1 PRODUCT DESCRIPTION

This document covers Analog SmartStix I/O programming and configuration parameters.

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 **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 OCS Control Stations are CsCAN Nodes while a PC running Cscape is a CsCAN Host.

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

To control physical outputs, data is sent by a Control Station to the SmartStix I/O Module using CsCAN Directed Data Messages. To monitor physical inputs, a Control Station 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 a Control Station and a SmartStix I/O Module.

For example, a Control Station 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 Control Station stops sending output control data. Also, a Control Station 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 Control Station. Since the Control Station dynamically configures the SmartStix I/O Module, SmartStix I/O Modules can be readily deployed without having to configure them first.

2 BASIC SMARTSTIX PROGRAMMING

2.1 Using GET and PUT

2.1.1 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 not 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.

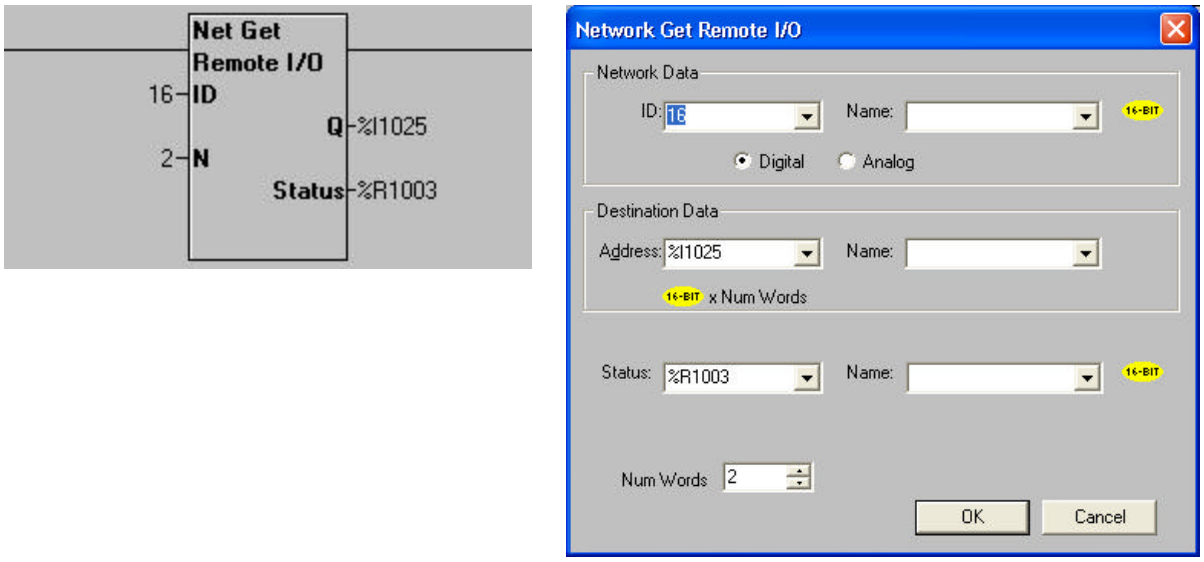

Figure 1 – Get Remote I/O Function Block and Parameter Screen

2.1.2 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 not 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. The functions of these words are described in Table 1.

2.1.3 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 not pass power flow if the remote I/O device has not 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.

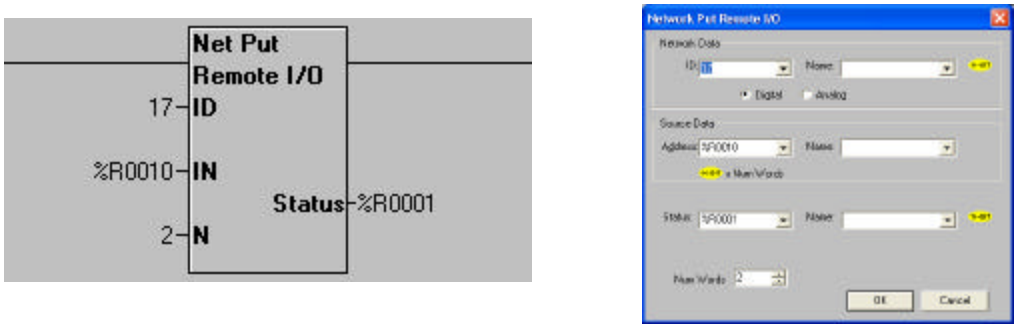

Figure 2 - Put Remote I/O Function Block and Parameter Screen

2.1.4 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 not 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. The functions of these words are described in Table 1.

