isoLynx®

8B SLX300
Data Acquisition System
Software User Manual

DATAFORTH®

8B isoLynx® SLX300 Software User Manual
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Errata Sheets

Refer to the Technical Support area of Dataforth's website (www.dataforth.com) for any errata information on this product.

1.0 Introduction

The 8B isoLynx® SLX300 is a fast, intelligent, fully isolated data acquisition system providing superior reliability, accuracy, and isolation for a wide range of rugged industrial applications. The flexible, modular design combines eight SCMD digital I/O channels, four 8B analog output channels and twelve 8B analog input channels into one single board.

The 8B isoLynx® implements the industry standard Modbus RTU and TCP protocols, thereby enabling communication with a wide variety of existing third-party software drivers and HMI/SCADA packages. Dataforth offers a Windows based, free Configuration Software Tool which makes it easy to make a few basic system connections and quickly start taking measurements.

The 8B isoLynx® is factory configured to communicate to a host PC using RS-232, RS-485, or USB serial links or Ethernet as its physical layer. Up to 16 systems can be multi-dropped on the RS-485 serial link.

1.1 Related Documents

The following documents are available from Dataforth Corporation:

- *MA1029 SLX300 Configuration Software Tool User Manual*
- *MA1030 SLX300 Quick Start Guide*
- *MA1031 SLX300 Hardware User Manual*
- *MA1033 SLX300 LabVIEW VI Examples User Manual*

The following documents are available from the Modbus Organization (www.modbus.org):

- *Modbus Application Protocol Specification, V1.1a, June 2004*
- *Modbus over Serial Line Specification & Implementation Guide, V1.0, November 2004*
- *Modbus Messaging on TCP/IP Implementation Guide, V1.0a, June 2004*

1.2 Document Conventions

This document follows the following conventions:

- Hexadecimal numbers are preceded by the ‘0x’ suffix (e.g., 0xFA02).
- Binary numbers are preceded by ‘b’ (e.g., b1011).
- If a given number is not preceded by a suffix, it is a decimal value (e.g., 123).

2.0 Device Operation

2.1 Device Configuration

An 8B isoLynx® SLX300 system must be configured before use. Configuration is best described in two steps: communication interface configuration and channel configuration.

The system ships with factory default communication parameter settings. These parameters and their factory defaults are described in Section 3.0 8B isoLynx® SLX300 Communication Interface Configuration. If the factory default settings are appropriate, communication interface configuration can be skipped.

Channel configuration cannot be skipped. The analog channel may need to be configured for cold junction compensation (CJC) if an 8B thermocouple input module is used or for alarm if the alarm function is used, etc. At a minimum, digital I/O channel states must be configured to enable read or write access to them. Each digital I/O channel can be configured in one of several states: vacant, input, output, or alarm. The factory default state for all digital I/O channels is vacant.

An analog channel refers to the physical slot on the system board where an 8B module can be installed. There are a total of 12 analog input and 4 analog output channels on the 8B isoLynx® SLX300. The 12 analog ADC channels are fixed as inputs and the 4 analog DAC channels are fixed as outputs; they do not need to be configured as inputs or outputs.

A digital channel refers to the physical slot on the system board where an SCMD module can be installed. There are a total of 8 digital channels on the 8B isoLynx® SLX300. A digital channel should be configured as an input if an SCMD digital input module is installed at that location. Doing so enables read access to the channel. Similarly, a digital channel should be configured as an output if an SCMD digital output module is installed at that location to enable write access to the channel.

Other channel parameters can be configured, such as input average weights for analog channels, analog and digital default output values, and digital I/O special function(s), but it is not absolutely necessary to do so. Analog channel parameters and their configuration are described in Section 4.0 Analog (ADC/DAC) Channel Configuration. Digital channel parameters and their configuration are described in Section 5.0 Digital I/O Channel Configuration. Digital I/O special function parameters and their configuration are described in Section 6.0 Digital I/O Special Function Configuration. Analog and digital channel configurations can be reset to factory default settings by issuing reset commands to the appropriate registers (see Section 13.2 Firmware Resets).

2.2 Analog Data

Analog data is read from analog input channels and written to analog output channels.

Analog input data values are 12-bit unsigned numbers that represent voltages in the 0 to +5V range. 0x0000 represents 0V, and 0x0FFF represents +5V. Each increment or count in the data value represents a 1.22mV step in voltage.

Analog output data values are 12-bit unsigned numbers that represent voltages in the 0 to +5V range. 0x0000 represents 0V, and 0x0FFF represents +5V. Each increment or count in the data value represents a 1.22mV step in voltage.

Analog data always represents a voltage. How this value maps to actual engineering units depends on the 8B module from which the data is read or to which the data is written.

Example 1: Data from an 8B37J thermocouple input module is read. This module has a -100°C to +760°C input range and a 0 to +5V output range. A data value of 0x0000 (0V) corresponds to an input of -100°C, and a data value of 0x0FFF (+5V) corresponds to an input of +760°C.

Example 2: Data is written to an 8B39-01 current output module. This module has a 0 to +5V input range and a 4 to 20mA output range. A data value of 0x0000 (0V) corresponds to an output of 4mA, and a data value of 0x0FFF (+5V) corresponds to an output of 20mA.

Only 8B input modules with a unipolar 0 to 5V output can be used in the 8B isoLynx® SLX300 system. The system has over-range clamps and protection but the use of a module with output range beyond this limit may damage the system after prolonged operation.

2.2.1 Reading Analog Data

Analog data can be read from analog input and analog output channels. Reading data from an analog output channel simply returns the last value written. How data is read from analog input channels depends on the selected scan mode. The 8B isoLynx® SLX300 supports two scan modes which are described below. For further details, see Section 8.0 Reading Analog Data.

2.2.1.1 Continuous Scan Mode

In this mode, the system continuously scans all 12 analog input channels, converting the installed 8B module output voltages to digital data values at a fixed scan rate of 6000 samples per second (1 sample every 160µs). The 12 analog input channels are sampled one at a time in sequential order. Once all analog inputs have been sampled, the scan restarts at the first analog input.

Since the scan rate is fixed and all analog input channels are scanned, the rate at which a given input channel is sampled is dependent on the number of analog inputs. The formula for the single channel sample rate is given below:

Sample Rate = 1 / (166.7µs x 12) = 500 samples / second

Analog data values are stored in a circular SRAM buffer. Only one conversion result per channel is stored at a time. New conversion results overwrite a channel's previous conversion result. The most recent conversion results may be retrieved at any time with a Modbus Read Registers command.

In addition, a running average is calculated for each analog input every time a channel is sampled. The weight used in the running average calculation is configurable on a per-channel basis (see Section 4.0 Analog (ADC/DAC) Channel Configuration). Running average results are stored in a circular SRAM buffer and can be accessed with a Modbus Read Registers command. The running average formula is:

Average = Average + ((Sampled Value - Average) ÷ Average Weight)

Maximum and minimum values are also maintained for each analog input and stored in circular SRAM buffers. The maximum and minimum values can be read at any time with a Modbus Read Registers command to the appropriate address. The average value, maximum value or minimum value can be reset at any time with a Modbus Write Registers command.

NOTE: Due to the circular buffer architecture of Continuous Scan Mode, if data from a contiguous group of analog input channels is read, it cannot be determined which channel's data is the most recent. The scan could be processing any one of the current analog inputs when the request is received; therefore, any one of the analog data values might be the most recent.

2.2.1.2 User-Defined Scan Mode (Burst Scan Mode)

In User-Defined Scan Mode (Burst Scan Mode), analog input channels are not continuously scanned. Instead, the scan is started and stopped at the direction of the host application. Analog conversion results are stored in a 192k-word FIFO buffer and can be read either after the scan completes or as data becomes available. The maximum sample rate is 100k samples / second. This will decrease if additional signal processing is enabled. Reference Section 7.2 User-Defined Scan Parameters for further details.

Before a User-Defined Scan can be started, a scan list must be configured. This is a list containing up to 48 entries of the 12 analog input channels. Each channel can be listed more than once and channels can be listed in any order.

A scan interval of as little as10µs and scan buffer memory size up to 192k words can also be configured; this defines how often the entries in the scan list are scanned and how much of the buffer's memory is used. When the defined buffer memory becomes full, the scan is stopped. In addition, a scan count can be read. The scan counter indicates how many samples are in the scan buffer memory.

A scan is started with a Modbus Write Registers command to a Scan Mode register. The scan continues until one of the following occurs: 1) the scan-defined buffer memory becomes full, or 2) the scan is aborted by the user. Due to the FIFO buffer architecture used by the User-Defined Scan Mode, conversion data is never overwritten. This allows an application to reconstruct a highly-accurate, time-correlated representation of the signals being measured. More details are given in Section 7.0 Analog Input Scan Configuration and Section 8.0 Reading Analog Data.

2.2.1.3 Deciding which Scan Mode to Use

For most general purpose signal monitoring applications, Continuous Scan Mode is more than adequate. Reading the most recent conversion results is like taking a snapshot in time of one or more analog input signals. Average, maximum, and minimum values give an indication of what the signals are doing over time. Continuous Scan Mode is also easy to use: just configure the channels and start reading data. The drawbacks to Continuous Scan Mode are: 1) due to the circular buffer architecture, when a block of channels is read, there is no way to determine which channel's data is the most recent, and 2) timing between scans is fixed.

Applications that require better time-correlation and a fast sampling rate are advised to use the User-Defined Scan Mode. Although average, maximum, and minimum values are not calculated in this mode, the user can construct a highly accurate representation of the signals in the time-domain. Post processing of the data can then be performed to derive FFTs, averages, maximums, minimums, etc.

2.2.2 Writing Analog Data

Analog data can be written to analog output channels at any time, regardless of the currently configured analog input scan mode. See Section 9.0 Writing Analog Output Data for details.

2.2.2.1 DAC Continuous Scan Mode

Once a value is written to an analog output register, an output will stay at the given value until a new value is written to the register or until the system is reset or power cycled. If reset or power cycle occurs, the channel will revert to its default output value. Default output values are configurable on a per-channel basis (see Section 4.0 Analog (ADC/DAC) Channel Configuration). There is no need to refresh analog output channels. A process internal to the 8B isoLynx® periodically refreshes all output channels with the value that was last written.

2.2.2.2 DAC User-Defined Scan Mode (Burst Scan Mode)

In User-Defined Scan Mode (Burst Scan Mode), analog output data can be preloaded in the 64k buffer memory. 16k values per channel are allowed. The scan interval is also configurable and can be as small as 1ms. A scan is started with a Modbus Write Registers command to a Scan Control register.

2.2.3 Cold Junction Compensation (CJC)

The CJC registers must be configured when an 8B37 or 8B47 thermocouple input module is installed in an analog input channel to allow calculation of the cold junction compensation factors (see Section 4.4 Cold Junction Compensation for details). All standard product 8B thermocouple input modules 8B37x and 8B47x-xx are supported.

2.2.4 Alarms

The 8B isoLynx® SLX300 allows alarms to be enabled individually on any analog input channel. Input samples are compared with pre-configured high- and low-level alarm limits or high-high and low-low alarm limits, and if the limits are exceeded, an alarm condition occurs. When an alarm condition is asserted, the system will do the following: 1) turn on the System Alarm LED, 2) set appropriate bits in the channel's Alarm Status register, and, 3) if enabled, set the corresponding alarm output to the pre-configured analog or digital alarm output value. No asynchronous communication with the host occurs as this violates the Modbus protocol..

Tracking and Latched alarm modes are supported on each input channel. In Tracking Mode, the system will de-assert the alarm condition when the input returns within limits, taking into account the deadband parameter. When used with an alarm output, this mode allows the user to implement a simple on/off controller.

In Latched Mode, the alarm condition remains asserted even if the input returns within limits. It is cleared by an appropriate command sent from the host or upon a system reset.

2.3 Digital Data

Digital data is read from digital input channels and written to digital output channels. Digital data values are either 1 or 0. See Section 10.0 Digital Data and I/O Special Functions for more details.

2.3.1 Reading Digital Data

Digital data can be read from digital input channels at any time. The interpretation of the data depends on the specific SCMD module installed at that channel. Digital data can also be read from digital output channels. This action will return the last value written.

