Honeywell

Modbus® RTU Serial Communications User Manual

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Revision T

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Honeywell Process Solutions

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Reference: Modicon Modbus Protocol Reference Guide - PI-MBUS-300 Rev. G

About This Document

Abstract

This document provides generic information for Honeywell instruments implementing the Modbus RTU Serial Communications protocol. Configuration information relating to specific devices is supplied in separate user manuals. Refer to 1.2 Modbus RTU Configuration Interface for a list of instruments and the corresponding configuration interface user manuals.

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Revision Information

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51-52-25-66	S	July 2010	Register Maps updated for Extended Comms, Alarm Values and Alarm Status (X Series Recorders)
51-52-25-66	T	February 2013	Decimal registers updated

Contents

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1. Introduction

1.1 Modbus RTU Implementation

This implementation is designed to provide a popular data exchange format connecting these instruments to both Honeywell and foreign master devices. The Modbus RTU allows the instrument to be a citizen on a data link shared with other devices that subscribe to the Modbus RTU RS-485 specification.

These instruments DO NOT emulate any MODICON type device. The Modbus RTU specification is respected in the physical and data link layers. The message structure of the Modbus RTU function codes is employed and standard IEEE 32-bit floating point and integer formats are used. Data register mapping is unique to these instruments. The definition in Table 2-1 is the register mapping for many Honeywell instruments and the corresponding parameter value within those instruments.

1.2 Modbus RTU Configuration Interface

This user manual does not include the configuration interfaces for the instruments supporting the Modbus RTU Protocol. The following table describes the references to the specific instrument's communication and configuration user manuals.

Table 1-1 Communication and Configuration User Manuals

Instrument Model	User Manual Part Number
RSX, VPR, VRX, UDC5300	51-52-25-68
Minitrend V5, Multitrend Plus V5	43-TV-25-08 Communications Manual
eZtrend V5	43-TV-25-08 Communications Manual V5 (Modbus TCP/IP only)
QX and SX (X Series)	43-TV-25-30
DR4300	51-52-25-71
DR4500	51-52-25-69
UDC2300	51-52-25-75
UDC3300	51-52-25-70 51-52-25-38 UDC3000A Modbus 485 RTU Communications Manual
DPR100	US1I-6149 DPR100C-DPR100D Communication Option Manual
DPR180/DPR250	EN1I-6189 DPR180/DPR250 Communication Option Manual
10260S/11280S/ SA201/SA2002	51-52-25-103 Modbus Configuration Interface for Herculine Actuators
UDC2500	51-52-25-127
UDC2500 Limit Controller	51-52-25-118
UDC3200	51-52-25-119
UDC3500	51-52-25-120

2. Modbus RTU Message Format

Table 2-1 Modbus RTU Message Formats

Coding system	8 bit binary
Number of data bits per character	10 Bits start bits - 1 data bits - 8 parity bits - 0 stop bits - 1
Parity	Not used
Bit transfer rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400 Selectable *NOTE: Not all instruments support all Baud Rates.*
Duplex	Half duplex Transceiver or TX/RX
Error checking	CRC (cyclic redundancy check)
Polynomial	(CRC-16 10100000000001)
Bit transfer order	LSB first
End of message	Idle line for 3.5 or more characters (>1.82 msec for 19200).

2.1 Modbus RTU Link Layer

The link layer includes the following properties/behaviors:

- Slave address recognition,
- Start / End of Frame detection,
- CRC-16 generation / checking,
- Transmit / receive message time-out,
- Buffer overflow detection,
- Framing error detection,
- Idle line detection.

Errors detected by the physical layer in messages received by the slave are ignored and the physical layer automatically restarts by initiating a new receive on the next idle line detection.

General Modbus RTU message format

Query message format
[Slave Address, Function Code, Function code dependent data, CRC 16]

Response message format
[Slave Address, Function Code*, Function code dependent data, CRC 16]

* If an error is detected in a valid message the response function code is modified by adding 80 (hex) and the function code dependent data is replaced by an exception response code as described in *Section 4 - Modbus RTU Exception Codes.*

Between messages, the RS-485 link is in a high impedance state. During this time receiving devices are more susceptible to noise generated false start of messages. Although noise-generated messages are rejected due to address, framing, and CRC checking, they can cause the loss of a good message when they are included in the message stream. In the slave, the transmitting device enables its transmitter line driver and forces an idle line state onto the link for three character time slots prior to transmitting. This action forces termination of any noise generated messages and improves message frame synchronization.

