VDC 27k ohms @ 24 VDC
OFF Voltage Level	+ 1 VDC	+ 5 VDC	**Maximum Frequency Response**	500 kHz, 50 kHz, 5 kHz
OUTPUT				
Operating Voltage	10 - 28VDC		**Minimum Load**	None
Output Type	Sourcing / 10K Pull-Down Positive Logic		**OFF to ON Response**	5 μs
Maximum Load Current Per Output	100 mA Maximum		**ON to OFF Response**	50 ns
			Output Characteristics	Current Sourcing
Maximum Voltage Drop	2 VDC		**Output Protection**	Short Circuit

8.5 NX Register Mapping

Note: Unlike a typical OCS, you can assign registers for the built-in high speed feature in the NX.

Table 8.4 – I/O Register Map for NX with Built-in High Speed I/O.		
Starting Analog In		
Default Reference	**Offset with Respect to Analog In field**	**Function**
%AI0385-0386	Offset 0 and Offset 1	Counter/Frequency Accumulator for CNT 1
%AI0387	Offset 2	Accumulator for CNT 2
%AI0389-0390	Offset 3 and Offset 4	Latch Register for CNT 1
Starting Analog Out		
Default Reference	**Offset with Respect to Analog Out field**	**Function**
%AQ0385-0386	Offset 0 and Offset 1	PreLoad Register for CNT 1
%AQ0387-0390	Offset 2 and Offset 3	Reserved
%AQ0391	Offset 4	Out 1 Duty Cycle (0 to 32000)
%AQ0392	Offset 5	Out 2 Duty Cycle (0 to 32000)
%AQ0393	Offset 6	Out 1 Frequency (0 to 65,535) Zero is manual output control
%AQ0394	Offset 7	Out 2 Frequency (0 to 65,535) Zero is manual output control
Starting Digital In		
Default Reference	**Offset with Respect to Digital In field**	**Function**
%I1537-1539	Offset 0 and Offset 1, 2	External input states
%I1540	Offset 3	Overflow status flag for CNT 1
%I1541	Offset 4	Underflow status flag for CNT 1
Starting Digital Out		
Default Reference	**Offset with Respect to Digital Out field**	**Function**
%Q1537	Offset 0	Latch trigger for CNT 1
%Q1538	Offset 1	Preload trigger for CNT 1
%Q1539	Offset 2	Clear trigger for CNT 1
%Q1540	Offset 3	Preload disable for CNT 1 (1-Disable)
%Q1541	Offset 4	Counter disable for CNT 1
%Q1542	Offset 5	Latch disable for CNT 1 (1-Disable)
%Q1543	Offset 6	Underflow/overflow reset (1-Reset)
%Q1544	Offset 7	Counter Direction for CNT 1 (1-Up)
%Q1545	Offset 8	Clear trigger for CNT 2
%Q1546	Offset 9	Counter disable for CNT 2 (1-Disable)
%Q1547	Offset 10	Counter direction for CNT 2 (1-Up)

8.5.1 PWM Examples

Example 1

To get a 50% Duty Cycle @ 10 kHz waveform:

Set %AQ391 = 16,000
Set %AQ393 = 10,000

Example 2

To get a 25% Duty Cycle @ 1 kHz waveform:

Set %AQ392 = 8,000
Set %AQ394= 1,000

8.6   Cscape Configuration for HSC / Frequency Measurement

8.6.1   Preliminary Configuration Procedures

Note: Although the example configuration in this section shows how to configure the NX22x- CsCAN/HSC, it applies to any NX controller that has *built-in* HSC.

1.   From the main menu in Cscape, software, select **Controller|I/O Configure**.

2.   Ensure that the desired controller is selected.
              -In this case, a different controller is shown than the one that is desired. Continue with Step 2.
              -If the controller you want to use is already selected, go to Step 3.

Note: The **Auto Config System** button can be pressed *prior* to selecting the desired controller *and* I/O. By pressing the button, the current settings are deleted from the configuration within Cscape, and the I/O is then set to what is physically contained in the attached controller. A dialog box appears and indicates that settings will be deleted from the configuration within Cscape. If OK, press **Yes**. Then press **OK**.
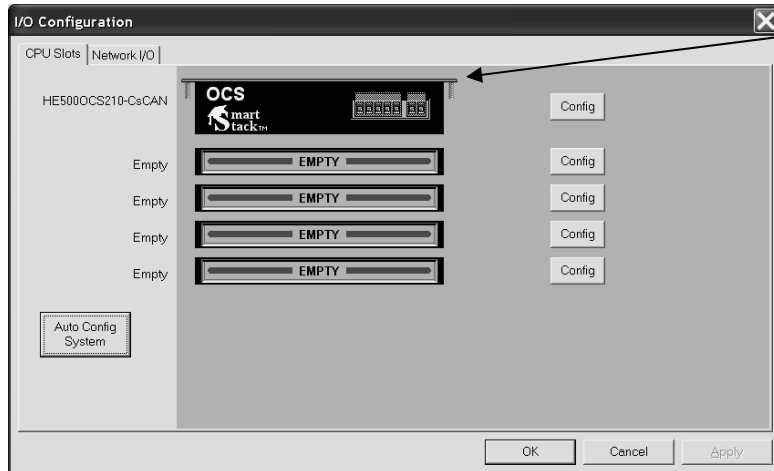
Figure 34 – Main Configuration I/O Screen

2.a To change the controller, click on the controller or the **Config** button next to it. The **Configure Controller** screen appears .