2.3.2 Writing Digital Data

Digital data can be written to digital output channels at any time. The effect of writing a data value to a channel depends on the function of the specific SCMD module installed at that channel.

2.3.3 Digital I/O Special Functions

The 8B isoLynx® SLX300 has two independent 32-bit counter/timers which are used to perform seven special functions. Each timer is associated with two digital I/O channels and will use one or both, depending on the selected special function. Unused channels can be used for regular digital I/O. The special functions are described in the following sections.

2.3.3.1 Pulse / Frequency Counter

The pulse counter can count up to 10,000,000 pulses from an external source. Input frequency can be up to 11kHz with a standard SCMD isolated module inserted in the channel or up to 80kHz if the SCMD-PT pass-through module is used. An optional hardware or software gate input can be used to enable or disable counting. This requires a second digital I/O channel. Pulse count can be reset to zero in software, and the edge to be counted is configurable as rising or falling. Pulse count can be displayed as RPM if the user specifies pulses per revolution.

The frequency counter counts pulses per second from an external source. Frequency limits are the same as those listed above.

2.3.3.2 Pulse / Frequency Counter with De-bounce

The Pulse / Frequency Counter with De-bounce function is the same as described above in Section 2.3.3.1 except that a timer is used to provide configurable stay-on (high) and stay-off (low) times, avoiding false triggering from noisy signals. Pulse polarity is also configurable. This function provides the de-bounced signal on the adjacent digital output. It is typically used for signals up to several hundred Hertz.

2.3.3.3 Waveform Measurement

Several types of waveform measurement can be performed with this function. Pulse width, period and duty cycle have an upper limit of 10,000,000 counts and frequency input is 15kHz max.

- Single pulse width measurement: Measures the duration of a pulse on a gated input, using a known timebase. To perform this measurement, wait until the gate is closed; when the gate opens, counting of timebase source pulses begins. When the gate closes, counting stops and the counter is disarmed. Capture registers are used for high precision. Source pulses are internal with timebase selectable in multiples of 10 from 1ns to 1sec. Pulse polarity is also selectable.
- Continuous pulse width measurement, with running average: This function operates the same as the single pulse width measurement, but instead of disarming the counter when the gate closes, the count is recorded and the system waits for the next pulse. This function computes a moving weighted average and reports the last measurement or average when queried.
- Single period measurement: Measures the period of the gated input. This function waits until the gate is closed then begins counting of timebase source pulses when the gate opens. When the gate opens a second time, counting stops and the counter is disarmed. Source pulses are internal.
- Continuous period measurement, with running average: This function operates the same as the single period measurement, but instead of disarming the counter when the gate opens, the count is recorded and the system continues timing the new period. This function computes the moving weighted average of the period and reports the last measurement or average when queried.
- Duty cycle measurement of a single period: This function measures pulse high time and pulse low time and is equivalent to PWM decoding. It uses two capture registers to record time high and time low. This function waits until the gated input is closed to arm and then disarms after the second gated input opens.
- Continuous duty cycle measurement, with running average: This function operates the same as the duty cycle measurement of a single period, but instead of disarming the counter it

records and resets the count values. This function computes the running average and reports the last or current measurement when queried.

2.3.3.4 Time Between Events

This function measures the time between events on two separate channels. It waits until both gates are closed, then when gate A opens it begins counting internal timebase source pulses, and when gate B opens it stops counting and disarms the timer.

2.3.3.5 Frequency Generator

This function generates a square wave with frequency up to 100kHz.

2.3.3.6 PWM Generator

This function takes a user specified period and duty cycle and generates a PWM signal on a digital output channel. A typical application would be ramping for servo control or light dimming by starting at one duty cycle and moving to another duty cycle over a given amount of time.

2.3.3.7 One-Shot Pulse Generator

This function provides a one-shot pulse which can be retriggered and which has configurable pulse width and optional delay before and after the pulse. The pulse can be triggered by software or an external pulse edge and the polarity of the pulse is selectable. Minimum pulse width, minimum delay before the pulse and minimum delay after the pulse are all 20µs.

3.0 8B isoLynx® SLX300 Communication Interface Configuration

See the *8B isoLynx® SLX300 Hardware User Manual* for communication port and cable wiring diagrams.

3.1 Modbus Protocol

The system is shipped pre-configured for use with one of the following Modbus protocols. The protocol choice is made when the system is ordered.

3.1.1 Modbus RTU

Modbus RTU is supported over RS-232, USB, and RS-485 2- or 4-wire serial links. Data rates up to 921.6kbps with even, odd, and no parity are supported.

3.1.2 Modbus TCP

Up to four simultaneous socket connections are supported. If all available sockets are currently used, new socket open requests will be denied. In such cases, a new socket can be opened only if one of the current sockets is closed by the client that opened the socket.

In addition to the four simultaneous socket connections, each socket can process up to four simultaneous Modbus TCP transactions. Trying to process more will result in a Server Busy Modbus exception response.

3.1.3 Modbus Function Codes

The 8B isoLynx® SLX300 supports the following Modbus function codes (commands):

- 3, Read Holding Registers
- 4, Read Input Registers
- 6, Write Single Register
- 16, Write Multiple Registers
- 23, Read/Write Multiple Registers

3.1.4 Modbus Addresses

The 8B isoLynx® SLX300 makes no distinction between Modbus Input registers and Modbus Holding registers. Read Input Registers will return the same data as Read Holding Registers as long as both commands use the same address and quantity.

Modbus addresses described in this manual are 0-based. In other words, the first address is 0x0000 (0) and the last is 0xFFFF (65535). Using this convention, address values map directly to address fields of all Modbus commands. Although only a small percentage of available Modbus addresses are mapped to data and/or control functions, the 8B isoLynx® SLX300 allows access to the entire range of all Modbus address spaces. If a Read command accesses an address that the 8B isoLynx® does not map, 0x0000 will be returned for registers. If a Write command accesses an address that the 8B isoLynx® SLX300 does not map, the write will have no effect.

Appendix A of this manual describes all Modbus addresses that the 8B isoLynx® SLX300 maps. The same information is also distributed throughout this document in the appropriate sections.

3.1.5 Modbus Exceptions

The 8B isoLynx® SLX300 will return the following Modbus exception codes under the given conditions:

- 1, Illegal Function: The received function code is unknown or not supported.
- 2, Illegal Address: The received address and quantity would access data beyond address 0xFFFF.
- 3, Illegal Data: The number of bytes in the request does not match that expected or one or more fields of the command contain an invalid value (i.e., a quantity field is zero or too large, a byte count field is zero or does not agree with the quantity field, etc.).
- 6, Server Busy: This exception only occurs with Modbus TCP and indicates that the 8B isoLynx® SLX300 is already processing its maximum number of simultaneous transactions and cannot accept more. Try the request again after a response is received from one of the four active transactions.

3.2 Changing the Communication Protocol Settings

Refer to the *8B isoLynx® SLX300 Hardware User Manual* for details on this process.

3.3 Resetting Communication Parameters to Factory Default Values

Communication parameters can be reset to the factory default settings by installing the Reset jumper and cycling power to the board. See the *8B isoLynx® SLX300 Hardware User Manual* for the location of this jumper. Use this procedure only when there is a need to return communication parameters to a known state.

3.4 Modbus Slave ID

The Modbus Slave ID is configurable. The factory default settings must be used for the initial connection.

Table 3.1 Configurable Interface and ID RTU Parameters

PARAMETER	VALID SETTINGS	DEFAULT SETTING
Slave ID	16 – 31 (0x10-0x1F)	16 (0x10)

The upper four bits of the Slave ID are stored in non-volatile memory on the system board and will persist across power cycles, resets, and brownouts. The Slave ID can be changed by writing the appropriate Modbus register.

The lower 4 bits of the Slave ID are configured by the address jumpers on the system board (see the *8B isoLynx® SLX300 Hardware User Manual* for jumper locations). If a jumper is open or removed, the corresponding bit is read as a 1, and if it is closed or installed, the bit reads as a 0.

3.5 Modbus RTU Parameters

Baud rate and parity are configurable. When using the SLX300-20x with RS-485 serial link, 4-wire half-duplex or 2-wire half duplex may be selected.

3.5.1 Modbus RTU Parameter Registers

The following table describes Modbus addresses and data values used to configure Modbus RTU parameters. If a value other than one specified below is written to a register, that value is ignored and the parameter remains unchanged.

Table 3.2 Modbus RTU Parameter Registers

REGISTER	ADDRESS	DATA VALUES
RS-485 2- or 4-Wire	33403 (0x827B)	0 = 2-wire 1 = 4-wire (default)
RS-485 Enable (termination resistors)	33404 (0x827C)	0 = Disable(default) 1 = Enable
Baud Rate	33401 (0x8279)	1 = 2400 2 = 4800 3 = 9600 4 = 19200 5 = 38400 6 = 57600 7 = 115200 (default) 8 = 230400 9 = 460800 10 = 921600
Parity	33402 (0x827A)	0 = None 1 = Odd 2 = Even (default)

3.6 Modbus TCP Parameters

The following Modbus TCP parameters are configurable. Factory default settings must be used for initial configuration.

Table 3.3 Configurable Modbus TCP Parameters

PARAMETER	VALID SETTINGS	DEFAULT SETTING
IP Address	Any valid IP Address	192.168.128.100
Subnet Mask	Any valid Subnet Mask	255.255.0.0

IP Address: This parameter specifies the device IP address. The IP address should be configured such that it is compatible with the network on which the device will be installed.

Subnet Mask: This parameter specifies the network's subnet mask. This parameter needs to be configured to match the subnet mask of the network on which the device will be installed.

3.6.1 Modbus TCP Parameter Registers

The following table identifies the Modbus register addresses and data values used to configure Modbus TCP parameters.

Table 3.4 Modbus TCP Parameter Registers

REGISTER	ADDRESS	DEFAULT VALUES
IP Address	33405 – 33408 (0x827D-0x8280)	192.168.128.100
Subnet Mask	33409 – 33412 (0x8281-0x8284)	255.255.0.0

These parameters are stored in non-volatile memory on the system board and will persist across power cycles, resets, and brownouts. Changes will take effect on the next system power cycle.

4.0 Analog (ADC / DAC) Channel Configuration

Analog channels have the following configurable parameters:

Table 4.1 Configurable Analog (ADC / DAC) Channel Parameters

ANALOG INPUT CHANNEL PARAMETER (12 CHANNELS)	VALID SETTINGS	DEFAULT SETTING
Analog ADC Data	Input	No need to be configured
ADC Average Weight	1 to 32768	4 (0x0004)
CJC Control	0 or 1	0 (0=disable, 1=enable)
CJC Type	Type number	11
CJC Temperature Range	-100 to +1750C	-100 to +760C
Alarm Control	0 or 1	0 (0=disable, 1=enable)
Alarm Upper Limit	0 – 4095	4095
Alarm Lower Limit	0 – 4095	0
Alarm Upper Deadband	0 – 4095	0
Alarm Lower Deadband	0 – 4095	0
Alarm HHLL Control	0 or 1	0 (0=disable, 1=enable)
Alarm HHLL Upper Limit	0 – 4095	4095
Alarm HHLL Lower Limit	0 – 4095	0
Alarm HHLL Upper Deadband	0 – 4095	0
Alarm HHLL Lower Deadband	0 – 4095	0
ANALOG OUTPUT CHANNEL PARAMETER (4 CHANNELS)	**VALID SETTINGS**	**DEFAULT SETTING**
Analog DAC Data	Output	No need to be configured
DAC Default Output	0 – 4095	0 (0x00)

Analog channel parameters are stored in non-volatile memory and will persist across power cycles, resets, and brownouts. They can be changed by writing the appropriate Modbus registers. Analog channel parameters can be reset back to factory default values by writing the Reset Register with the appropriate value (see Section 13.2 Firmware Resets).

4.1 Analog (ADC / DAC) Channel States

- *Input*: Input channels are enabled for Read operations. An 8B input module must be installed in the corresponding channel and the system configured accordingly. Input channels are automatically included in the input conversion list if the system is in Continuous Scan Mode. In User-Defined Scan Mode, input channels are available for inclusion in the user-defined scan list.

- *Output*: Output channels are enabled for Write operations. An 8B output module must be installed in the corresponding channel and the system configured accordingly. Output channels are automatically included in the refresh scan list.