2.2 Modbus RTU Data Layer

The data layer includes:

- Diagnostic loopback,
- Function code recognition / rejection,
- Busy / repoll,
- Data error code generation

Errors detected by the data layer are rejected and the slave responds to the polling device with a Modbus-type status exception error. A summary of the Modbus status exception codes is listed in
Section 4 - Modbus RTU Exception Codes

2.3 IEEE 32-bit Floating-Point Register Information

The Modbus applications support IEEE 32-bit floating-point information for several of the function codes.

IEEE Floating-Point Data Format

The formula for calculating the floating-point number is:

$$\text{mantissa} \times 2^{(\text{exponent} - 127)}$$

(23 bit signed binary with 8 bit biased binary exponent)

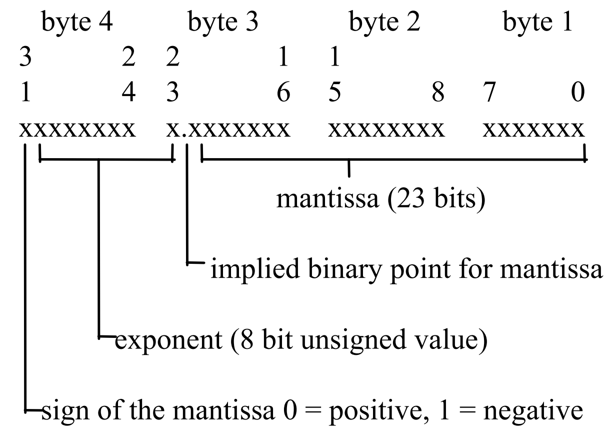


Figure 2-1 IEEE Floating-Point Data format

Mantissa and Sign

The mantissa is defined by a sign bit (31), and a 23-bit binary fraction. This binary fraction is combined with an "implied" value of 1 to create a mantissa value, which is greater than or equal to 1.0 and less than 2.0.

The mantissa is positive if the sign bit is zero (reset), and negative if the sign bit is one (set). For example:

DECIMAL	HEXADECIMAL	BINARY
100	42C80000	01000010 11001000 00000000 00000000

The sign bit (31) is zero, indicating a positive mantissa. Removing the sign bits and exponent bits, the mantissa becomes:

HEXADECIMAL	BINARY
480000	xxxxxxxx x1001000 00000000 00000000

Add an "implied" value of one to the left of the binary point:

BINARY
1.1001000 00000000 00000000

Using positioned notation, this binary number is equal to:

$$1.0 + (1x2^{-1}) + (0x2^{-2}) + (0x2^{-3}) + (1x2^{-4}) = 1.0 + 0.5 + 0.0 + 0.0 + 0.0625 = 1.5625$$

Exponent

The exponent is defined by an unsigned 8-bit binary value (bits 23 through 30). The value of the exponent is derived by performing a signed subtraction of 127 (decimal) from the 8-bit exponent value.

DECIMAL	HEXADECIMAL	BINARY
100	42C80000	01000010 11001000 00000000 00000000

removing the sign and mantissa bits, the exponent becomes:

DECIMAL	HEXADECIMAL	BINARY
133	85	x1000010 1xxxxxxx xxxxxxxx xxxxxxxx

or:

$$1x2^7 + 0x2^6 + 0x2^5 + 0x2^4 + 0x2^3 + 1x2^2 + 0x2^1 + 1x2^0$$

Subtract a bias of 127 (decimal) from the exponent to determine its value: 133 – 127 = 6.

Mantissa and Exponent Combination

Combining the mantissa and exponent from the two previous examples:

$$\text{float number} = \text{mantissa x } 2^{\text{exponent}}$$

$$\text{float number} = 1.5625 \text{ x } 2^6 = 1.5625 \text{ x } 64 = 100.0$$

Below is a list of sample float values in IEEE format:

DECIMAL	HEXADECIMAL
100.0	42C80000
-100.0	C2C80000
0.5	3F000000
-1.75	BFE00000
0.0625	3D800000
1.0	3F800000
0.0	00000000
2.0	40000000
55.32	425047AE

Reserved Operands

Per the Standard certain exceptional forms of floating-point operands are excluded from the numbering system. These are as follows:

EXCEPTION	EXPONENT	MANTISSA
+/- Infinity	All 1's	All 0's
Not-a-Number (NAN)	All 1's	Other than 0's
Denormalized Number	All 0's	Other than 0's
Zero	All 0's	All 0's