2.b To select a different controller, click on the **Type** list box and select the desired controller. Press **OK**. Then, go to Step 3.
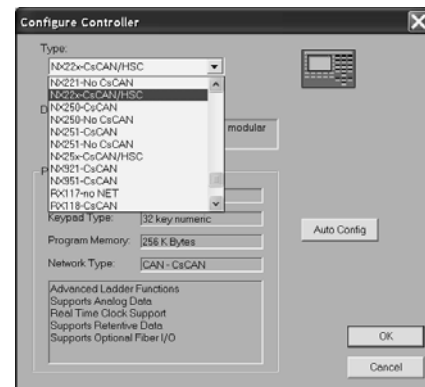
Figure 35 – Selecting a Controller
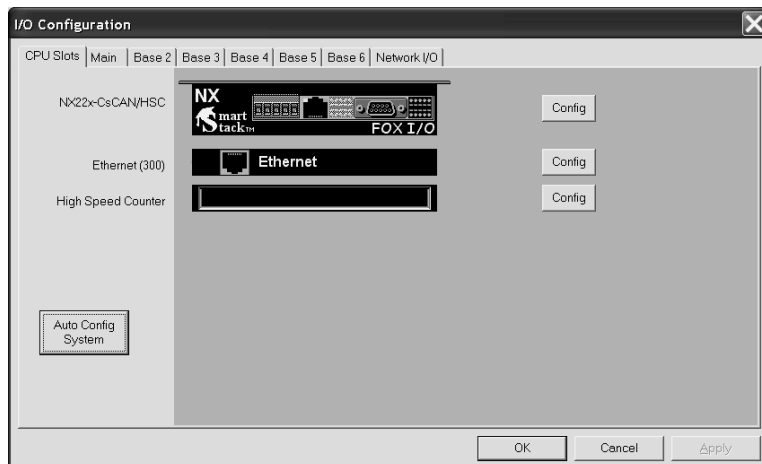
Figure 36 – Screen with Desired Controller Selected

Tabs on the I/O Configuration Screen

The CPU Slots tab is already pressed in this screen allowing you to view and configure the controller and any built-in I/O including HSC.

For I/O that is <u>not</u> built-in to the NX:
Press the Main tab to configure and view the I/O in the slots directly located on the back of the NX.

Press any **Base** tab to configure and view I/O in the slots located on a remote FOX base. It is <u>not</u> necessary to select bases in a specific order.

3. If satisfied with the controller now selected, click the **High Speed Counter** slot or the **Config** button next to it.
   Note: In this example configuration, Ethernet is <u>not</u> used, but it is available for use.

4. The **Module Configuration** screen appears with two tabs at the top: Press the **HSC Setup** tab.

8.6.2   Configuration Procedures

Two NX HSC counters are available that have the following functions depending upon configuration:
Counter #1 – Totalizer (32-Bit) or Frequency Counter.
Counter #2 – Totalizer (16-Bit) only.

Both Counter #1 and Counter #2 can be configured for use.

Configuring Counter #1:
1. Select **Totalize** or **Frequency** from the **Type** pull-down box.

a. If Totalize is chosen: Select how the counter counts by choosing an option from the **Mode** pull-down box.

   Internal (10 MHz Clock)
   Count up (Inputs 1 and 2)
   Count down (Inputs 1 and 2)
   Up/down (Input 1 up, Input 2 down)
   Clock/dir (Input 1 clock, dir from Input 2)
   Clock/dir (Input 1 clock, dir from %Q)
   Quadrature (Inputs 1 and 2)

b. If Frequency is chosen: Select a time base option for counting from the **Frequency Period** pull-down box.

Note: The Frequency counter measures the counts per frequency period. If **Frequency Period** is set to one second, the counts are in Hz.

2. Select the functions that apply to the counter.
Functions show the sources from where triggers come from to disable, latch, preload, or clear the counter.

Note: Not all functions are available in both types of counters as indicated by the following descriptions.

♦ Disable Function -Triggers counter to stop.
♦ Latch Function –Triggers snapshot of the accumulator value upon an event.
♦ Preload Function –(Not used in Frequency Counter) Triggers loading of a value upon event.
♦ Clear Function–(Not used in Frequency Counter) Triggers the accumulating register to be zeroed out.

The functions each have a pull-down box with the following options:

   Disabled
   External Input #1
   External Input #2
   External Input #3
   Overflow Interrupt – Triggers when the accumulator value goes beyond the maximum value (rolls over).
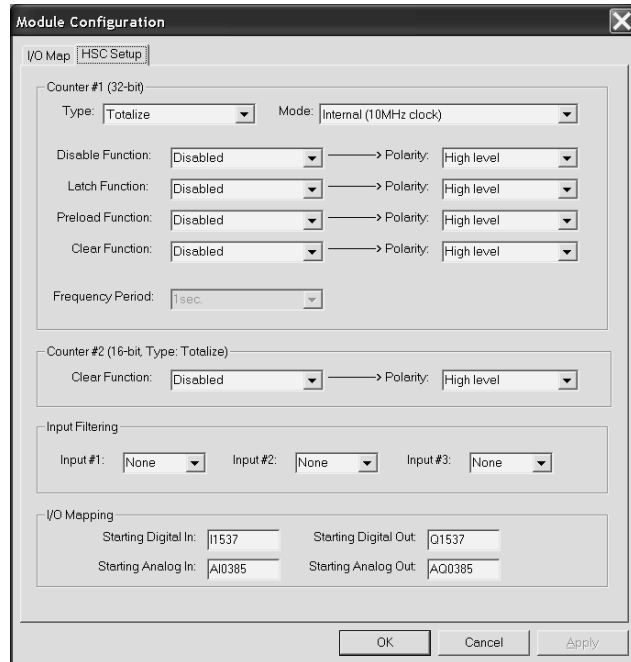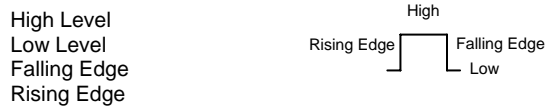   Underflow Interrupt – Triggers when signal goes below zero.
   Assigned %Q

Figure 37 – Built-In HSC Configuration Screen

3..Select a **Polarity** option. A Polarity pull-down box is associated with each function and indicates the manner in which the trigger happens. The options for *Latch, Preload, and Clear* are:

   High Level
   Low Level
   Falling Edge
   Rising Edge

The options for *Disable* are High or Low Level.

4. Select input filtering options for the three high-speed inputs from the **Input Filtering** pull-down box. Example: If 500 kHz is selected, any frequency above 500 kHz is filtered.

5. I/O Mapping – Allows the user to set where the HSC data is mapped. Default references are set automatically and are initially shown on the screen until the user changes them. See Runtime I/O Map at the end of this configuration procedure.