4.2 Analog ADC Channel Average Weights

The average weight parameter is configurable on a per-channel basis and has a default setting of 4 (0x0004).

When the system is in Continuous Scan Mode, a running average is calculated for each analog input channel each time it is sampled. The running average formula is:

Average = Average + ((Sampled Value - Average) ÷ Average Weight)

When in Continuous Scan Mode, analog input channels are sampled every 160µs (6000 samples per second). Therefore, the sample rate for a given input channel is dependent on the number of channels configured as inputs. The per-channel sample rate is given by the following formula:

Sample Rate (samples / second) = 1 ÷ (160µs x 12)

4.2.1 Analog Channel Average Weight Registers

The following table identifies the Modbus register addresses and data values used to configure average weight parameters. If a value other than one specified below is written to a register, it will be interpreted as the next smallest valid average weight.

Table 4.2 Analog ADC Channel Average Weight Registers

REGISTER	ADDRESS	DATA VALUES
Channel Average Weight	48 – 59 (0x0030-0x003B)	Integers1 to 32768 Default = 4

4.3 Analog DAC Channel Default Outputs

The default output is configurable on a per-channel basis and has a default setting of 0 (0x00).

At power-up all analog output channels are set to the configured default value.

4.3.1 Analog Channel Default Output Registers

The following table identifies the Modbus register addresses and data values used to configure analog default output parameters.

Table 4.3 Analog DAC Channel Default Output Registers

REGISTER	ADDRESS	DATA VALUES
Channel Default Output	4368 – 4371 (0x1110-0x1113)	Integers 0 to 4095 Default = 0 (0x00)

4.4 Cold Junction Compensation (CJC)

The CJC registers must be configured when an 8B37x or 8B47x-xx thermocouple input module is installed in an analog input channel. CJC is configurable on a per-channel basis. There are 4x12 CJC parameter registers including 12 channel control registers, 12 thermocouple type registers, 12 lower temperature range registers, and 12 upper temperature range registers.

4.4.1 CJC Channel Control Registers

The following table identifies the Modbus register addresses and data values used to configure CJC control parameters. The CJC calculation starts when the scan mode is initiated.

Table 4.4 CJC Channel Control Registers

REGISTER	ADDRESS	DATA VALUES
12 Control Registers	5888 – 5899 (0x1700-0x170B)	1 = Enable, 0 = Disable Default = 0

4.4.2 CJC Type Registers

The following table identifies the Modbus register addresses and data values used to configure CJC type parameters. The CJC type register must be configured to match the type of the 8B thermocouple input module that is installed in the analog input channel slot. The value is determined by whether the module is an 8B37x or 8B47x-xx module and the input thermocouple type.

Table 4.5 CJC Type Registers

REGISTER	ADDRESS	DATA VALUES
12 Type Registers	5904 – 5917 (0x1710-0x171B)	8B37J = 11 (default) 8B37K = 12 8B37R = 13 8B37S = 14 8B37T = 15 8B47J-01 = 21 8B47J-02 = 21 8B47J-03 = 21 8B47J-12 = 21 8B47K-04 = 22 8B47K-05 = 22 8B47K-13 = 22 8B47K-14 = 22 8B47T-06 = 25 8B47T-07 = 25

4.4.3 CJC Lower and Upper Range Registers

The following table identifies the Modbus register addresses and data values used to configure CJC lower and upper temperature ranges. The CJC range registers must be configured to match the input temperature limits of the 8B37x or 8B47x-xx thermocouple input module that is installed in the analog input channel.

Following are the temperature ranges for standard Dataforth 8B thermocouple input modules:

Non-Linearized thermocouple input modules:
8B37J: -100°C to +760°C
8B37K: -100°C to +1350°C
8B37R: -100°C to +400°C
8B37S: 0°C to +1750°C
8B37T: 0°C to +1750°C

Linearized J type thermocouple input modules:
8B47J-01: 0°C to +760°C
8B47J-02: -100°C to +300°C
8B47J-03: 0°C to +500°C
8B47J-12: -100°C to +760°C

Linearized K type thermocouple input modules:
8B47K-04: 0°C to +1000°C
8B47K-05: 0°C to +500°C
8B47K-13: -100°C to +1350°C
8B47K-14: 0°C to +1200°C

Linearized T type thermocouple input modules:
8B47T-06: -100°C to +400°C
8B47T-07: 0°C to +200°C

Table 4.6 CJC Lower and Upper Range Registers

REGISTER	ADDRESS	DATA VALUES
Lower Range Registers	5920 – 5931 (0x1720-0x172B)	-100 to 0C Default = -100C
Upper Range Registers	5932 – 5943 (0x172C-0x1737)	200 to 1750C Default = 760C

4.5 Alarms

Alarm processing and control can be enabled on any analog input channel and can be configured on a per-channel basis. The alarm parameter register must be configured before the alarm can be enabled.

4.5.1 Alarm Channel Control Registers

The following table identifies the Modbus register addresses and data values used to configure the alarm control parameters. See Section 2.2.4 Alarms for a discussion on how alarms work.

Table 4.7 Alarm Channel Control Registers

REGISTER	ADDRESS	DATA VALUES
High-Low Alarm Control Registers	8192 – 8203 (0x2000-0x200B)	High-Low Alarm Control Code Default = 0
High-High Low-Low Alarm Control Registers	8704 – 8715 (0x2200-0x220B)	High-High Low-Low Alarm Control Code Default = 0

Alarm control codes for High and Low Limit alarms are as follows:

H-L Alarm Control =
H-L Control Mode + H-L Control Limit + H-L Control Output Active + H-L Control Output Channel
H-L Control Mode:
10000 = Tracking Mode
20000 = Latched Mode

H-L Control Limit:
1000 = Upper Limit
2000 = Lower Limit
3000 = Both Limits

H-L Control Output Active:
100 = Active High
200 = Active Low
300 = Not Active

H-L Control Output Channel:
00 = DIO channel 0
01 = DIO channel 1
02 = DIO channel 2
03 = DIO channel 3
04 = DIO channel 4
05 = DIO channel 5
06 = DIO channel 6
07 = DIO channel 7
08 = Analog Output channel 0
09 = Analog Output channel 1
10 = Analog Output channel 2
11 = Analog Output channel 3

Example 1: Set up an alarm on analog input channel 0 for latched mode, lower limit, output active high and output to analog output channel 0.
Write to register address 8192 a data value of 20000+2000+100+8 = 22108.

Alarm control codes for High-High and Low-Low Limit alarms are the same as those above although the resulting value is written to a separate set of registers:

HH-LL Alarm Control = HH-LL Output Active + HH-LL Output Channel

HH-LL Output Active:
100 = Active High
200 = Active Low
300 = Not Active

HH-LL Output Channel:
00 = DIO channel 0
01 = DIO channel 1
02 = DIO channel 2
03 = DIO channel 3
04 = DIO channel 4
05 = DIO channel 5
06 = DIO channel 6
07 = DIO channel 7
08 = Analog Output channel 0

09 = Analog Output channel 1
10 = Analog Output channel 2
11 = Analog Output channel 3

Example 2: Add a High-High Low-Low alarm to Example 1 which is active low and has output set to DIO channel 6.
Write to register address 8704 a data value of 200+6 = 206.

4.5.2 Alarm Limit Registers

For alarm control and processing there are 8 different limit parameter registers for each of the 12 analog input channels. These registers are: upper limit, lower limit, high-high limit, low-low limit, upper deadband, lower deadband, high-high deadband, and low-low deadband.

Table 4.8 Alarm Limit Registers

REGISTER	ADDRESS	DATA VALUES
Upper Limit Registers	8208 – 8219 (0x2010-0x201B)	0 – 4095, Default = 4095
Lower Limit Registers	8224 – 8235 (0x2020-0x202B)	0 – 4095, Default = 0
Upper Deadband Registers	8256 – 8267 (0x2040-0x204B)	0 – 4095, Default = 0
Lower Deadband Registers	8272 – 8283 (0x2050-0x205B)	0 – 4095, Default = 0
High-High Limit Registers	8720 – 8731 (0x2210-0x221B)	0 – 4095, Default = 4095
Low-Low Limit Registers	8736 – 8747 (0x2220-0x222B)	0 – 4095, Default = 0
High-High Deadband Registers	8768 – 8779 (0x2240-0x224B)	0 – 4095, Default = 0
Low-Low Deadband Registers	8784 – 8795 (0x2250-0x225B)	0 – 4095, Default = 0

4.5.3 Alarm Status Registers

The high-low alarm and high-high low-low alarm processing will set the appropriate bits of the Alarm Status Register. There are two alarm status registers: one for high-low alarm and the other for high-high low-low alarm. Writing 0 to the status register will clear all latched mode alarms.

Table 4.9 Alarm Status Registers

REGISTER	ADDRESS	DATA VALUES
Status Registers	8240 (0x2030)	Set alarm bit by alarm processing. Write 0 to clear all latched alarms.
High-High Low-Low Status Registers	8752 (0x2230)	Set alarm bit by alarm processing. Write 0 to clear all latched alarms.

4.6 Save Analog Channel Parameters to EEPROM

Analog channel parameters can be saved to EEPROM by writing a data value of 0-4 to register address 8448 (0 = save all parameters, 1 = save ADC parameters, 2 = save DAC parameters, 3 = save CJC parameters, and 4 = save alarm parameters). The saved parameters will take effect immediately and will replace the default settings upon power cycle or firmware reset.

Table 4.10 Save Analog Channel Parameters to EEPROM Registers

REGISTER	ADDRESS	DATA VALUES
Save to EEPROM	8448 (0x2100)	0 = All 1 = ADC 2 = DAC 3 = CJC 4 = Alarm

5.0 Digital I/O Channel Configuration

Digital I/O channels have the following configurable parameters.

Table 5.1 Configurable Digital Channel Parameters

DIGITAL CHANNEL PARAMETER	VALID SETTINGS	DEFAULT SETTING
Channel State	Vacant, Input, Output, Alarm	Vacant
Default Output (Output Channels Only)	0 or 1	0

Digital I/O channel parameters are stored in non-volatile memory on the 8B isoLynx® SLX300 and can be configured by writing the appropriate Modbus registers. The above parameters persist across power cycles, resets, and brownouts. Digital I/O channel parameters can be reset back to factory default values by writing the Reset Register.

5.1 Digital I/O Channel States

Digital I/O channels must be in one of the following states:

- *Vacant:* Vacant channels are not enabled for read or write operations. This is the factory default state for all channels.
- *Input*: Input channels are enabled for read operations. An SCMD input module must be physically installed in the corresponding channel.
- *Output*: Output channels are enabled for write operations. An SCMD output module must be physically installed in the corresponding channel.
- *Alarm*: Alarm channels are enabled for alarm output. An SCMD output module must be physically installed in the corresponding channel.

5.1.1 Digital I/O Channel State Registers

The following table identifies the Modbus register addresses and data values used to configure the digital I/O channel states. If a value other than one specified below is written to one of the following registers, the value will be interpreted as vacant by 8B isoLynx® SLX300 firmware.

Table 5.2 Digital Channel State Registers

REGISTER	ADDRESS	DATA VALUES
8 DIO States	32810 – 32817 (0x802A-0x8031)	Vacant = 0, Input = 1, Output = 2, Alarm = 3

5.2 Digital Output Default Outputs

The default output parameter is configurable for each digital I/O channel configured as an output. Default outputs are the initial values output channels are set to on power-up and firmware reset.

5.2.1 Digital Channel Default Output Registers

The following table identifies the Modbus register addresses and data values used to configure digital output channel default output parameters.

Table 5.3 Digital Output Channel Default Output Registers

REGISTER	ADDRESS	DATA VALUES
DIO Default Output	32820 – 32827 (0x8034-803B)	0 or 1

5.3 Save Digital I/O Setting to EEPROM

The system provides a save I/O setting to EEPROM function for channel states and default output. To save the parameter setting, write any value to Modbus register address 32890. The saved parameter will replace the default setting upon power cycle or firmware reset.