Table 1 - Consumed / Produced Parameter Descriptions			
Consumed Directed Digital Data Words	**Function**		**Affects**
Word 1 (bits 1 to 16)	Voltage/Current Mode, Input Filter Control		All Analog Modules
Word 2 (bits 17 to 32)	Scale factor		All Analog Modules
Word 3 (bits 33 to 48)	Specifies whether SmartStix uses default configuration or values from Word 4.		All Analog Modules
Word 4 (bits 49 to 64)	Sets digital inputs / heartbeat and life expectancy time data.		All Analog Modules
Word 5 (bits 65 to 80)	Sets the default state of Analog outputs.		Modules with Analog Outputs
Produced Global Digital Data Words	**Function**		**Affects**
Word 1 (bits 1 to 16)	Reserved		
Word 2 (bits 17 to 32)	Reserved		
Word 3 (bits 33 to 48)	Status bits and diagnostic data		All Analog Modules
Word 4 (bits 49 to 64)	Device class number and firmware identifier sent by SmartStix module.		All Analog Modules
Consumed Directed Analog Data Words	**Function**		**Affects**
	HE550MIX977	**HE550DAC207**	
Word 1	Output Channel 1 Data	Output Channel 1 Data	Modules with Analog Outputs
Word 2	Output Channel 2 Data	Output Channel 2 Data	Modules with Analog Outputs
Word 3	Output Channel 3 Data	Output Channel 3 Data	Modules with Analog Outputs
Word 4	Output Channel 4 Data	Output Channel 4 Data	Modules with Analog Outputs
Word 5	Output 1 Default Data	Output Channel 5 Data	Modules with Analog Outputs
Word 6	Output 2 Default Data	Output Channel 6 Data	Modules with Analog Outputs
Word 7	Output 3 Default Data	Output Channel 7 Data	Modules with Analog Outputs
Word 8	Output 4 Default Data	Output Channel 8 Data	Modules with Analog Outputs
Word 9	Not used	Output 1 Default Data	Modules with Analog Outputs
Word 10	Not used	Output 2 Default Data	Modules with Analog Outputs
Word 11	Not used	Output 3 Default Data	Modules with Analog Outputs
Word 12	Not used	Output 4 Default Data	Modules with Analog Outputs
Word 13	Not used	Output 5 Default Data	Modules with Analog Outputs
Word 14	Not used	Output 6 Default Data	Modules with Analog Outputs
Word 15	Not used	Output 7 Default Data	Modules with Analog Outputs
Word 16	Not used	Output 8 Default Data	Modules with Analog Outputs
Produced Global Analog Data Words	**Function**		**Affects**
	HE550MIX977	**HE550ADC970**	
Word 1	Input Channel 1 Data	Input Channel 1 Data	Modules with Analog Inputs
Word 2	Input Channel 2 Data	Input Channel 2 Data	Modules with Analog Inputs
Word 3	Input Channel 3 Data	Input Channel 3 Data	Modules with Analog Inputs
Word 4	Input Channel 4 Data	Input Channel 4 Data	Modules with Analog Inputs
Word 5	Input Channel 5 Data	Input Channel 5 Data	Modules with Analog Inputs
Word 6	Input Channel 6 Data	Input Channel 6 Data	Modules with Analog Inputs
Word 7	Input Channel 7 Data	Input Channel 7 Data	Modules with Analog Inputs
Word 8	Input Channel 8 Data	Input Channel 8 Data	Modules with Analog Inputs
Word 9	Not used	Input Channel 9 Data	Modules with Analog Inputs
Word 10	Not used	Input Channel 10 Data	Modules with Analog Inputs
Word 11	Not used	Input Channel 11 Data	Modules with Analog Inputs
Word 12	Not used	Input Channel 12 Data	Modules with Analog Inputs

Note: Table 1 summarizes SmartStix I/O analog module consumed and produced data words. For advanced users, refer to Section Three: Advanced Programming for explanations describing consumed and produced words in detail.

11.5 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 2. To change the default operator, see *Advanced SmartStix Programming* (Section 3).