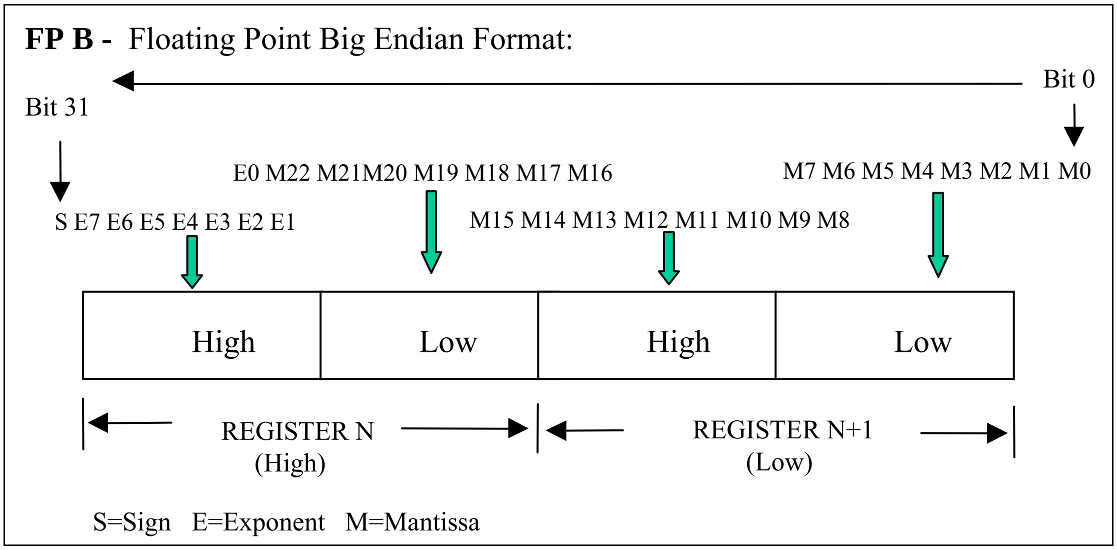
Modbus Double Register Format

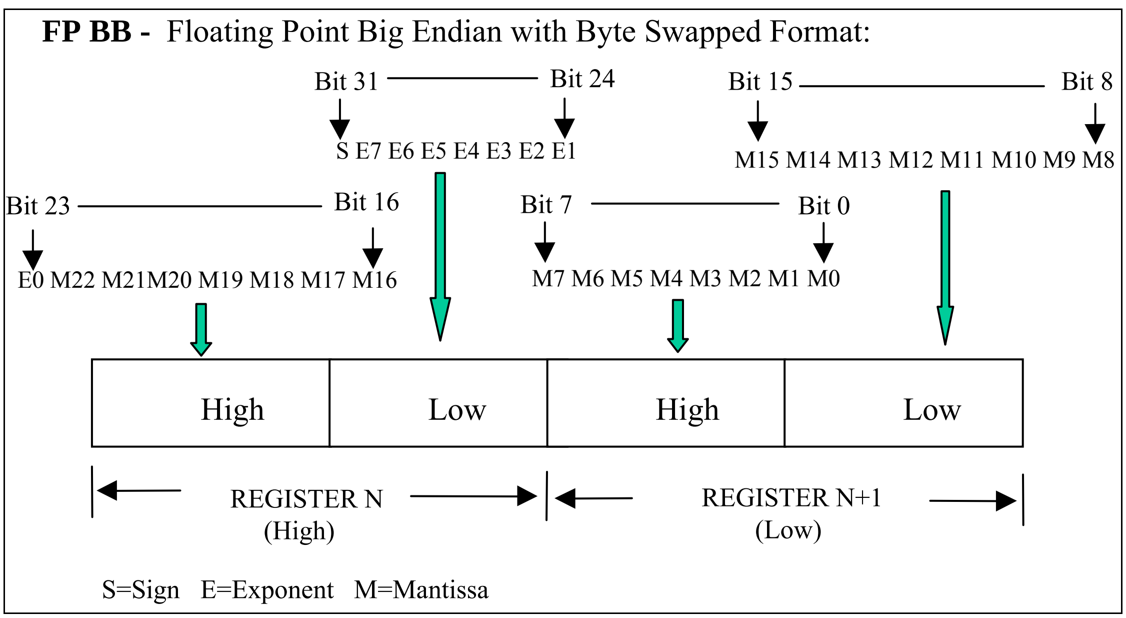
Each IEEE 32-bit floating point number requires two consecutive registers (four bytes) starting with the register defined as the starting register for the information. The stuffing order of the bytes into the two registers differs among Modbus hosts. The selections are:

Selection	Description	Byte order (See Figure 2-1)	Notes
FP B	Floating Point Big Endian Format	4, 3, 2, 1	
FP BB	Floating Point Big Endian with byte-swapped	3, 4, 1, 2	
FP L	Floating Point Little Endian Format	1, 2, 3, 4	
FP LB	Floating Point Little Endian with byte-swapped	2, 1, 4, 3	Modicon and Wonderware standard

See IEEE Formats starting on next page.