Table 5.4 Save Digital I/O Setting to EEPROM Registers

REGISTER	ADDRESS	DATA VALUES
Save I/O Setting to EEPROM	32890 (0x807A)	Write any value

6.0 Digital I/O Special Function Configuration

The DIO channels are grouped into two banks: Channels 0-3 are Bank 0 and Channels 4-7 are Bank 1. Each of the two banks can run any one of seven special functions at any given time. The system has two timers associated with these banks. Timer1 controls Bank 0 functions and Timer 2 controls Bank 1 functions. Each digital I/O special function uses one or two specific DIO channels. These channels must be configured as input or output before a special function can be used. The following tables identify the digital I/O channel(s) associated with each of the seven special functions and the state that needs to be configured for each timer.

Table 6.1 Bank 0 (Timer1) Special Function Digital I/O Channel

SPECIAL FUNCTION	DIGITAL I/O CHANNEL	STATE / FUNCTION
Pulse / Frequency Counter	I/O Channel 0 I/O Channel 1	Input / Main Signal Input / Main Trigger
Pulse / Frequency Counter with De-bounce	I/O Channel 0 I/O Channel 2	Input / Main Signal Output / De-bounced Version of Input Signal
Waveform Measurement	I/O Channel 0	Input / Main Signal
Time Between Events	I/O Channel 0 I/O Channel 1	Input / Event 1 (Trigger) Input / Event 2
Frequency Generator	I/O Channel 2	Output / Output Signal
PWM Generator	I/O Channel 2 I/O Channel 3	Output / Output Signal 1 Output / Output Signal 2
One-Shot Pulse Generator	I/O Channel 2 I/O Channel 1	Output / One-Shot Signal Input / Trigger Signal

Table 6.2 Bank 1 (Timer2) Special Function Digital I/O Channel

SPECIAL FUNCTION	DIGITAL I/O CHANNEL	STATE / FUNCTION
Pulse / Frequency Counter	I/O Channel 4 I/O Channel 5	Input / Main Signal Input / Main Trigger
Pulse / Frequency Counter with De-bounce	I/O Channel 4 I/O Channel 6	Input / Main Signal Output / De-bounced Version of Input Signal
Waveform Measurement	I/O Channel 4	Input / Main Signal
Time Between Events	I/O Channel 4 I/O Channel 5	Input / Event 1 (Trigger) Input / Event 2
Frequency Generator	I/O Channel 6	Output / Output Signal
PWM Generator	I/O Channel 6 I/O Channel 7	Output / Output Signal 1 Output / Output Signal 2

One-Shot Pulse Generator	I/O Channel 6 I/O Channel 5	Output / One-Shot Signal Input / Trigger Signal

The Modbus register base addresses for Timer1 and Timer2 are shown below. To configure a special function, write a data value of 1-7 to the appropriate register. For example, writing a 1 to address 32900 or 33000 sets the function to Pulse/Frequency Counter; then the remainder of the parameter registers start from base address 32900 or 33000.

The following table identifies Modbus register base addresses for the I/O special functions.

Table 6.3 Digital I/O Special Function Base Address Registers

REGISTER	BASE ADDRESS	DATA VALUES
Timer1	32900 (0x8084)	1 = Pulse/Frequency Counter 2 = Pulse/Frequency Counter with De-bounce 3 = Waveform Measurement 4 = Time Between Events 5 = Frequency Generator 6 = PWM Generator 7 = One-Shot Pulse Generator 0 = Disable Special Function default setting
Timer2	33000 (0x80E0)	

6.1 Pulse / Frequency Counter

The following table identifies Modbus registers used to configure the Pulse/Frequency Counter I/O special function.

Table 6.4 Pulse / Frequency Counter Registers

REGISTER	ADDRESS	DATA VALUES
Ticks per Revolution	Base + 9	1-0xFFFF, Default = 1
Input 0 Polarity	Base + 10	0 = rising, 1 = falling, 2 = both
Timer Gate	Base + 11	0 = user, 1 = positive, 2 = negative
Alarm Configure	Base + 35	1 = pulse, 2 = frequency, 3 = RPM
Alarm High-High Limit	Base + 36	High-High Limit (2 words)
Alarm High Limit	Base + 38	High Limit (2 words)
Alarm Low Limit	Base + 40	Low Limit (2 words)
Alarm Low-Low Limit	Base + 42	Low-Low Limit (2 words)
Alarm HL Deadband Limit	Base + 44	Deadband (1 word)
Alarm HHLL Deadband Limit	Base + 45	Deadband (1 word)
Save Configuration to EEPROM	Base + 90	Write any value to save the current configuration

6.2 Pulse / Frequency Counter with De-bounce

The following table identifies Modbus registers used to configure the Pulse/Frequency Counter with De-bounce I/O special function.

Table 6.5 Pulse / Frequency Counter with De-bounce Registers

REGISTER	ADDRESS	DATA VALUES
Input 0 Polarity	Base + 8	0 = positive, 1 = negative
Output Enable	Base + 9	0 = not enable, 1 = enable
Stay-On Time	Base + 10	Default = 100, or 10ms
Stay-Off Time	Base + 11	Default = 100, or 10ms
Alarm Configure	Base + 35	1 = pulse, 2 = frequency
Alarm High-High Limit	Base + 36	High-High Limit (2 words)
Alarm High Limit	Base + 38	High Limit (2 words)
Alarm Low Limit	Base + 40	Low Limit (2 words)
Alarm Low-Low Limit	Base + 42	Low-Low Limit (2 words)
Alarm HL Deadband Limit	Base + 44	Deadband (1 word)
Alarm HHLL Deadband Limit	Base + 45	Deadband (1 word)
Save Configuration to EEPROM	Base + 90	Write any value to save the current configuration

6.3 Waveform Measurement

The following table identifies Modbus registers used to configure the Waveform Measurement I/O special function.

Table 6.6 Waveform Measurement Registers

REGISTER	ADDRESS	DATA VALUES
Timebase	Base + 30	Timebase
Input 0 Polarity	Base + 31	0 = positive, 1 = negative
Events to Measure	Base + 32	Number of periods to measure 10M max
Average Weight	Base + 34	Integers1 to 32768 Default = 4
Alarm Configure	Base + 35	1 = pulse, 2 = frequency, 3 = duty cycle
Alarm High-High Limit	Base + 36	High-High Limit (2 words)
Alarm High Limit	Base + 38	High Limit (2 words)
Alarm Low Limit	Base + 40	Low Limit (2 words)

Alarm Low-Low Limit	Base + 42	Low-Low Limit (2 words)
Alarm HL Deadband Limit	Base + 44	Deadband (1 word)
Alarm HHLL Deadband Limit	Base + 45	Deadband (1 word)
Save Configuration to EEPROM	Base + 90	Write any value to save the current configuration

6.4 Time Between Events

The following table identifies Modbus registers used to configure the Time Between Events I/O special function.

Table 6.7 Time Between Events Registers

REGISTER	ADDRESS	DATA VALUES
Timebase	Base + 16	Timebase
Channel 0 Polarity	Base + 17	0 = positive, 1 = negative
Channel 1 Polarity	Base + 18	0 = positive, 1 = negative
Average Weight	Base + 19	Integers1 to 32768 Default = 4
Events to Measure	Base + 20	Number of intervals to measure
Alarm Configure	Base + 35	1 = pulse, 2 = frequency, 3 = duty cycle
Alarm High-High Limit	Base + 36	High-High Limit (2 words)
Alarm High Limit	Base + 38	High Limit (2 words)
Alarm Low Limit	Base + 40	Low Limit (2 words)
Alarm Low-Low Limit	Base + 42	Low-Low Limit (2 words)
Alarm HL Deadband Limit	Base + 44	Deadband (1 word)
Alarm HHLL Deadband Limit	Base + 45	Deadband (1 word)
Save Configuration to EEPROM	Base + 90	Write any value to save the current configuration

6.5 Frequency Generator

The following table identifies Modbus registers used to configure the Frequency Generator I/O special function.

Table 6.8 Frequency Generator Registers

REGISTER	ADDRESS	DATA VALUES
Desired Frequency	Base + 4	Desired frequency in Hz Default = 10Hz 100kHz max

Save Configuration to EEPROM	Base + 90	Write any value to save the current configuration

6.6 PWM Generator

The following table identifies Modbus registers used to configure the PWM Generator I/O special function.

Table 6.9 PWM Generator Registers

REGISTER	ADDRESS	DATA VALUES
Timebase	Base + 3	Timebase
Output1 Enable	Base + 4	0 = disable, 1 = enable
PWM Period	Base + 6	Length of period in timebase (2 words)
Output0 Low Time	Base + 8	Length of period in timebase Default = 100
Output1 Low Time	Base + 10	Length of period in timebase Default = 100
Save Configuration to EEPROM	Base + 90	Write any value to save the current configuration

6.7 One-Shot Pulse Generator

The following table identifies Modbus registers used to configure the One-Shot Pulse Generator I/O special function.

Table 6.10 One-Shot Pulse Generator Registers

REGISTER	ADDRESS	DATA VALUES
Timebase	Base + 3	Timebase
Pulse Count	Base + 4	Number of pulses generated
Pulse Count Limit	Base + 6	Number of pulses generated before disarming timer
Output Polarity	Base + 8	0 = positive, 1 = negative
Gate Trigger Select	Base + 9	0 = user, 1 = positive, 2 = negative
Pulse Length	Base + 10	Length of pulse in timebase Default = 100
Pre-delay Length	Base + 12	Length of pre-delay in timebase Default = 100
Post-delay Length	Base + 14	Length of post-delay in timebase Default = 100
Save Configuration to EEPROM	Base + 90	Write any value to save the current configuration

7.0 Analog Input Scan Configuration

The following scan parameters are configurable.

Table 7.1 Analog Input Scan Parameters

SCAN PARAMETERS	VALID SETTINGS	DEFAULT SETTING
Scan Mode	Idle, Continuous, or User-Defined	Idle
Scan List	Any analog input channel ID (0-11) or the end-of-list indicator	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 255
Scan Interval	0 – 65535	1044 (40k sample rate)
Scan Buffer Size	2 – 1920	200 (20k words buffer memory)

Scan parameters are stored in non-volatile memory and can be configured by writing the appropriate Modbus registers. They will persist across power cycles, resets, and brownouts. Scan parameters can be reset back to factory default values by writing the Reset Register with the appropriate value (see Section 13.2 Firmware Resets).

7.1 Scan Mode

The Scan Mode must be one of the following:

- *Idle:* The system is in idle condition for configuration and analog inputs are not scanned. The continuous and user-defined scans must be started from idle mode.
- *Continuous:* All analog inputs are scanned continuously, in sequential order, at a fixed 6000 samples per second scan rate. Channel data is placed in a circular buffer in Processor Board SRAM. Only the most recent conversion is kept for each analog input. A running average, maximum, and minimum value is maintained for each analog input. Channel data is accessed by reading the appropriate Modbus registers.
- *User-Defined*: The user defines parameters such as the scan list, scan interval, and scan buffer size. The scan process is started by writing the appropriate value to the Scan Control Register. The scan process samples each entry in the scan list in the sequence specified and inserts the conversion results into a first-in first-out (FIFO) queue. Channel data is read from the FIFO queue by reading the appropriate Modbus registers.

7.1.1 Scan Mode Register

The following table identifies the Modbus register address and data values used to configure the analog input scan mode. If a value other than the one specified below is written, that value is ignored and the analog scan mode remains unchanged. The scan will start from idle mode. Set the mode back to idle before changing to another scan mode.

Table 7.2 Analog Input Scan Mode Register

REGISTER	ADDRESS	DATA VALUES
Scan Mode	4612 (x1204)	0 = Idle 1 = Continuous 2 = User-Defined

7.2 User-Defined Scan Parameters

The following parameters are only valid in User-Defined Scan Mode.

Scan List

The scan list is a list of up to 48 analog input channel numbers (0-11) terminated by an end-of-list indicator (255). The scan list defines the channels that are scanned and the order in which they are scanned. Channels can be listed in any order and may be duplicated, but they must be one of the 12 analog input channels. There is an end-of-list indicator in position 4912 that cannot be erased. If the user leaves out the end-of-list indicator (255), scan entries between the last programmed channel and entry 48 will be set to 0 and the scan will cover 48 channels.

Scan Interval

The scan interval defines the scan time between two channels. The formula for the interval value is given below:

Interval Value = 41780000 / Sample Rate

Example: For a 10k sample rate, Interval Value = 41780000 / 10000 = 4178.

The maximum sample rate is 100k samples / second. This will decrease if additional signal processing is enabled.