Table 2 – SmartStix Analog I/O Default Operation	
Amalog Input Devices	
Data Reporting Method	Every 500 milliseconds
Heartbeat Generation Interval	1000msec.
Analog Output Devices	
Update Method (using NETPUT Remote I/O Function block)	Updated by each Consumed Directed Analog Data transmission
Heartbeat Generation Interval	1000msec.
(LET) Life Expectance Time (Receipt of Heartbeat)	2000msec.
(LET) Action Upon Expiration	Turn all outputs OFF

3 ADVANCED SMARTSTIX PROGRAMMING

3.1 SmartStix I/O Module Device Classes

There are currently three SmartStix Analog I/O Module device classes (8, 9, and 10) that control and monitor Analog I/O points and exchange Directed and Global Analog Data words with a Control Station via the CsCAN Network.

Table 3 shows the three device classes along with the number of I/O points they contain and the number of Directed and Global Data words they exchange. Note that the digital outputs are virtual and do not correspond to physical outputs. They are used by the Analog module firmware to configure the individual analog channels.

Example: Determining the class of a SmartStix module:

1. Identify the row containing the corresponding quantity of analog I/O in Table 3.
2. The device class is located in the same row along with the total number of words consumed and produced for that device class.

Table 3 – SmartStix I/O Module Device Classes

Device Class	Analog Inputs	Analog Outputs	Directed Digital Data Words Consumed	Global Digital Data Words Produced	Directed Analog Data Words Consumed	Global Analog Data Words Produced
8	12	0	4	4	0	12
9	8	4	5	4	8	8
10	0	8	5	4	16	0
Device classes greater than 10 are reserved for future products.						

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

Table 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.

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

Table 4 – Consumed Directed Digital Data Word 1

16-bit Word															
8-bit High Byte								8-bit Low Byte							
Digital Output Control Data – Low Word															
A16 M16	F15 M15	F14 M15	F13 M15	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1

Table.5 – Consumed Directed Digital Data Word 2

16-bit Word															
8-bit High Byte								8-bit Low Byte							
Digital Output Control Data - High Word															
S16	S15	S14	S13	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1

M16..M1 Mode bits. A low mode bit selects ±10V and a high mode bit selects ±20mA.
F15..F13 Filter bits. Input digital filter time constant codes for analog input modules.
A16 Adaptive filter enable bit for analog input modules.
F13 through F15 and A16 are used in place of M13 through M16 by modules with analog inputs.
S16..S1 Scale bits. A low scale bit selects ±10V or ±20mA for the corresponding channel. A high scale bit selects ±5V or 4-20mA. S13 through S16 are not used by modules with analog inputs.

Table 6 - Mode & Scale Bit to Channel Correspondence

Bit	Channel		
	HE550ADC970	HE550MIX977	HE550DAC207
M1, S1	INPUT CHANNEL 1	INPUT CHANNEL 1	Not used
M2, S2	INPUT CHANNEL 2	INPUT CHANNEL 2	Not used
M3, S3	INPUT CHANNEL 3	INPUT CHANNEL 3	Not used
M4, S4	INPUT CHANNEL 4	INPUT CHANNEL 4	Not used
M5, S5	INPUT CHANNEL 5	INPUT CHANNEL 5	Not used
M6, S6	INPUT CHANNEL 6	INPUT CHANNEL 6	Not used
M7, S7	INPUT CHANNEL 7	INPUT CHANNEL 7	Not used
M8, S8	INPUT CHANNEL 8	INPUT CHANNEL 8	Not used
M9, S9	INPUT CHANNEL 9	OUTPUT CHANNEL 1	OUTPUT CHANNEL 1
M10, S10	INPUT CHANNEL 10	OUTPUT CHANNEL 2	OUTPUT CHANNEL 2
M11, S11	INPUT CHANNEL 11	OUTPUT CHANNEL 3	OUTPUT CHANNEL 3
M12, S12	INPUT CHANNEL 12	OUTPUT CHANNEL 4	OUTPUT CHANNEL 4
F13, M13, S13	See filter bits.	See filter bits.	OUTPUT CHANNEL 5
F14, M14, S14	See filter bits.	See filter bits.	OUTPUT CHANNEL 6
F15, M15, S15	See filter bits.	See filter bits.	OUTPUT CHANNEL 7
A16, M16, S16	See filter bits.	See filter bits.	OUTPUT CHANNEL 8

Each analog input has a single pole 345Hz (461uS) cutoff high frequency noise filter. In addition a second digital filter may be specified with the following time constants.