IEEE Floating Point Formats





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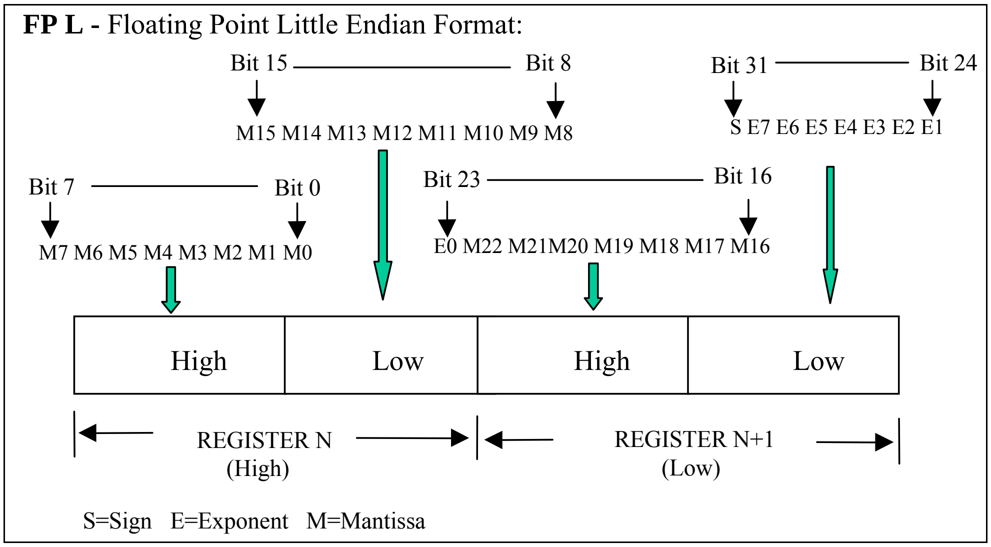

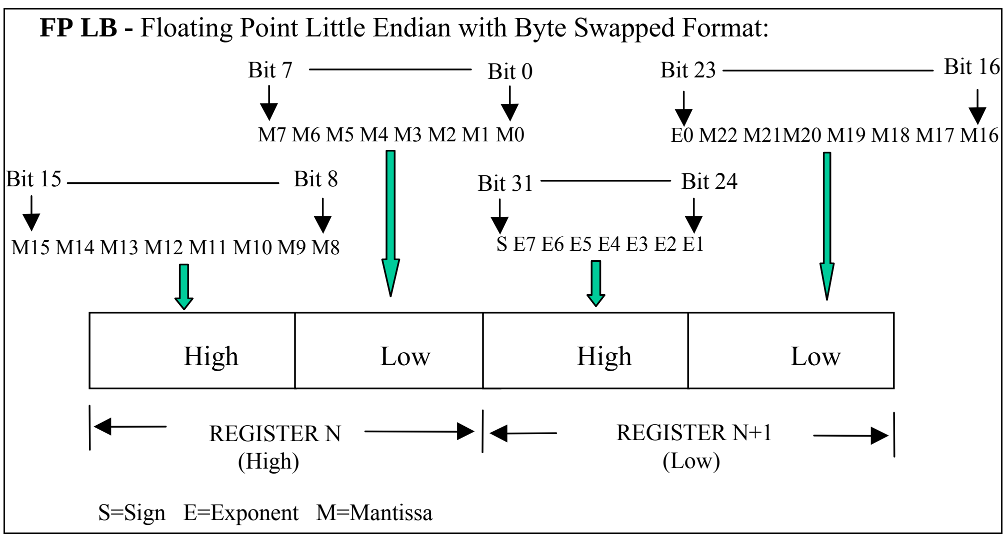

Figure 2-2 IEEE Floating Point Formats

Table 2-2 IEEE Floating Point Number Examples in FP B Format

Value (decimal)	IEEE FP B MSB LSB	Register N		Register N+1	
		high	low	high	low
100.0	42C80000h	42h	C8h	00h	00h
55.32	425D47AEh	42h	5Dh	47h	AEh
2.0	40000000h	40h	00h	00h	00h
1.0	3F800000h	3Fh	80h	00h	00h
-1.0	BF800000h	BFh	80h	00h	00h

3. Modbus RTU Function Codes

The Honeywell Universal Modbus RTU protocol uses a subset of the standard Modbus RTU function codes to provide access to process-related information. Several MODICON function codes are employed. It is appropriate to define instrument-specific "user-defined" function codes. Several standard Modbus RTU function codes are supported. These standard function codes provide basic support for IEEE 32-bit floating point numbers and 16-bit integer register representation of instrument's process data.