Maximum Sample Rate	Conditions
100kS/s	All input modules except 8B37, 8B47 Averaging disabled Alarms disabled
60kS/s	All input modules except 8B37, 8B47 Averaging enabled Alarms enabled
40kS/s	8B37, 8B47 input module Averaging disabled Alarms disabled
20kS/s	8B37, 8B47 input module Averaging enabled Alarms enabled

It is possible for the user to specify a scan interval that is too fast for the system to realize. In such a situation, the scan will fail when the scan start is attempted.

Scan Buffer Size

The scan buffer size defines the amount of memory used to store data from the scan list entries. If the scan fills the buffer that is defined, the scan will end immediately. The maximum scan buffer size is 192k words and the minimum scan buffer size is 2 words. Configure the scan buffer size by writing the register value to the appropriate address.

Buffer Size Register Value = Buffer Size (words) / 100.

7.2.1 User-Defined Scan Parameter Registers

The following table identifies the Modbus register addresses and data values used to configure user-defined scan parameters.

Table 7.3 User-Defined Scan Parameter Registers

REGISTER	ADDRESS	DATA VALUES
Scan List	4864 – 4912 (0x1300-0x1330)	12 Channel IDs (0-11) End-of-list Indicator = 255(0x00FF)
Scan Interval	4913 (0x1331)	41780000 / Sample Rate
Scan Buffer Size	4914 (0x1332)	2-1920 (Buffer size in words/100)

8.0 Reading Analog Data

In order to acquire data, an 8B input module must be installed in one or more of the analog input channels. The method in which data is read from analog input channels depends on the configured scan mode (see Section 7.1 Scan Mode). This section describes how to read data using Continuous and User-Defined Scan Modes.

8.1 Continuous Scan Data

To start a continuous scan, write a 1 to the Scan Mode Register when the system is in idle mode. The continuous scan LED will turn on to indicate the continuous scan is in progress. To stop a continuous scan, write a 0 to the Scan Mode Register; the system will then return to idle mode. Four types of data can be read from analog input channels while in Continuous Scan Mode.

- *Recent:* A channel's most recent conversion result.
- *Average:* A channel's running average. The weight used in the average calculation is a configurable parameter (see Section 4.0 Analog (ADC/DAC) Channel Configuration).
- *Maximum:* A channel's largest conversion result since the maximum was last reset.
- *Minimum:* A channel's smallest conversion result since the minimum was last reset.

8.1.1 Continuous Scan Data Registers

The following table identifies the Modbus register addresses used to read continuous scan analog data. Registers that correspond to analog input channels will return current analog data when read, if the scan mode is continuous. If the scan mode is user-defined, registers that correspond to analog input ADC channels will return 0x0000. Registers that correspond to analog output DAC channels will return the last value written when read, regardless of the configured scan mode.

To reset minimum, maximum, and average, write a 0 to the relevant register.

Table 8.1 Continuous Scan Data Registers

REGISTER	ADDRESS	DATA VALUES
Recent Counts	0 – 11 (0x0000-0x000B)	0 – 4095 (0x0000-0x0FFF) 0=0V, 4095=5V
Minimum Counts	12 – 23 (0x000C-0x0017)	0 – 4095 (0x0000-0x0FFF) Write 0 to reset
Maximum Counts	24 – 35 (0x0018-0x0023)	0 – 4095 (0x0000-0x0FFF) Write 0 to reset
Average Counts	36 – 47 (0x0024-0x0029)	0 – 4095 (0x0000-0x0FFF) Write 0 to reset

8.2 User-Defined Scan Data

Before reading data from a user-defined scan, scan parameters must be set up as described in Section 7.2 User-Defined Scan Parameters. After a scan is started, the Scan Counter Register can be polled for scan completion. Data can be read from the Scan Data Register when the scan completes, or as data becomes available.

8.2.1 Starting a User-Defined Scan

To start a user-defined scan, write a 2 to the Scan Mode Register when in idle mode. If the scan parameters described in Section 7.2 User-Defined Scan Parameters were configured correctly, the scan will start. The SCN LED will turn on to indicate the user-defined scan is in progress and will stay on until the scan completes.

8.2.2 Polling the Scan Count Register

Once the command to start the scan is issued, the Scan Count Register can be periodically polled to determine if the scan is still in progress and the number of data words currently available in the scan data buffer. A scan can be aborted by writing a 0 to the Scan Mode Register.

8.2.3 Reading Data from the Scan Data Register

The Scan Data Buffer is a 192k FIFO (first-in, first-out) buffer used to store conversion results from a user-defined scan. Conversion results are inserted into the buffer by the scan process as entries in the scan list are converted. A user-defined scan will stop if the scan data buffer becomes full.

The Scan Data Register is the host application's interface to the scan data buffer. Reads from this register extract data from the scan data buffer. Multiple words (up to 125) can be read with a single command, provided they are available (see Section 8.2.2 Polling the Scan Count Register). The Scan Data Register can be read any time that data is available, either while a scan is in progress or after one is complete. If more words than are available are read from the scan data buffer, 0 will be returned for the data values that are not yet available. Starting a new scan will clear the contents of the scan data buffer. After data is read from the buffer, it is no longer available.

8.2.4 User-Defined Scan Data Registers

The following table identifies the Modbus register addresses and data values used to read analog data resulting from the user-defined scan.

Table 8.2 User-Defined Scan Control/Data Registers

REGISTER	ADDRESS	DATA VALUES
Scan Data FIFO	256 – 381 (0x0100-0x017D)	0 – 4095 (0x0000-0x0FFF)

9.0 Writing Analog Output Data

In order to write analog data, an 8B39 or 8B49 output module must be installed in one or more of the analog output channels. Writing data to an analog output channel results in the voltage represented by the data value being placed at the input of the 8B39 or 8B49 output module. The 8B isoLynx® SLX300 stores the last value written to each channel.

9.1 Write Analog Output Data Registers

The following table identifies the Modbus register addresses and data values used to write data to analog output channels.

Table 9.1 Write Analog Data Registers

REGISTER	ADDRESS	DATA VALUES
4 Channel DAC Output	4352 – 4355 (0x1100-0x1103)	0 – 4095 (0x0000-0x0FFF) 0 = 0V, 4095 = 5V

9.2 Analog Output DAC User-Defined-Scan (Burst Mode)

In DAC User-Defined Scan Mode (Burst Mode), the analog output data can be preloaded in the 64k buffer memory (16k per channel). A scan interval needs to be configured, and then a scan is started with a Modbus Write Registers command to the Scan Control register.

The DAC User-Defined Scan Mode (Burst Mode) has the following configurable parameters:

Table 9.2 Configurable DAC Burst Mode Parameters

DAC BURST MODE PARAMETER	VALID SETTINGS	DEFAULT SETTING
Burst Scan Control	0 = Stop, 1 = Run Write a 0 to reset buffer memory pointers	0
Interval	1 – 65535ms	10ms
4x16k Buffer	Data 0-4095 0 = 0V 4095 = +5V -1 = Stop 4096 = Loop Back	0

9.2.1 4x16k Buffer Registers

Valid data has a range of 0 to 4095 which represents a 0-5 volt output signal from the DAC to the input of an 8B39 or 8B49 module. A data value of -1 (0xFFFF) will cause the scan to stop and a data value of 4096 (0x1000) will cause the scan to loop back to the beginning and restart.

Ten Modbus register addresses are used to read and write data from or to the 16k segment of buffer memory associated with each output channel. A read or write to the bottom address in each segment allows the user to transfer 10 data values at a time from or to the memory. After each read or write operation, the buffer memory pointer is incremented such that subsequent read or write operations to the same bottom address will advance to the next 10 value block of the 16k memory. Read and write operations occur sequentially starting at the beginning of the memory segment. Data cannot be read from or written to specific locations in the middle of the memory segment. If a read or write operation exceeds the 16k segment boundary, the operation wraps around to the beginning of the segment. The buffer memory is volatile. Data stored here will be lost upon power cycle, reset or brownout.

The following table identifies the Modbus register addresses and data values used to configure a 4x16k words buffer memory.

Table 9.3 4x16k Buffer Registers

REGISTER	ADDRESS	DATA VALUES
Channel 0 16k Buffer	4432 – 4442 (0x1150-0x115A)	Data = 108 – 4084 (0-5V)
Channel 1 16k Buffer	4448 – 4458 (0x1160-0x116A)	0 = Stop, 4095 = Loop Back
Channel 2 16k Buffer	4464 – 4474 (0x1170-0x117A)	
Channel 3 16k Buffer	4480 – 4490 (0x1180-0x118A)	

9.2.2 DAC Interval Register

The following table identifies the Modbus register address and data values used to configure the DAC interval parameters.

Table 9.4 DAC Interval Register

REGISTER	ADDRESS	DATA VALUES
DAC Interval	4416 (0x1140)	1 – 65535, Default = 10ms

9.2.3 DAC Burst Control Register

The following table identifies the Modbus register address and data values used to configure the DAC burst control parameters.

Table 9.5 DAC Burst Control Registers

REGISTER	ADDRESS	DATA VALUES
Burst Scan Control	4608 (0x1200)	0 = Stop, 1 = Run

Writing a 0 to the Burst Control Register will also reset all channel buffer memory read and write pointers to 0.

10.0 Digital Data and I/O Special Functions

In order to read or write digital data, an SCMD input or output module must be installed in one or more of the digital I/O channels.

The 8B isoLynx® SLX300 has seven digital I/O special functions: Pulse/Frequency Counter, Pulse/Frequency Counter with De-bounce, Waveform Measurement, Time Between Events, Frequency Generator, PWM Generator, and One-Shot Pulse Generator.

10.1 Digital Data Read and Write

Digital input and output channels can be read by issuing the Modbus Read command to the appropriate addresses. Reading a digital input and/or output returns the current digital state of that channel. Reading a vacant channel returns a 1.

Digital output channels can be written by issuing the Modbus Write command to the appropriate addresses. Writing a digital input or vacant channel will have no effect.

The following table identifies the Modbus addresses and data values used to read data from and write data to digital data channel registers.

Table 10.1 Digital Data Channel Registers

REGISTER	ADDRESS	DATA VALUES
8 DIO Data	32800 – 32807 (0x8020-0x8027)	0 or 1
DIO Data Combined	32829 (0x803D)	0x0000 – 0x00FF

10.2 Digital I/O Special Functions

There are two 32-bit timers. Each timer is independent of the other and can perform seven special functions. Each timer also has two digital I/O channels on the system board that are associated with it and can use one or both, depending on the selected special function. To start a special function, first configure the associated I/O channel(s) to input or output, then write the special function code into the timer base address (see Section 6.0 Digital I/O Special Function Configuration).

The Modbus base address of Timer1 is 32900 (0x8084) and of Timer2 is 33000 (0x80E0).

10.2.1 Pulse / Frequency Counter Function

To use the pulse/frequency counter function, write a 1 to the base address of one of the timers and configure the counters as described in Section 6.1 Pulse/Frequency Counter.

To start the counter, write a 1 to the Arm/Disarm register, and to stop the counter, write a 0 to the Arm/Disarm register.

The following table identifies the Modbus addresses, access and data values used to operate the counters.

Table 10.2 Pulse / Frequency Counter Registers

REGISTER	ADDRESS	ACCESS	DATA VALUES
Arm/Disarm	Base+1	R/W	0 = Disarm, 1 = Arm
Status	Base+2	R/	Status
Alarm Status	Base+3	R/	Alarm status
Pulse Count	Base+4-5	R/W	Pulse count 10M max Write any value to reset counter
Frequency Count	Base+6-7	R/	Frequency count 11kHz max w/ SCMD isolated modules 80kHz max w/ SCMD-PT non-isolated module
RPM	Base+8	R/	Revolutions per minute 65536 max
Hardware Gate Status	Base+12	R/	0 = not selected 1 = open 2 = closed

10.2.2 Pulse / Frequency Counter with De-bounce Function

To use the pulse/frequency counter with de-bounce function, write a 2 to the base address of one of the timers and configure the counters as described in Section 6.2 Pulse/Frequency Counter with De-bounce.

To start the counter, write a 1 to the Arm/Disarm register, and to stop the counter, write a 0 to the Arm/Disarm register.