6. If satisfied with selections, press **OK**. Cscape configuration is completed for this example.
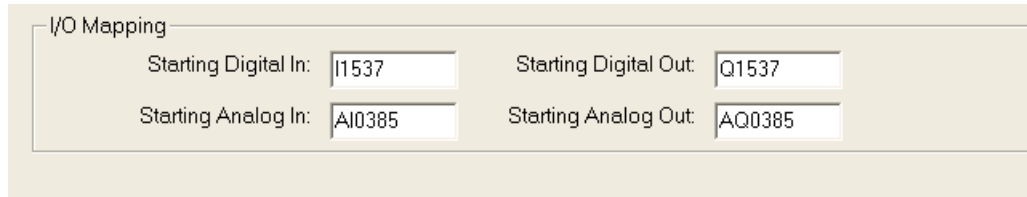
Configuring Counter #2:

Configuring Counter #2 uses the same procedure for configuring Counter #1 as a Totalizer counter. To configure Counter #2, start at the beginning of the **Configuration Procedures** section.

Note: The only function available for Counter #2 is the *Clear Function*.

8.6.3   Run-time I/O Map

This is a close-up taken from the bottom of the Built-in HSC configuration screen shown in **Figure 37**.

Remember, the **I/O Mapping** fields allow you to set where the HSC data is mapped. Default references are set automatically and are initially shown on the screen until you change them.

Figure 38 – Close-up of the I/O Mapping Section

CHAPTER 9: FAIL – SAFE SYSTEM

9.1   Overview

The Fail-Safe System is a set of features that allow an application to continue running in the event of certain types of "soft" failures. These "soft" failures include:

- Battery power loss
- Battery-Backed Register RAM or Application Flash corruption due to, for example, an excessive EMI event.

The Fail-Safe System has the following capabilities:

- Manually backup the current Battery-Backed RAM Register Settings into Flash memory.
- Manually restore Register Settings from the values previously backed up in Flash to Battery-Backed RAM.
- Detect corrupted Register Settings at power-up and then automatically restore them from Flash.
- Detect corrupted or empty application in Flash memory at power-up and then automatically load the AUTOLOAD.PGM application file from Removable Media (Compact Flash or MicroSD).
- If an automatic Register Restore or Application Load occurs, the OCS can automatically be placed in RUN mode

The fail-safe system can be accessed by going to the system menu of the controller. A new menu "Fail-Safe System" has been added at the end of the main system menu for this. Selecting "Fail-Safe System" menu will open the following menus on the screen:

```
Backup/Restore Data
Enable AutoRun
Enable AutoLoad

(ESC to exit)
```

Figure 9.1 Fail – Safe System Menu

9.2   Settings

To use the fail – safe feature, the user needs to do the following:

1. Backup the current Battery-Backed RAM Register contents in On-Board Flash memory using System Menu options.
2. From Cscape, create AUTOLOAD.PGM for the application program using 'Export to Removable Media'.
3. Place the Removable Media with AUTOLOAD.PGM in the device.
4. Set the 'Enable AutoLoad' option in the device to YES.
5. Set the 'Enable AutoRun' option to YES if the controller needs to be placed in RUN mode automatically after automatic restore of data or AutoLoad operation.

9.3   Backup / Restore Data

Selecting this option brings up a screen having four operations:
- Backup OCS Data.
- Restore OCS Data.
- Clear Backup Data.
- Exit

Figure 9.2 Backup / Restore Data

Backup OCS Data:

When initiated, this will allow the user to manually copy Battery-Backed RAM contents on to the onboard FLASH memory of the OCS. This will have the effect of backing up all the registers and controller settings (Network ID, etc.) that would otherwise be lost due to a battery failure.
%SR164.4 is set to 1 when backup operation is performed.

Figure 9.3 Backup Registers

Restore OCS Data:

When initiated, this will allow the user to manually copy the backed up data from the onboard FLASH to the Battery-Backed RAM.
A restore operation will be automatically initiated if a backup has been previously created and on power-up the Battery-Backed RAM registers fail their check.

The following process will be followed for restoring data:
- The controller will be placed in IDLE mode.
- Data will be copied from onboard FLASH to OCS Battery-Backed RAM
- The controller will reset.
- The controller will be put in RUN mode if the AutoRun setting is 'Yes' else it will remain in IDLE mode.
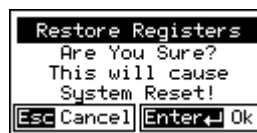

Figure 9.4 Restore OCS Data

%SR164.3 is set to 1 only when an automatic restore operation is performed - not on a manual one. This bit is reset to 0 when a new backup is created.

Restoring of data can be manually performed by selecting RESTORE option from the Backup / Restore Data menu. This will cause the controller to reset.

Clear Backup Data:

When initiated, the backup data will be erased from the onboard Flash and no backup will exist. %SR164.4 and %SR164.3 is reset to 0 when backed up data is erased.

```
┌─────────────────────────┐
│      Clear Backup       │
│                         │
│      Are You Sure?      │
│                         │
│ [Esc]Cancel [Enter↵]Ok  │
└─────────────────────────┘
```

Figure 9.5 Clear Backup Data

Exit: Goes back to the previous screen.