Table 7 - Time Contstants

Filter Bit			Time Constant
15	14	13	
0	0	0	10 milliseconds (Nominal hardware scan rate)
0	0	1	15 milliseconds
0	1	0	35 milliseconds
0	1	1	75 milliseconds
1	0	0	155 milliseconds
1	0	1	315 milliseconds
1	1	0	635 milliseconds
1	1	1	1.275 seconds

The standard digital filter is useful for applications with significant amounts of random (Gaussian) noise. The slower time constants, while yielding better noise suppression, take a longer time to settle after step changes and are also somewhat sensitive to impulse noise which is treated like Gaussian noise and averaged in.

Bit 16 may be set to specify an adaptive filter algorithm that:

1. Responds much more quickly to large step changes at slower time constants with full filtering of low level noise.
2. Suppresses impulse noise at the expense of slightly slower response at the shortest time constant settings. (Approximately 10 additional milliseconds)

Note that actual system response time is network dependent.

Table 8 – Consumed Directed Digital Data Word 3

16-bit Word								
8-bit High Byte	**8-bit Low Byte**							
Diagnostic Command Data	**Configuration Command Data**							
Reserved for Future Products					CAIT	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 Control Station 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 Control Station 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 For digital modules, command the SmartStix I/O Module to send its Digital Input data to the Control Station, only when the Digital Inputs change state.

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

CAIT = 0 For analog modules, command the SmartStix I/O Module to send its Analog Input data to the Control Station every 500 milliseconds.

CAIT = 1 For analog modules, command the SmartStix I/O Module to use Word 4's Input Send Time, to determine how often to periodically send its Digital Input data to the Control Station. In this case, a value of 0.0 disables *automatic* sending of Digital Input data.

Note: Regardless of the CIT / CAIT setting, Inputs are always sent to the Control Station when the SmartStix I/O Module powers-up, and when specifically requested by the Control Station.

Table 9 – Consumed Directed Digital Data Word 4	
16-bit Word	
8-bit High Byte	**8-bit Low Byte**
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 (page 8).

Table 10 – Consumed Directed Digital 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								

H16…H9 Determines default state of the SmartStix Analog I/O Module's Analog Outputs, if any, when the configured Life Expectancy Time expires. If an H bit is 1, its corresponding Analog Output holds its last state. If an H bit is 0, its corresponding Analog Output is forced to the value contained in the associated Default Consumed Directed Analog Data Word (Table 1).

Table 11 - Hold Bit to Channel Correspondence		
Bit	**Channel**	
	HE550MIX977	**HE550DAC207**
H9	OUTPUT CHANNEL 1	OUTPUT CHANNEL 1
H10	OUTPUT CHANNEL 2	OUTPUT CHANNEL 2
H11	OUTPUT CHANNEL 3	OUTPUT CHANNEL 3
H12	OUTPUT CHANNEL 4	OUTPUT CHANNEL 4
H13	Not used	OUTPUT CHANNEL 5
H14	Not used	OUTPUT CHANNEL 6
H15	Not used	OUTPUT CHANNEL 7
H16	Not used	OUTPUT CHANNEL 8

3.3 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 a Control Station, the SmartStix I/O Module will exhibit the following behavior:

1. All Analog Outputs are Off, until analog output data is received from a Control Station.
2. The device expects to receive analog output data at least every two seconds.
3. The device transmits a Heartbeat every second.
4. The device transmits its Analog Input data every 500 milliseconds.
5. If analog output 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.

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

Table 12 – Produced Global Digital Data Word 1															
16-bit Word															
8-bit High Byte								**8-bit Low Byte**							
Low Word															

Reserved.

Table 13 – Produced Global Digital Data Word 2															
16-bit Word															
8-bit High Byte								**8-bit Low Byte**							
High Word															

Reserved

Table 14 – Produced Global Digital 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 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 3).
Version Number SmartStix I/O Module's numeric firmware identifier

3.5 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. Zeros are 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.

4 SmartStix I/O Module LED Indicators

SmartStix I/O Modules provide diagnostic and status LED indicators

4.1 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 .
The following table shows the possible LED states and their meanings:

Table 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)

4.2 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.

5 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