The following table identifies the Modbus addresses, access and data values used to operate the counters.

Table 10.3 Pulse / Frequency Counter with De-bounce Registers

REGISTER	ADDRESS	ACCESS	DATA VALUES
Arm/Disarm	Base+1	R/W	0 = Disarm, 1 = Arm
Status	Base+2	R/	Status
Alarm Status	Base+3	R/	Alarm status
Pulse Count	Base+4-5	R/W	Pulse count 10M max Write any value to reset counter
Frequency Count	Base+6-7	R/	Frequency count 11kHz max w/ SCMD isolated modules 80kHz max w/ SCMD-PT non-isolated module

10.2.3 Waveform Measurement Function

To use the waveform measurement function, write a 3 to the base address of one of the timers and configure the timer as described in Section 6.3 Waveform Measurement.

To start the measurement, write a 1 to the Arm/Disarm register, and to stop the measurement, write a 0 to the Arm/Disarm register.

The following table identifies the Modbus addresses, access and data values used to operate the waveform measurement function.

Table 10.4 Pulse Waveform Measurement Registers

REGISTER	ADDRESS	ACCESS	DATA VALUES
Arm/Disarm	Base+1	R/W	0 = Disarm, 1 = Arm
Status	Base+2	R/	Status
Alarm Status	Base+3	R/	Alarm status
Events Measured	Base+4-5	R/W	Number of cycles, Write any value to reset events 10M max
Frequency Count	Base+6-7	R/	Frequency count 15kHz max
Duty Cycle Combined	Base+8-9	R/	Duty cycles (8-bit integer, 8-bit fraction)
Period	Base+10-11	R/	Period of waveform
Open Time	Base+12-13	R/	Time open (positive pulse width)
Close Time	Base+14-15	R/	Time close (negative pulse width)
Average Open Time	Base+16-17	R/	Average open time
Average Close Time	Base+18-19	R/	Average close time
Max Open Time	Base+20-21	R/W	Max time open, Write any value to reset to zero
Min Open Time	Base+22-23	R/W	Min time open, Write any value to reset to zero
Max Close Time	Base+24-25	R/W	Max time close, Write any value to reset to zero
Min Close Time	Base+26-27	R/W	Min time close, Write any value to reset to zero
Duty Cycle Integer	Base+28	R/	Duty cycle (integer portion, 0-100)
Duty Cycle Fractional	Base+29	R/	Duty cycle (fraction portion)

10.2.4 Time Between Events Function

To use the time between events function, write a 4 to the base address of one of the timers and configure the function as described in Section 6.4 Time Between Events.

To start measuring, write a 1 to the Arm/Disarm register, and to stop measuring, write a 0 to the Arm/Disarm register.

The following table identifies the Modbus addresses, access and data values used to operate the time between events function.

Table 10.5 Time Between Events Registers

REGISTER	ADDRESS	ACCESS	DATA VALUES
Arm/Disarm	Base+1	R/W	0 = Disarm, 1 = Arm
Status	Base+2	R/	Status
Alarm Status	Base+3	R/	Alarm status
Events Measured	Base+4-5	R/W	Number of intervals, Write any value to reset to zero
Frequency of Events	Base+6-7	R/	Event frequency
Time Between Events	Base+8-9	R/	Interval length
TBE Max	Base+10-11	R/W	Maximum Write any value to reset to zero
TBE Min	Base+12-13	R/W	Minimum Write any value to reset to zero
TBE Average	Base+14-15	R/	Average

10.2.5 Frequency Generator Function

To use the frequency generator function, write a 5 to the base address of one of the timers and configure the generator as described in Section 6.5 Frequency Generator.

To start the generator, write a 1 to the Arm/Disarm register, and to stop the generator, write a 0 to the Arm/Disarm register.

The following table identifies the Modbus addresses, access and data values used to operate the frequency generator function.

Table 10.6 Frequency Generator Registers

REGISTER	ADDRESS	ACCESS	DATA VALUES
Arm/Disarm	Base+1	R/W	0 = Disarm, 1 = Arm
Status	Base+2	R/	Status

10.2.6 PWM Generator Function

To use the PWM generator function, write a 6 to the base address of one of the timers and configure the generator as described in Section 6.6 PWM Generator.

To start the generator, write a 1 to the Arm/Disarm register, and to stop the generator, write a 0 to the Arm/Disarm register.

The following table identifies the Modbus addresses, access and data values used to operate the PWM generator function.

Table 10.7 PWM Generator Registers

REGISTER	ADDRESS	ACCESS	DATA VALUES
Arm/Disarm	Base+1	R/W	0 = Disarm, 1 = Arm
Status	Base+2	R/	Status

10.2.7 One-Shot Pulse Generator Function

To use the one-shot pulse generator function, write a 7 to the base address of one of the timers and configure the generator as described in Section 6.7 One-Shot Pulse Generator.

To start the generator, write a 1 to the Arm/Disarm register, and to stop the generator, write a 0 to the Arm/Disarm register.

The following table identifies the Modbus addresses, access and data values used to operate the one-shot pulse generator function.

Table 10.8 One-Shot Pulse Generator Registers

REGISTER	ADDRESS	ACCESS	DATA VALUES
Arm/Disarm	Base+1	R/W	0 = Disarm, 1 = Arm
Status	Base+2	R/	Status
Pulse Count	Base+4-5	R/W	Pulse count Write any value to reset to zero

11.0 User Data

Two hundred fifty-six (256) 16-bit words of memory are reserved for general purpose user data. Users are free to make use of this memory as they see fit. Any data value can be written and later retrieved by issuing standard Modbus register Read/Write commands. Eight locations are stored in non-volatile memory and data values written to these locations persist across power cycles, resets, and brownouts.

11.1 User Data Registers

The following table identifies the Modbus register addresses used to read and write user data.

Table 11.1 User Data Registers

REGISTER	ADDRESS	DATA VALUES
User Data Registers	0x2400 – 0x24FF	0x0000 – 0xFFFF

12.0 Device Information

The following information can be obtained for the system board:

- Company Logo
- Date Code
- Serial Number
- AIO Firmware Revision
- DIO Firmware Revision
- Ethernet Firmware Revision

12.1 Device Information Registers

The following table identifies the Modbus register addresses used to read device information.

Table 12.1 Device Information Registers

REGISTER	ADDRESS	DATA VALUES
Company Logo	33300 – 33331	ASCII Codes 0x0000 – 0x007F
Date Code	33332 – 33336	
Serial Number	33337 – 33347	
AIO Firmware Revision	33348 – 33352	
DIO Firmware Revision	33353 – 33357	
Ethernet Firmware Revision	33358 – 33362	

13.0 Miscellaneous Function and Control

13.1 Temperature Sensor

The 8B isoLynx® SLX300 has one onboard temperature sensor which is used for Cold Junction Compensation when 8B37x or 8B47x-xx thermocouple modules are installed. This sensor can be read by issuing the Modbus Read command to the appropriate address.

13.1.1 Temperature Sensor Register

The following table identifies the Modbus register address used to read the onboard temperature sensor information.

Table 13.1 Temperature Sensor Register

REGISTER	ADDRESS	DATA VALUES
Temperature	5633 (0x1601)	0 – 4095 (16 count / Degrees C)

13.2 Firmware Resets

Two types of firmware reset are supported on the 8B isoLynx® SLX300.

Standard Reset: This reset is used to bring the system back to a known user-defined state. It resets analog and digital output channels to configured default output values, resets analog input average, max and min values, resets the scan sample and mode registers, the CJC control register and the alarm control and status register. Communications parameters are not affected.

Reset-to-Default: This reset is used to bring the system back to the settings established at the factory during manufacture. It performs the standard reset actions plus resets most non-volatile parameters to default settings. Communication parameters are not affected by a reset-to-default. Refer to the tables below for further details.

Table 13.2 Analog I/O Parameters Affected by Reset Commands

RESET TYPE	PARAMETERS
Standard Reset	• Analog output channels (to configured default output settings) • Analog input channels: average, maximum, and minimum values • Scan sample and mode register • CJC control register • Alarm control and status register • User data (except non-volatile)
Reset-to-Default	• All parameters listed under Standard Reset, plus: • ADC: average weight, scan list, scan interval, buffer size, gain coefficient and offset coefficient register • DAC: default output, slope, intercept and

	scan interval register • CJC: type and temperature coefficient register • Alarm: upper limit, lower limit, HH limit, LL limit, and deadband register

Table 13.3 Digital I/O Parameters Affected by Reset Commands

RESET TYPE	PARAMETERS
Standard Reset	• Digital output channels (to configured default output settings)
Reset-to-Default	• All parameters listed under Standard Reset, plus: • Channel states • Default outputs

13.2.1 Reset Registers

Writing a reset register with an appropriate data value will cause the system to undergo a firmware reset. The data value written determines the type of reset.

NOTE: The 8B isoLynx® SLX300 sends a response to the reset register write before carrying out the reset. This means the system will be unresponsive to the host immediately after the host receives the reset response. The host should delay for 3 seconds to allow the 8B isoLynx® SLX300 time to start up before attempting communication again.

The following table identifies the Modbus register addresses and data values used to perform firmware resets. Reading a reset register has no effect and will return a data value of 0x0000.

Table 13.4 Reset Registers

REGISTER	ADDRESS	DATA VALUES
AIO Reset	8960 (0x2300)	0 = Standard Reset 255 = Reset-to-Default
DIO Reset	32769 (0x8001)	0 = Standard Reset 255 = Reset-to-Default

14.0 Appendix A: 8B isoLynx® SLX300 Modbus Address Map

Board Information			
Read			
Description	**Address 33300**	**Access**	**Values**
Company Logo	0 – 31	R	"Dataforth Corp - isoLynx 8B"
Date Code	32 – 36	R	"D0123"
Serial Number	37 – 47	R	"S1234567-89"
AIO Firmware	48 – 52	R	"Ax.xx"
DIO Firmware	53 – 57	R	"Lx.xx"
Ethernet Firmware	58 – 62	R	"Ex.xx"

Communication Settings			
Description	**Address 33400**	**Access**	**Values**
Device Type	0	R	1 = Serial, 2 = Ethernet
Baud Rate	1	R/W	10 = 921600 9 = 460800 8 = 230400 7 = 115200 (default) 6 = 57600 5 = 38400 4 = 19200 3 = 9600 2 = 4800 1 = 2400
Parity	2	R/W	0 = None, 1 = Odd, 2 = Even
RS-485 2- or 4-Wire	3	R/W	1 = 4-Wire, 0 = 2-Wire
RS-485 Termination Enable	4	R/W	0 = Disabled, 1 = Enabled
Ethernet IP Address	5 – 8	R/W	MSB = 5, LSB = 8 (192.168.128.100)
Ethernet Subnet Mask	9 – 12	R/W	MSB = 9, LSB = 12 (255.255.0.0)
Modbus Timeout Percentage	13	R/W	20 to 100 percent

Analog I/O			
Description	**Address**	**Access**	**Values**
ADC Continuous Scan Mode			
12 Channels Current Data	0 – 11	R	0 – 4095 (0x0000-0x0FFF) 0 = 0V, 4095 = 5V
12 Channels Minimum Data	12 – 23	R/W	0 – 4095 (0x0000-0x0FFF) Write a 0 to reset
12 Channels Maximum Data	24 – 35	RW	0 – 4095 (0x0000-0x0FFF) Write a 0 to reset
12 Channels Average Data	36 – 47	RW	0 – 4095 (0x0000-0x0FFF) Write a 0 to reset
12 Channels Average Weight	48 – 59	R/W	Average = Average + ((Sampled Value - Average) / Average Weight) Default Average Weight = 4
ADC User-Defined Scan			
Data	256 - 381	R	0 – 4095 (0x0000-0x0FFF) 0 = 0V, 4095 = 5V Multiple reads up to 125 with one read command
Scan List	4864 - 4912	R/W	Total 48 entry scan list 12 analog channel IDs(0-11) End-of-list indicator is 255(0x00FF) Default = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 255
Scan Interval	4913	R/W	Scan interval value = 41780000 / sample rate Default = 1044 (40k sample rate)
Scan Buffer Size	4914	R/W	Scan buffer size register value = Scan buffer size /100 Valid setting is 2 – 1920 (200-1920000) Default = 200 (20k words buffer memory)
Scan Samples Counter	4915	R	0 – 65535 (0x0000-0xFFFF) If the counter is over 0xFFFF, counter = 0xFFFF
Scan Mode Command	4612	W	0 = Idle, 1 = Continuous, 2 = User-Defined To change from continuous mode to user-defined mode, set to idle mode first
DAC Continuous Scan Mode			
4 Channels Output	4352 - 4355	R/W	0 – 4095 (0x0000-0x0FFF) 0 = 0V, 4095 = 5V
4 Channels Default Output	4368 - 4371	R/W	0 – 4095 (0x0000-0x0FFF) 0 = 0V, 4095 = 5V Default = 0 (0V)