The OCS follows the following sequence in execution of Automatic Restore:

```
                        ┌───────────────────────┐
                       (    OCS Power Cycle      )
                        └───────────┬───────────┘
                                    │
                        ┌───────────┴───────────┐
                        │ Battery Backed RAM    │
                        │ Registers check failed│
                        └───────────┬───────────┘
                                    │
                               ╱────┴────╲              NO
                              ╱  Backup   ╲─────────────────────────┐
                              ╲  exists?  ╱                         │
                               ╲────┬────╱                         │
                                    │ YES                          │
                        ┌───────────┴───────────┐      ┌───────────┴───────────┐
                        │  Controller placed in │      │     Application       │
                        │      IDLE mode        │      │   Program erased      │
                        └───────────┬───────────┘      └───────────┬───────────┘
                                    │                              │
          ┌─────────────────────────┴─────────────────────────┐   │
          │ Data copied from Onboard FLASH to OCS Battery backed│   │
          │                     RAM                            │   │
          └─────────────────────────┬─────────────────────────┘   │
                                    │                              │
                        ┌───────────┴───────────┐                 │
                        │   Controller Resets   │                 │
                        └───────────┬───────────┘                 │
                                    │                              │
                               ╱────┴────╲         NO    ┌─────────┴─────────┐
                              ╱ AutoRun   ╲─────────────▶│ OCS put in IDLE   │
                              ╲ Enabled?  ╱              │      Mode         │
                               ╲────┬────╱               └───────────────────┘
                                    │ YES
                        ┌───────────┴───────────┐
                        │  OCS put in RUN Mode  │
                        └───────────────────────┘
```
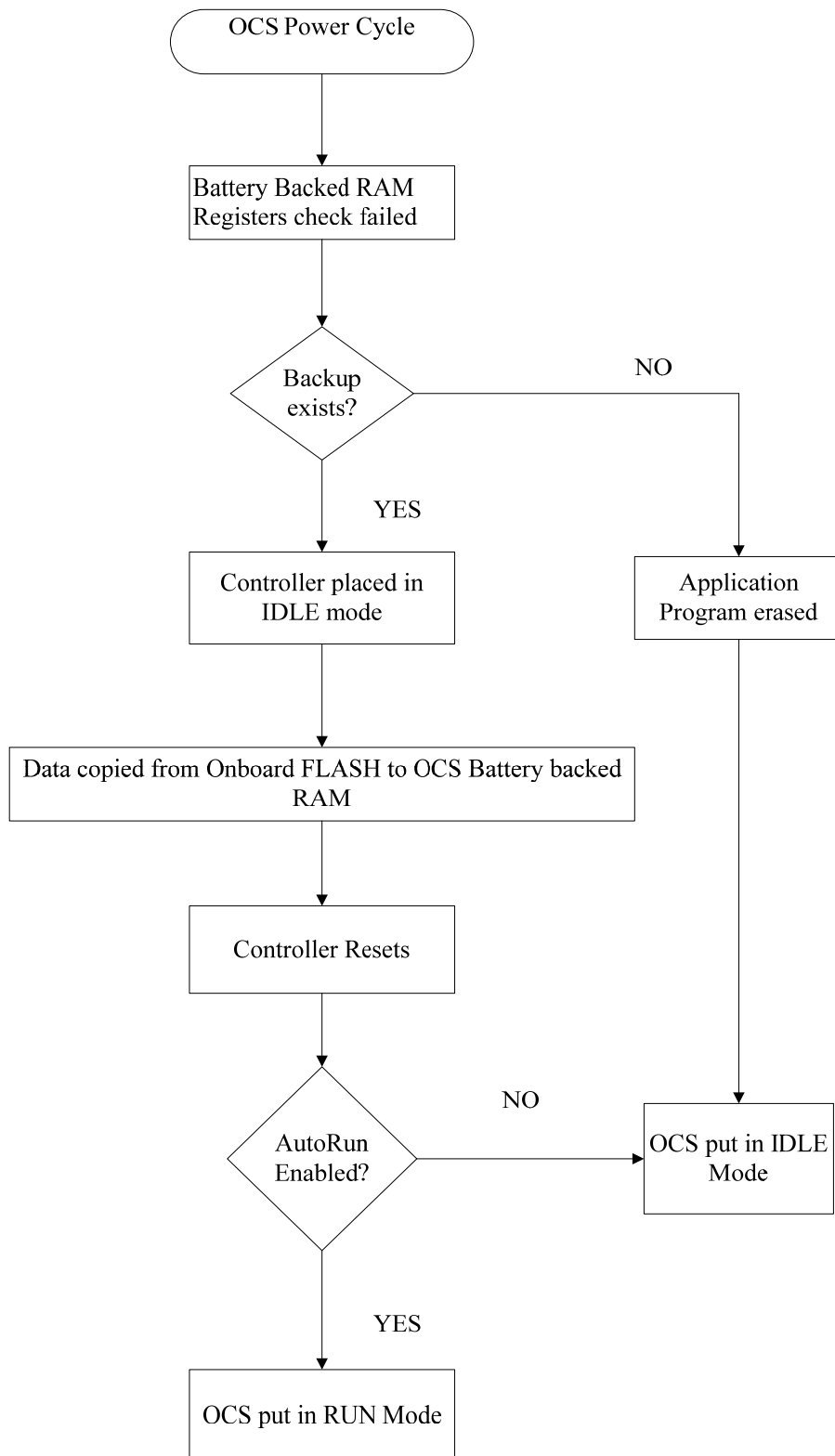
Figure 9.6 Flow Chart for Automatic Restore

9.4 AutoLoad

```
Enable AutoLoad   No

( AutoLoad from     )
( Removable Media's )
( AUTOLOAD.PGM file )
( when triggered    )
```

Figure 9.7 AutoLoad Menu

This system menu option allows the user to specify whether the OCS automatically loads the application AUTOLOAD.PGM located in Removable Media.

When the AutoLoad setting is enabled (set to YES), it can either be manually initiated or automatically initiated at power-up.

The automatic initiation will happen only in the following two cases:
- When there is no application program in the OCS and a valid AUTOLOAD.PGM is available in the removable media of the device.
- When the program residing in onboard memory is corrupted and a valid AUTOLOAD.PGM is available in the removable media of the device.

AutoLoad can be manually initiated when the SYS-F3 key is pressed (OCS can be in any of the following mode – Idle / Run / DOIO). This also requires a valid AUTOLOAD.PGM to be present in the removable media of the device.

When the AutoLoad setting is not enabled (set to NO), OCS will be in IDLE mode and the application is not loaded.

If the AUTOLOAD.PGM is security enabled, the user will be prompted to enter the password before loading the application. The application will be loaded from the Removable media only after getting the correct password.

%SR164.6 can be set to enable AutoLoad feature.

The OCS follows the following sequence in execution of AutoLoad:

```
                          ┌─────────────────────┐
                          │    Power up OCS      │
                          └─────────────────────┘
                                    │
                                    ▼
                    ┌───────────────────────────────┐
                    │  Application Program absent    │
                    │              or                │
                    │  Application Program corrupted │
                    └───────────────────────────────┘
                                    │
                                    ▼
                              ◇ AutoLoad ◇          NO        ┌──────────────────────┐
                              ◇ Enabled? ◇ ──────────────────▶│  OCS put in IDLE mode │
                                    │                         └──────────────────────┘
                                   YES
                                    │
                                    ▼
                        ◇ AUTOLOAD.PGM present in ◇   NO      ┌──────────────────────┐
                        ◇ the RM of the device ?  ◇ ────────▶│ AutoLoad run sequence │
                                    │                         │ failed (with reasons │
                                   YES                        │     for failure)      │
                                    │                         └──────────────────────┘
                                    ▼
                    ┌───────────────────────────────┐
                    │      AutoLoad initiated.       │
                    └───────────────────────────────┘
                                    │
                                    ▼
                              ◇ AutoRun  ◇         NO        ┌──────────────────────┐
                              ◇ Enabled? ◇ ──────────────────▶│  OCS put in IDLE Mode │
                                    │                         └──────────────────────┘
                                   YES
                                    │
                                    ▼
                    ┌───────────────────────────────┐
                    │     OCS put in RUN Mode        │
                    └───────────────────────────────┘
```
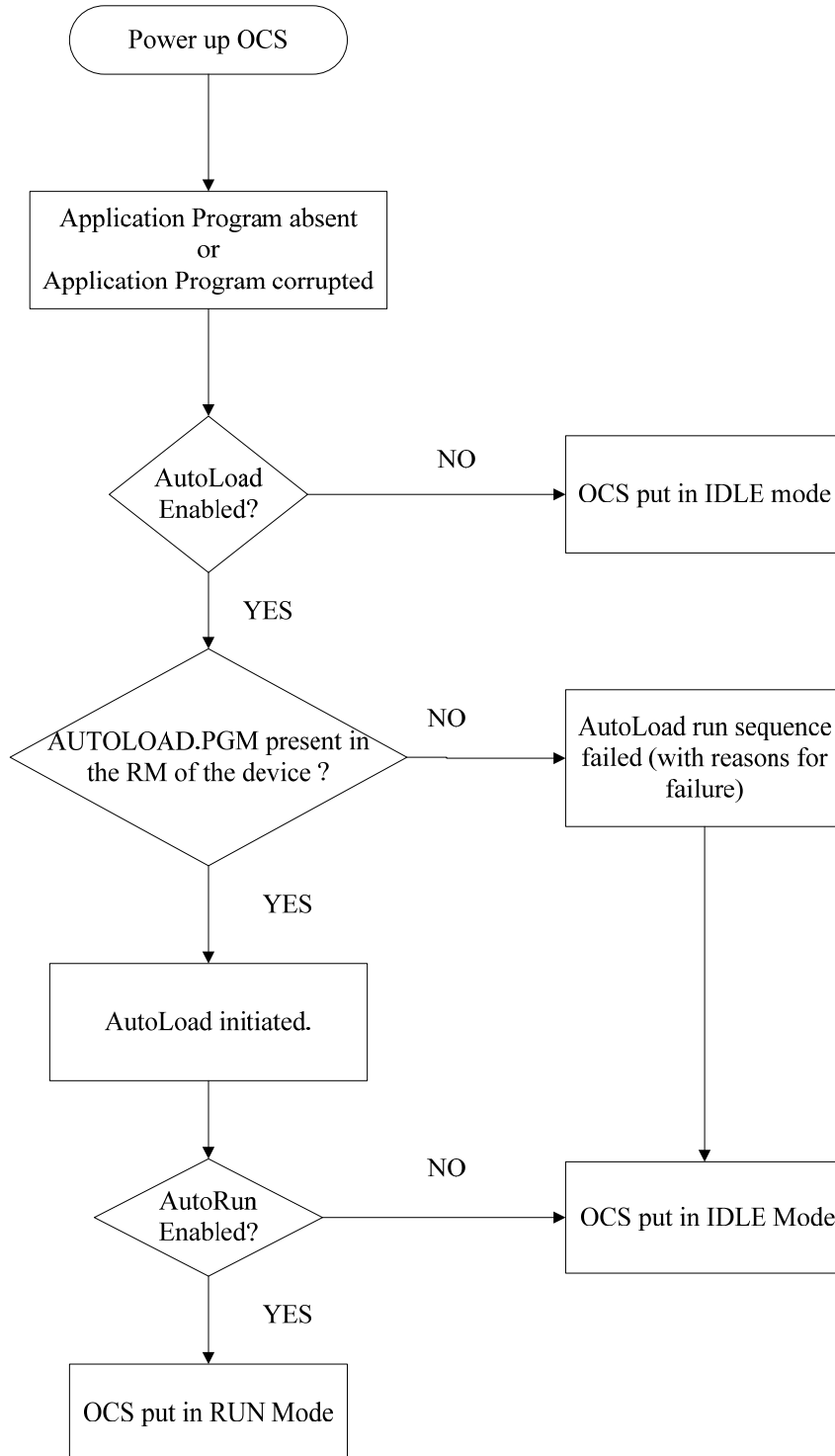
Figure 9.8 Flow Chart for AutoLoad

9.5 AutoRun

```
Enable AutoRun     No

(******CAUTION******)
( Auto Enters RUN   )
( after AutoLoad    )
( or Battery Fail   )
```

Figure 9.9 AutoRun Menu

This system menu option, when enabled (YES), allows the user to automatically place the OCS into RUN mode after the AutoLoad operation or automatic Restore Data operation.

When the AutoRun setting is disabled (NO), the OCS remains in the IDLE mode after a Restore Data or AutoLoad operation.

%SR164.5 can be set by putting the system into RUN mode automatically, once an AutoLoad has been performed or an Automatic Restore has occurred.