DAC User-Defined Scan			
Channel 0 16k Memory	4432 - 4442	R/W	Data Value = 0 – 4095 (0-5V) -1 = stop scan 4096 = loop back scan Multiple read/write up to 10 data entries with one read/write command To reset the read/write pointer, write a 0 to the scan control register at Modbus address 4608
Channel 1 16k Memory	4448 - 4458	R/W	Data Value = 0 – 4095 (0-5V) -1 = stop scan 4096 = loop back scan Multiple read/write up to 10 data entries with one read/write command To reset the read/write pointer, write a 0 to the scan control register at Modbus address 4608
Channel 2 16k Memory	4464 - 4474	R/W	Data Value = 0 – 4095 (0-5V) -1 = stop scan 4096 = loop back scan Multiple read/write up to 10 data entries with one read/write command To reset the read/write pointer, write a 0 to the scan control register at Modbus address 4608
Channel 3 16k Memory	4480 - 4490	R/W	Data Value = 0 – 4095 (0-5V) -1 = stop scan 4096 = loop back scan Multiple read/write up to 10 data entries with one read/write command To reset the read/write pointer, write a 0 to the scan control register at Modbus address 4608
Interval	4416	R/W	1 – 65536ms, Default = 10ms
Scan Control	4608	W	0 = stop and reset read/write pointer, 1 = run
Temperature	5633	R	0 – 4095 (16 count / Degrees C) Used for CJC
Alarm			
12 Channels Control	8192 - 8203	R/W	Alarm control code Default = 0 (Disable)
12 Upper Limit	8208 - 8219	R/W	0 – 4095 Default = 4095
12 Lower Limit	8224 - 8235	R/W	0 – 4095 Default = 0
12 Upper Deadband	8256 - 8267	R/W	0 – 4095 Default = 0
12 Lower Deadband	8272 - 8283	R/W	0 – 4095 Default = 0
Alarm Status	8240	R/W	Set channel bit to 1 for alarm LSB = analog channel 0 Write a 0 to clear latched mode alarm
12 HHLL Control	8704 - 8715	R/W	HHLL alarm control code Default = 0 (Disable)
12 HHLL Upper Limit	8720 - 8731	R/W	0 – 4095 Default = 4095

12 HHLL Lower Limit	8736 - 8747	R/W	0 – 4095 Default = 0
12 HHLL Upper Deadband	8768 - 8779	R/W	0 – 4095 Default = 0
12 HHLL Lower Deadband	8784 - 8795	R/W	0 – 4095 Default = 0
HHLL Alarm Status	8752	R/W	Set channel bit to 1 for alarm LSB = analog channel 0 Write a 0 to clear latched mode alarm
Cold Junction Compensation			
12 Channels Control	5888 - 5899	R/W	1 = Enable CJC, 0 = Disable CJC
12 Channels Type	5904 - 5915	R/W	Type code: 8B37J = 11 (default) 8B37K = 12 8B37R = 13 8B37S = 14 8B37T = 15 8B47J-01 = 21 8B47J-02 = 21 8B47J-03 = 21 8B47J-12 = 21 8B47K-04 = 22 8B47K-05 = 22 8B47K-13 = 22 8B47K-14 = 22 8B47T-06 = 25 8B47T-07 = 25
12 Lower Range	5920 - 5931	R/W	Lower range temperature
12 Upper Range	5932 - 5943	R/W	Upper range temperature
Save to EEPROM Command	8448	W	0 = Save all, 1 = Save ADC, 2 = Save DAC, 3 = Save CJC, 4 = Save Alarm
Reset (Standard/Default)	8960	W	0 = Standard Reset, 255 = Reset-to-Default

Digital I/O			
Description	**Address 32800**	**Access**	**Values**
Digital Channel Data	0 – 7	R/W	Each address in this range corresponds to a single channel. Valid values are 0 and 1 (8 words). Values written to input channels are accepted, but will not appear on output unless the channel state is changed to output. A value written to a channel reserved as a timer output returns an error.
Digital Error Register	9	R/W	Indicates errors Writing any value to this register sets it to zero

Digital Channel States	10 – 17	R/W	Each address in this range corresponds to the state of a single digital channel (8 words) Valid channel states are Vacant (0x0000)(Default) Input (0x0001) Output (0x0002) Alarm (0x0003)
Digital Panel Default Outputs	20 – 27	R/W	Each address in this range corresponds to the default output for a single digital output channel (8 words) The default output is the value a digital output channel is set to upon power cycle or reset Factory default = 0
Store Digital Channel Settings	90	W	A write to this register will store the current settings of the digital I/O channels (i.e., input or output) and their default settings in EEPROM. These values are read upon power cycle or reset.
Digital Channel Data Combined	29	R/W	The lower 8 bits of this word control all 8 channels. Values written to input channels, vacant channels, or channels configured as timer outputs are ignored.

Reset Register			
Description	**Address**	**Access**	**Values**
Reset (Standard/Default)	32769	W	0 = Standard Reset, 255 = Reset-to-Default

Channels 0 to 3 (Counter 0) - **Special Function Base Address** = **32900**			
Channels 4 to 7 (Counter 1) - **Special Function Base Address** = **33000**			
Counter-Timer Function 1: Pulse / Frequency Counter			
Description	**Address**	**Access**	**Values**
Timer Function	0	R/W	0x0001 pulse counter
Timer Arm/Disarm	1	R/W	0x0000 disarmed/disarm 0x0001 armed/arm
Timer Status	2	R	0 = Timer OK 11 = Invalid Channel Configuration 12 = Timer arm attempted with no function selected 17 = Pulse rate or frequency exceeds max

Alarm Status	3	R	Contains alarm status
Pulse Count	4	R/W	Pulse count (2 words) 10M max Writing any value to either of these words resets the counter to zero
Frequency	6	R	Frequency of input signal (2 words) 11kHz max w/ SCMD isolated modules 80kHz max w/ SCMD-PT non-isolated module
RPM	8	R	Revolutions per minute 65536 max
Ticks per Revolution	9	R/W	Ticks per revolution for RPM measurement Default = 1
Input 0 Polarity	10	R/W	0x0000 positive (rising) 0x0001 negative (falling)
Timer Gate	11	R/W	0x0000 user command 0x0001 hardware, positive polarity 0x0002 hardware, negative polarity
Hardware Gate Status	12	R	0x0000 hardware gate not selected 0x0001 hardware gate currently open 0x0002 hardware gate currently closed This register shows what the current gate status is and can be used to check whether polarity is correct.
Timer Rollover (future)	13	R	Pulse count (2 words)
Alarm Configuration	35	R/W	Valid alarms for this function are: 1 = Pulse Count, 2 = Frequency, 3 = RPM
Alarm High-High Limit	36	R/W	High-High limit (2 words)
Alarm High Limit	38	R/W	High limit (2 words)
Alarm Low Limit	40	R/W	Low limit (2 words)
Alarm Low-Low Limit	42	R/W	Low-Low limit (2 words)
Alarm HL Deadband	44	R/W	High-Low Deadband (1 word)
Alarm HHLL Deadband	45	R/W	High-High Low-Low Deadband (1 word)
Timer Save Function Configuration	90	W	Write any value to save the current configuration for this function

Counter-Timer Function 2: Pulse / Frequency Counter with De-bounce			
Description	**Address**	**Access**	**Values**
Timer Function	0	R/W	0x0002 pulse counter with de-bounce
Timer Arm/Disarm	1	R/W	0x0000 disarmed/disarm 0x0001 armed/arm
Timer Status	2	R	0 = Timer OK 11 = Invalid Channel Configuration 12 = Timer arm attempted with no function selected 17 = Pulse rate or frequency exceeds max
Alarm Status	3	R	Contains alarm status
Pulse Count	4	R/W	Pulse count (2 words) 10M max Writing any value to either of these words resets the counter to zero
Frequency	6	R	Frequency of input signal (2 words) 11kHz max w/ SCMD isolated modules 80kHz max w/ SCMD-PT non-isolated module
Input 0 Polarity	8	R/W	0x0000 positive (default) 0x0001 negative
De-bounce Output Enable	9	R/W	0x0000 not enabled (default) 0x0001 enabled (“cleaned” output appears on Output0)
Stay-On Time	10	R/W	Length of time, in ten-thousandths of a second, that the input pin must stay high (low) to count as a valid pulse Default = 100, or 10ms
Stay-Off Time	11	R/W	Length of time, in ten-thousandths of a second, that the input pin must stay low (high) to count as a valid interval between pulses Default = 100, or 10ms
Alarm Configuration	35	R/W	Valid alarms for this function are: 1 = Pulse Count, 2 = Frequency
Alarm High-High Limit	36	R/W	High-High limit (2 words)
Alarm High Limit	38	R/W	High limit (2 words)
Alarm Low Limit	40	R/W	Low limit (2 words)
Alarm Low-Low Limit	42	R/W	Low-Low limit (2 words)
Alarm HL Deadband	44	R/W	High-Low Deadband (1 word)
Alarm HHLL Deadband	45	R/W	High-High Low-Low Deadband (1 word)
Timer Save Function Configuration	90	W	Write any value to save the current configuration for this function

Counter-Timer Function 3: Waveform Measurement			
Description	**Address**	**Access**	**Values**
Timer Function	0	R/W	0x0003 duty cycle measurement
Timer Arm/Disarm	1	R/W	0x0000 disarmed/disarm 0x0001 armed/arm
Timer Status	2	R	0 = Timer OK 11 = Invalid Channel Configuration 12 = Timer arm attempted with no function selected 17 = Pulse rate or frequency exceeds max
Alarm Status	3	R	Contains alarm status
Events Measured	4	R/W	Number of cycles measured 10M max Writing any value to this register resets it to zero
Frequency	6	R	Frequency of waveform
Duty Cycle Combined	8	R	Duty cycle, fixed-point (8-bit integer, 8-bit fraction) Use to read duty cycle with one Modbus query Provides fractional precision
Period	10	R	Period of waveform in timebase units (2 words)
Open Time	12	R	Time open in timebase units (2 words) Positive Pulse Width
Closed Time	14	R	Time closed in timebase units (2 words) Negative Pulse Width
Avg Open Time	16	R	Average time open in timebase units (2 words)
Avg Closed Time	18	R	Average time closed in timebase units (2 words)
Max Open Time	20	R/W	Max time open in timebase units (2 words) Writing any value to this register resets it to zero
Min Open Time	22	R/W	Min time open in timebase units (2 words) Writing any value to this register resets it to high values
Max Closed Time	24	R/W	Max time closed in timebase units (2 words) Writing any value to this register resets it to zero
Min Closed Time	26	R/W	Min time closed in timebase units (2 words) Writing any value to this register resets it to high values
Duty Cycle Integer	28	R	Duty cycle (integer portion, 0 to 100) Duty cycle = GateOpenTime / PeriodLength

Duty Cycle Fractional	29	R	Duty cycle (16-bit fractional portion) The counter-timer may change this value at any time. To be associated properly with the integer portion, this register is latched when the integer portion is read, and must be read by the next Modbus command.
Timebase	30	R/W	0 = 1 second 1 = 1 millisecond 2 = 1 microsecond 3 = 1 nanosecond
Input0 Polarity	31	R/W	0x0000 positive polarity 0x0001 negative polarity
Events to Measure	32	R/W	Number of periods to measure (2 words) Default = 0 0 = continue measuring until a Modbus command is sent to stop
Average Weight	34	R/W	Sample weight for prior moving average calculations Default = 4
Alarm Configuration	35	R/W	Valid alarms for this function are: 1 = Pulse Count, 2 = Frequency, 3 = Duty Cycle
Alarm High-High Limit	36	R/W	High-High limit (2 words)
Alarm High Limit	38	R/W	High limit (2 words)
Alarm Low Limit	40	R/W	Low limit (2 words)
Alarm Low-Low Limit	42	R/W	Low-Low limit (2 words)
Alarm HL Deadband	44	R/W	High-Low Deadband (1 word)
Alarm HHLL Deadband	45	R/W	High-High Low-Low Deadband (1 word)
Timer Save Function Configuration	90	W	Write any value to save the current configuration for this function