If for any reason the AutoLoad-Run (Loading the AUTOLOAD.PGM automatically and OCS put in RUN mode) sequence does not succeed, a pop-up message box saying "AUTO-LOAD-RUN SEQUENCE FAILED" will be displayed. It will also show the reason for its failure. On acknowledging this message box the AutoLoad-Run sequence will be terminated, controller will return to the first user-screen and will be placed in IDLE mode.

NOTES

CHAPTER 10: CLONE UNIT

10.1   Overview

'Clone Unit' feature allows the user to "clone" the OCS of the exact same model. This feature "clones" application program and unit settings stored in Battery backed RAM of an OCS into the RM (refer Removable Media Chapter 7 for details on using RM). It can then be used to clone a different OCS (exact same model).

This feature can be used for:

- Replacing an OCS by another unit of the same model.
- Duplicating or "clone" units without a PC.

10.2   Clone

User needs to perform the following to Clone:

1. The 'Clone Unit' can be accessed by going to the 'System Menu' of the OCS. A new menu "Clone Unit" has been added at the end of the main system menu as shown below:
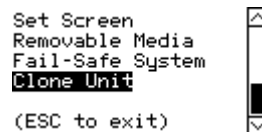
Figure 10-1 – System Menu

2. Selecting "Clone Unit" menu will open the following menu screen:
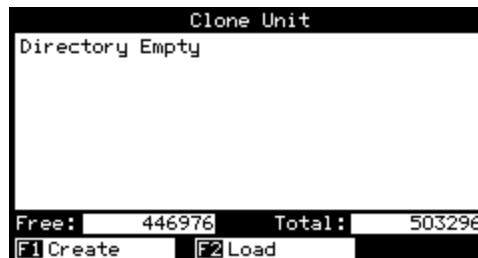
Figure 10-2 – Clone Unit Menu before Cloning

Note: **Free**/**Total** – displays number of free and total bytes in Removable Media.

3. Make/Create Clone option enables user to duplicate / Clone application file, all unit settings and all register values from Battery Backed RAM.

Selecting Create Clone brings up the screen below for the user:
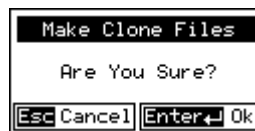
Figure 10-3 – Clone Unit Confirm Screen

After confirmation, the OCS will create two new files in the root directory of the Removable Media Drive as shown below:

AUTOLOAD.PGM   Application file
CLONE.DAT   File having all unit settings and register values from Battery Backed RAM

```
                          Clone Unit
 CLONE    .BMP     4158 08-07-98 12:02a
 IMAGE    .BMP     4158 08-07-98 12:00a




 Free:      437248      Total:       503296
 F1 Create         F2 Load
```
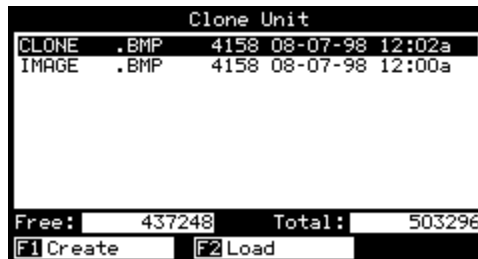
Figure 10-4 – Clone Unit Files

NOTE: Make/Create clone operation automatically includes the security in \AUTOLOAD.PGM file for security enabled files.

4. Once the cloning is successful, OCS gives a message as below:

```
    Cloning Status
 SUCCESS: MAKE CLONE

      Enter↵ Ok
```
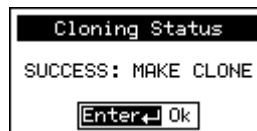
Figure 10-5 – Cloning Status

Make/Create clone can also be triggered by setting %SR164.9 bit to "1" from Ladder program or graphics. Once the operation is completed, this bit is made zero by the firmware. When Make clone operation is triggered by this SR bit, it does not ask the user for confirmation for making clone. The success / failure of the operation is also not notified on screen to the user.

In case of failure of "Make Clone" operation, %SR164.11 bit is set to "1" by the firmware and never reset.

NOTE: Backup of registers in flash memory is not performed by Clone Feature. If user desires, Backup should be done as explained in Chapter 9 (Fail Safe System).

10.3   Load Clone

This option loads the application, all unit settings and register values from Removable media to the Battery backed RAM (Regardless of AutoLoad settings) and then resets the OCS for the settings to take effect.

User needs to perform the following to Load Clone:

1. Select "Clone Unit" from main system menu of OCS as shown below:

```
 Set Screen                      △
 Removable Media
 Fail-Safe System
 Clone Unit                      ▮
                                 
 (ESC to exit)                   ▽
```
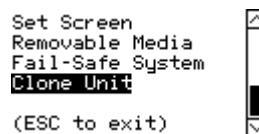
Figure 10-6 – System Menu

2. Selecting "Clone Unit" menu will open the following menu screen. Select "Load".

```
            Clone Unit
AUTOLOAD.PGM   1520  08-06-09
CLONE    .DAT 24670  08-06-09



Free:  193536   Total:   501248
F1Create   F2Load
```
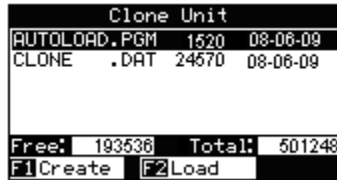
Figure 10-7 – Clone Unit Menu after Cloning

3. User needs to confirm Load Clone as shown below:

```
   Load Clone Files
     Are You Sure?

Esc Cancel Enter↵ Ok
```
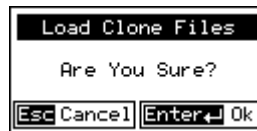
Figure 10-8 – Load Clone Confirm Screen

4. After confirmation, all unit settings and register values will be loaded from Removable media to the Battery backed RAM (Regardless of AutoLoad settings) and then OCS resets for the settings to take effect.

NOTE: For security enabled files, Load clone asks for password validation before loading the application.

Load clone can also be triggered by setting %SR164.10 bit to "1" from Ladder program or graphics. Once the operation is completed, this bit is made zero by the firmware. When Load clone operation is triggered by this SR bit, it does not ask the user for confirmation for loading clone. The success / failure of the operation is also not notified on screen to the user.

In case of failure of "Load Clone" operation, %SR164.12 bit is set to "1" by the firmware and never reset.

Notes

APPENDIX A: NETWORKS

1   CAN and CsCAN Networks

Appendix A describes the Controller Area Network (CAN) and CsCAN.

2   Controller Area Network (CAN) Overview

The controller area network (or CAN bus) is a serial communications bus that was originally developed in the late 1980's by a German company (Robert Bosch) for use in the automotive industry. CAN is an ISO (**I**nternational **S**tandards **O**rganization) - defined serial communications bus for real-time applications. Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards. Specifically, CAN is documented in ISO 11898 (for high-speed applications) and ISO 11519 (for lower-speed applications).

a.   CAN Features

CAN-based open automation technology successfully competes on the market of distributed automation systems because of the special features of the CAN protocol. The special features are CAN's producer-consumer-oriented (or peer-to-peer) principle of data transmission and its multi-master capability. The general design of CAN originally specified a high bit rate, high immunity to electrical interference and an ability to detect any errors produced. CAN networks have the following general attributes:

Automatic error detection
Easily configurable
Cost-effective to design and implement
Capable of operating in harsh environments

b.   CAN Protocol

The CAN communications protocol simply describes the method by which information is passed between various devices. The CAN protocol conforms to the Open Systems Interconnection (OSI) model. An open system is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture. The OSI model is defined in terms of seven ordered layers. These layers consist of the Physical (bottom-most layer), Data Link, Network, Transport, Session, Presentation and Application (top-most layer). CAN architecture defines the bottom two layers of the model. These layers are the physical and data link layers.

The physical and data link layers are typically transparent to the system designer and are included in any component that implements the CAN protocols. The physical layer is responsible for functions such as physical signaling, encoding, bit timing and bit synchronization. The data link layer performs functions such as bus arbitration, message framing and data security, message validation, and error detection. The application levels are linked to the physical medium by the layers of various emerging protocols (such as DeviceNet) dedicated to particular industry areas plus a variety of custom protocols defined and developed by individual CAN users.
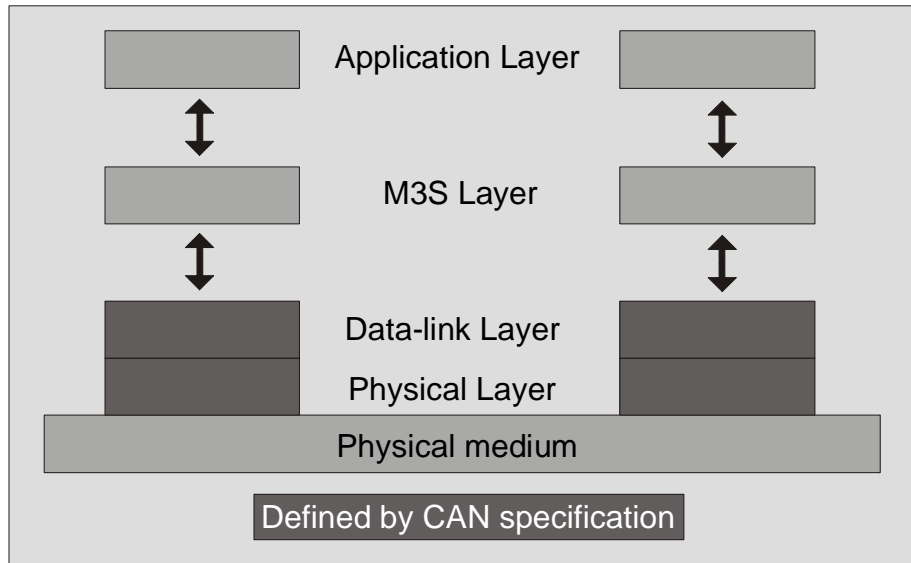
Figure 1 - OSI-Based Model

c.   CAN Operation

CAN is capable of using a variety of physical media for transmission purposes. Two examples are twisted wire-pairs and fiber-optics.   The most common physical medium consists of a twisted-pair with a termination resistance that is applicable to the cable in use (the CsCAN network typically calls for the use of a 121Ω resistor). CAN operates at data rates of up to 1 Megabits per second.

The signaling in CAN is carried out using differential voltages. The two signal lines are termed 'CAN_H' and 'CAN_L'.   The use of voltage differentials allows CAN networks to function in very noisy environments. With the twisted pair, differential configuration, each wire is closer to the noise source (if a noise source is present) for half the time and farther away for the other half. Therefore, the cumulative effect of the interference is equal on both wires, thus canceling the interference.

The Full CAN protocol allows for two lengths of identifiers. These two parts are "Part A" and "Part B". Part A allows for 11 message identification bits, which result in 2032 different identifiers. Extended CAN (Part B) utilizes 29 identification bits, resulting in 536,870,912 separate identifiers.

Note: DeviceNet currently specifies Part A only, and the balance of this discussion is specific to Part A only.

Descriptor byte 1   Descriptor byte 2

Identifier field

Remote transmission request bit

Data-length code
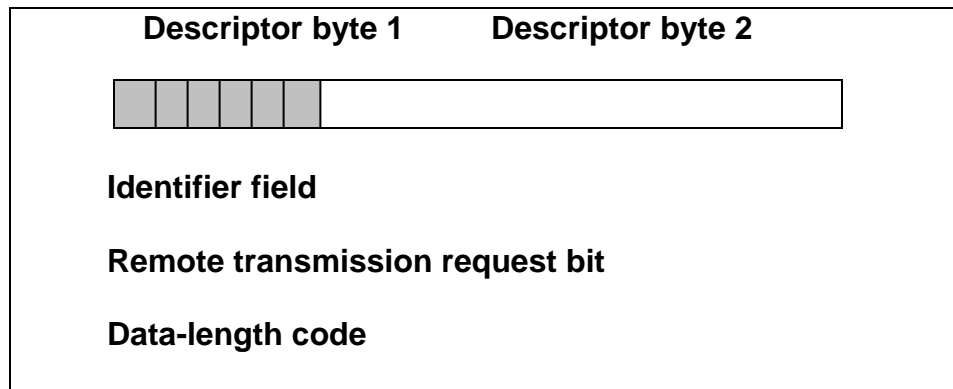
Figure 2 – Descriptor Bytes

There are 11 bits in the identifier field. The bits are used for identification of the message as well as determining its bus access priority. The priority is defined to be highest for the smallest binary value of the identifier. One very attractive quality of CAN is that it is capable of allocating priorities to messages. This feature makes it attractive for use within real-time control environments. All bits of the identifier field define the message priority. The CAN specification guarantees the latency time associated with priority values.