Counter-Timer Function 4: Time Between Events

Description	Address	Access	Values
Timer Function	0	R/W	0x0004 time between events
Timer Arm/Disarm	1	R/W	0x0000 disarmed/disarm 0x0001 armed/arm
Timer Status	2	R	0 = Timer OK 11 = Invalid Channel Configuration 12 = Timer arm attempted with no function selected 17 = Pulse rate or frequency exceeds max
Alarm Status	3	R	Contains alarm status

Events Measured	4	R/W	Number of intervals measured (2 words) Write any value to clear this register
Frequency of Events	6	R	Number of times per second the time-between-events is occurring (2 words)
Time Between Events	8	R	Interval length in timebase units (2 words)
TBE Maximum	10	R/W	Maximum time between events (2 words) Write any value to clear this register
TBE Minimum	12	R/W	Minimum time between events (2 words) Write any value to clear this register
TBE Average	14	R	Average interval length in timebase units (2 words) Can only be cleared by disarming and rearming the timer
Timebase	16	R/W	0 = 1 second 1 = 1 millisecond 2 = 1 microsecond 3 = 1 nanosecond
Channel 0 Polarity	17	R/W	0x0000 positive edge 0x0001 negative edge Any non-zero value written to this register selects negative edge Zero selects positive edge (default)
Channel 1 Polarity	18	R/W	0x0000 positive edge 0x0001 negative edge Any non-zero value written to this register selects negative edge Zero selects positive edge (default)
Moving Average Weight	19	R/W	Number of samples to include in moving average Average is calculated as prior moving average Moving average weight is the inverse weight of each new sample Default value = 4
Events to Measure	20	R/W	Number of intervals to measure (2 words) Default = 0 0 = continue measuring until a Modbus command is sent to stop
Alarm Configuration	35	R/W	Valid alarms for this function are 1 = Events Measured 2 = Time Between Events
Alarm High-High Limit	36	R/W	High-High limit (2 words)
Alarm High Limit	38	R/W	High limit (2 words)
Alarm Low Limit	40	R/W	Low limit (2 words)
Alarm Low-Low Limit	42	R/W	Low-Low limit (2 words)

Alarm HL Deadband	44	R/W	High-Low Deadband (1 word)
Alarm HHLL Deadband	45	R/W	High-High Low-Low Deadband (1 word)
Timer Save Function Configuration	90	W	Write any value to save the current configuration for this function

Counter-Timer Function 5: Frequency Generator			
Description	**Address**	**Access**	**Values**
Timer Function	0	R/W	0x0005 frequency generation
Timer Arm/Disarm	1	R/W	0x0000 disarmed/disarm 0x0001 armed/arm
Timer Status	3	R	0 = Timer OK 11 = Invalid Channel Configuration 12 = Timer arm attempted with no function selected 16 = Invalid frequency, exceeds max
Timer Desired Frequency	4	R/W	Desired frequency in Hz (2 words) 100kHz max
Timer Save Function Configuration	90	W	Write any value to save the current configuration for this function

Counter-Timer Function 6: PWM Generator			
Description	**Address**	**Access**	**Values**
Timer Function	0	R/W	0x0006 PWM generation
Timer Arm/Disarm	1	R/W	0x0000 disarmed/disarm 0x0001 armed/arm
Timer Status	2	R	0 = Timer OK 11 = Invalid Channel Configuration 12 = Timer arm attempted with no function selected 16 = Invalid frequency, exceeds max
Timer Timebase	3	R/W	0 = 1 second 1 = 1 millisecond 2 = 1 microsecond 3 = 1 nanosecond
Timer PWM Output 1 Enable	4	R/W	0x0000 Output 1 disabled (default value) 0x0001 Output 1 enabled
Timer PWM Period	6	R/W	Length of period in timebase units (2 words)
Timer PWM Output 0 Low Time	8	R/W	Length of low time on output 0 in timebase units Default = 100

Timer PWM Output 1 Low Time	10	R/W	Length of low time on output 1 in timebase units Default = 100
Timer Save Function Configuration	90	W	Write any value to save the current configuration for this function

Counter-Timer Function 7: One-Shot Pulse Generator			
Description	**Address**	**Access**	**Values**
Timer Function	0	R/W	0x0007 triggered pulse generation
Timer Arm/Disarm	1	R/W	0x0000 disarmed/disarm 0x0001 armed/arm
Timer Status	2	R	0 = Timer OK 11 = Invalid Channel Configuration 12 = Timer arm attempted with no function selected 16 =Invalid frequency, exceeds max
Timer Timebase	3	R/W	0 = 1 second 1 = 1 millisecond 2 = 1 microsecond 3 = 1 nanosecond
Timer Pulse Count (events measured register)	4	R/W	Number of pulses generated (2 words) 10M max Writing any value to this register resets it to 0
Timer Pulse Count Limit (events to measure register)	6	R/W	Number of pulses to generate before disarming timer (2 words) 10M max Zero (default value) means no limit
Timer Output Pulse Polarity	8	R/W	0x0000 positive 0x0001 negative
Timer Gate (trigger select)	9	R/W	0x0000 user command 0x0001 hardware, positive edge triggered 0x0002 hardware, negative edge triggered
Timer Pulse Length	10	R/W	Length of pulse using timebase (2 words) Default = 100 Minimum value = 20
Timer Pre-delay Length	12	R/W	Length of pre-delay using timebase (2 words) Default = 0
Timer Post-delay Length	14	R/W	Length of post-delay using timebase (2 words) Default = 0
Timer Software Trigger	20	W	Generate pulse A pulse is triggered by a Modbus write to this address
Timer Save Function Configuration	90	W	Write any value to save the current configuration for this function

15.0 Appendix B: 8B isoLynx® SLX300 Throughput

This section outlines 8B isoLynx® SLX300 calculated throughput values based on command processing times and compares them against actual measured performance. All data presented represents system performance in Continuous Scan Mode. Short-term throughput is significantly higher if the system is operated in Burst Scan Mode.

B.1 Test Networks and Test Setup

Modbus RTU throughput was measured using a point-to-point RS-232 connection or point-to-point USB connection between an 8B isoLynx® SLX300 and a host computer. Serial communication was performed at 921.6kbps, with 8 data bits, 1 stop bit and even parity.

Modbus TCP throughput was measured using an Ethernet switch with 10/100 Base T connection between an 8B isoLynx® SLX300 and a host computer.

Calculated data is based on command processing time in the system firmware and Modbus communication requirements.

Measured performance was determined by executing the appropriate command 100,000 times and averaging the command execution time every 10,000 transactions. Commands were looped using a Windows application.

Observation of the data reveals that measured performance is slower than calculated performance for some commands. The specific computer hardware and operating system used can affect realized performance and should be carefully evaluated in applications where throughput is critical.

The system used for measuring performance is as follows:

Computer:	Systemax
Operating System:	Windows XP, SP3
RS-232 Interface:	SIIG CyberPro PCI 8S
USB Interface:	CP210x XP driver to communicate with the SLX300 USB to Serial Bridge
Ethernet Interface:	Realtek RTL8139/810x Fast Ethernet Card

B.2 Throughput Descriptors

8B isoLynx® SLX300 throughput can be described in several ways. The following descriptors are useful when discussing throughput.

- *Command Time*: Minimum time required to fully process a command. This value includes both 8B isoLynx® SLX300 command processing time and communication overhead. See Table B.1 for 8B isoLynx® SLX300 calculated and measured command times.
- *Command Rate*: Maximum rate at which a command can be sent to an 8B isoLynx® SLX300 system expressed in commands per second (Hz). This value is the inverse of the Command Time. See Table B.2 for 8B isoLynx® SLX300 calculated and measured command rates.
- *Throughput*: The maximum number of channel reads or writes per second (Hz) that can be achieved using a multiple channel command at its Command Rate. This value is dependent on the number of channels processed by the command and is calculated by multiplying the Command Rate by the number of channels processed by the command. See Table B.3 for 8B isoLynx® SLX300 calculated and measured throughput.

B.3 Command Times

TABLE B.1 COMMAND TIMES (ms)

	CALCULATED					MEASURED			
	Number of Channels Processed					Number of Channels Processed			
	1	4	8	12		1	4	8	12
Modbus RTU (RS-232)									
Read Analog Data[1]	1.2			1.6		3.0			3.5
Write Analog Data[2]	1.3	1.5				3.0	3.0		
Read Digital Data[1]	2.0		2.2			3.0		3.0	
Write Digital Data[2]	2.0		3.3			3.0		2.8	
Modbus RTU (USB)									
Read Analog Data[1]	1.2			1.6		6.9			7.1
Write Analog Data[2]	1.3	1.5				7.0	7.1		
Read Digital Data[1]	2.0		2.2			6.7		7.0	
Write Digital Data[2]	2.0		3.3			6.7		7.0	
Modbus TCP									
Read Analog Data[1]	2.8			3.3		3.1			3.5
Write Analog Data[2]	2.9	3.1				3.1	3.4		
Read Digital Data[1]	3.5		3.8			3.0		3.3	
Write Digital Data[2]	3.6		3.9			3.0		3.3	

(1) Read Single Registers and Read Multiple Registers use Modbus Command 0x03.
(2) Write Single Register uses Modbus command 0x06. Write Multiple Registers uses Modbus command 0x10.

B.4 Command Rates

TABLE B.2 COMMAND RATES (Hz)

	CALCULATED					MEASURED			
	Number of Channels Processed					Number of Channels Processed			
	1	4	8	12		1	4	8	12
Modbus RTU (RS-232)									
Read Analog Data[1]	833			625		338			286
Write Analog Data[2]	769	667				337	333		
Read Digital Data[1]	500		455			338		333	
Write Digital Data[2]	500		303			338		357	
Modbus RTU (USB)									
Read Analog Data[1]	833			625		145			141
Write Analog Data[2]	769	667				144	141		
Read Digital Data[1]	500		455			149		142	
Write Digital Data[2]	500		303			148		142	

Modbus TCP									
Read Analog Data(1)	357			303		322			286
Write Analog Data(2)	345	323				318	295		
Read Digital Data(1)	286		263			331		305	
Write Digital Data(2)	278		256			329		300	

(1) Read Single Registers and Read Multiple Registers use Modbus Command 0x03.
(2) Write Single Register uses Modbus command 0x06. Write Multiple Registers uses Modbus command 0x10.

B.5 Throughput

TABLE B.3 THROUGHPUT (Ch/s)

	CALCULATED					MEASURED			
	Number of Channels Processed					Number of Channels Processed			
	1	4	8	12		1	4	8	12
Modbus RTU (RS-232)									
Read Analog Data(1)	833			7500		338			3429
Write Analog Data(2)	769	2667				337	1333		
Read Digital Data(1)	500		3636			338		2667	
Write Digital Data(2)	500		2424			338		2857	
Modbus RTU (USB)									
Read Analog Data(1)	833			7500		145			1690
Write Analog Data(2)	769	2667				144	563		
Read Digital Data(1)	500		3636			149		1140	
Write Digital Data(2)	500		2424			148		1138	
Modbus TCP									
Read Analog Data(1)	357			3636		322			3429
Write Analog Data(2)	345	1290				318	1180		
Read Digital Data(1)	286		2105			331		2439	
Write Digital Data(2)	278		2051			329		2402	

(1) Read Single Registers and Read Multiple Registers use Modbus Command 0x03.
(2) Write Single Register uses Modbus command 0x06. Write Multiple Registers uses Modbus command 0x10.

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2. Product serial number.
3. Name, address, and telephone number of person returning product.
4. Special repair instructions.
5. Purchase order number for out-of-warranty repairs.

The product should be carefully packaged, making sure the RMA number appears on the outside of the package, and ship prepaid to:

Dataforth Corporation
3331 E. Hemisphere Loop
Tucson, AZ 85706 USA