Since the CAN protocol specifies no rules for the assignment of message-identifiers, a variety of different, application-specific uses are possible. Assignment of the CAN message identifiers therefore is one of the most important decisions when designing a CAN-based communication system.

To summarize, CAN is currently being used in a very large number of applications in the automotive industry and in many other industrial applications. CAN is an excellent network to use in situations where microcontrollers need to communicate with each other or with remote devices. The popularity of CAN has been the result of the automatic error detection capabilities, the ability to operate in harsh environments, the relatively low-cost for development tools, and the wide availability of hardware.

3   CsCAN Network Overview

The CsCAN Network was first developed in 1993 by Horner. It was developed for use in a project that Horner completed for the United States Post Office. Horner developed its own network, because it needed a network that had a specific set of powerful peer-to-peer and host-to-node capabilities. The CsCAN Network has a "pass-through" feature whereby PC-based programs access other nodes connected to a network by passing the programming command through the serial port to the network port. (For a more detailed description, see below.) Horner found that by developing its own network, it satisfied several important needs. Horner continues CsCAN Network development to satisfy the requirements of today and the requirements of the future.

CsCAN Network Features

The CsCAN Network is based on CAN, which has many desirable features such as ruggedness, ease of configuration, etc. With Horner Controllers, data is passed at 125Kbps using a differential pair of wires plus a ground. It is important to note that the data rate is _not_ limited to 125Kbps. The maximum data rate is 1Mbps (limited by the speed of light). The CAN implementation in the CsCAN controller allows up to 64 controllers to be networked with no additional hardware and up to 253 controllers with three CAN repeaters.

For the ladder programmer, little knowledge of networking procedures is needed. However for troubleshooting and optimizing, the following information is helpful. Instead of using master/slave or token passing, the hardware self-arbitrates based on the Network ID. **Controllers with lower Network ID numbers are given a higher priority than controllers with higher Network ID numbers.**

CsCAN Network Operation

When a controller needs to send data over the network, it first waits for the network to be idle (currently a maximum of 900μs). If two controllers start broadcasting information on the network at the same time, the "self-arbitration" causes the controller with the greater Network ID number to cease broadcasting without affecting the message-in-progress of the other controller.

In applications with a large number of networked controllers, better results may be achieved by assigning lower Network IDs to controllers that have more critical network data than other controllers. By assigning higher Network IDs to controllers that provide numerous network updates, the controllers are prevented from monopolizing the bus time.

Each controller is capable of broadcasting Global Digital Output bits (%QG) and Global Analog Output bits (%AQG), which are periodically broadcasted to the other controllers on the network. The coil representations %QG and %AQG can be used in ladder logic like any other coil or register reference.

All global outputs are broadcast to the network according to the way the programmer sets them up under the Program, Network Config in Cscape.

In addition to global data, the CsCAN Network is used to exchange data between a controller on the network and a PC-based Host Supervisory Tool such as the Cscape Ladder Editor or an OEM-specific cell controller.

A useful feature of the CsCAN network is that it supports a "Host-to-Node" protocol and has the ability to "pass through" programming commands. A programming package (like Cscape™), when attached to an NX serial port, can access other NX units connected to a network by passing the programming command through the serial port to the network port. In this way, one Cscape™ package connected to one NX unit can program all NX units on the network.

APPENDIX B: DISTRIBUTED CONTROL SYSTEMS (DCS)

1   General

A Distributed Control System (DCS) is defined as a system for the control and monitoring of an industrial process which shares the computer-processing requirement between several processors. With DCS, processing is distributed among a multitude of different processors instead of one very large processing system.

MIMD (multiple instruction, multiple data) parallel processing technique is used in the CsCAN network. Each processor is capable of sharing data in this system. Typically, the processors are located in a wide variety of devices. These devices may take the form of Micro PLCs, conveyor controllers, operator interfaces, etc. Each of these devices serves a specific function.

It is common in a DCS for several different modules to be physically distributed in some type of arrangement around a plant. This is typically the case with devices connected to plant instrumentation since this greatly reduces plant cabling costs. The name "Distributed Control System" is <u>not</u> a reference to a *physical* layout but rather to the distribution of the processing. The devices in DCS are connected together via a high-speed communication link. Links such as CsCAN and DeviceNet are typical in DCS.

2   Attributes Desirable in DCS Design

There are three attributes that are desirable in any DCS design:

a.   Ease of Implementation

Modern Distributed Control Systems should be able to implement most control requirements without the need for complex or unusual design.

b.   Intuitive to the Operator

The group of individuals that use DCS most frequently are the operators. It is important that applications are designed so that they are operable in a logical and consistent manner and in a way that complements the general operation of a plant.

c.   Maintainable

Achieving the required functionality is only part of the solution. The design must also be maintainable. The system should be designed so that it can be maintained without the need for major re-engineering.

Distributed control is becoming ever-increasingly popular. As the presence of networks become more common in industrial automation, finding better ways to use the networks effectively will become much more important. Central to the DCS philosophy, control needs to be distributed out onto the network so that control is implemented <u>where</u> the process actually takes place. With DCS, the overall amount of data on the network is essentially reduced, because only data that has been processed is broadcasted on the network. This allows for more devices to be installed on a network that have a finite bandwidth.

3   Key Factors in Distributed Control Systems

All programmable nodes can be programmed via the network. Each node communicates data onto the network that is readable by any other node on the network in the Producer/Consumer network mode. (Also known as Peer-to-Peer Networking). Network medium is flexible. Currently, the Controller Area Network (CAN) is the preferred solution, but it is anticipated that Ethernet will likely be dominant within 1-3 years.

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