Repolling of data is not supported by these instruments.

Table 3-1 Modbus RTU Function Codes Definitions

Function Code	Name	Usage
01	Read Coil Status	Read the State of a Digital Output
02	Read Input Status	Read the State of a Digital Input
03 04	Read Holding Registers / Read Input Registers	Read Data in 16 bit Register Format (high/low). Used to read integer or floating point process data. Registers are consecutive and are imaged from the instrument to the host.
05	Force Single Coil	Write data to force Digital Output ON/OFF Values of FF 00 forces DO ON Values of 00 00 forces DO OFF Values of FF FF releases the force of the DO All other values are illegal and will not affect the DO. *RSX, VPR, VRX, UDC5300 ONLY*
06	Preset Single Register	Write Data in **16-bit Integer** Format (high/low) ONLY.
08	Loopback Test	Used for diagnostic testing of the communications port.
16 (10h)	Preset Multiple Registers	Write Data in 16-bit Format (high/low). Used to write **integer and floating point override data.** Registers are consecutive and are imaged from the host to the instrument. Note: UDC will write floating point data using this Function Code
17 (11h)	Report Device ID	Read instrument ID and connection information, ROM version, etc.
20 (14h)	Read General Reference	Used to Read or upload the instrument's configuration into the host device. See *Section 1.2 - Modbus RTU Configuration Interface* for a reference to the User Manual for the specific instrument.
21 (15h)	Write General Reference	Used to Write or download an instrument's configuration into the instrument from a host device. See *Section 1.2 - Modbus RTU Configuration Interface* for a reference to the User Manual for the specific instrument.

Table 3-2 Maximum Number of Object Addresses for Each Instrument Type

Part 1

Object Name	RSX	VRX100 VRX150 VPR100	VRX180	DR 4300	DR 4500	DPR 100	DPR 180	DPR 250	Herculine Smart Actuators	See Sub section
Alarms Status	12	16	96	2	6	12	48	64	4	**A.15**
Alarm Set Point Value	12	16	96	2	6	12	48	64	8	**A.16**
Analog Inputs	6	12	48	1	4	6	24	64	1	**A.6**
Analog Output	6	8	16	1	2	4	8	8	1	**N/A**
Comm. or Constant Values	10	16	32	0	0	6	24	32	0	**A.7**
Discrete Input	6	24	36	2	2	4	36	48	1	**N/A**
Discrete Output/Coil	6	24	36	2	6	12	36	48	4	**N/A**
Loop	2	4	8	1	2	0	0	0	0	**A.5**
Math, Calculated, or Variable Value	24	32	64	0	1	6	24	32	2	**A.8**
Math or Calculated Value Status	24	32	64	0	1	6	24	32	0	**A.9**
Set Point Programmer Value	0	4	4	1	2	0	0	0	0	**A.17**
Segments per Set Point Programmer	0	63	63	24	12	0	0	0	0	**A.19**
Totalizer	6	12	48	1	4	0	0	0	0	**A.11**

Table 3-2 Maximum Number of Object Addresses for Each instrument Type

Part 2

Object Name	QX Minitrend	SX Multitrend	Minitrend V5	Multirend Plus V5	UDC 2300	UDC 2500	UDC 3200	UDC 3300	UDC 3500	UDC 5300	See Sub section
Alarms Status	16	48	16	32	2	2	2	2	4	4	**A.15**
Alarm Set Point Value	N/A	N/A	N/A	N/A	4	4	4	4	8	4	**A.16**
Exended Comms variables	64 (32 std plus 32)	64 (32 std plus 32)									
Analog Inputs	16	48	16	32	2	2	2	3	5	3	**A.6**
Analog Output	4	8	N/A	N/A	1	2	2	2	3	4	**N/A**

Object Name	QX Minitrend	SX Multitrend	Minitrend V5	Multirend Plus V5	UDC 2300	UDC 2500	UDC 3200	UDC 3300	UDC 3500	UDC 5300	See Sub section
Comm. or Constant Values	32	32	32	32	0	0	0	0	0	9	**A.7**
Discrete Input	16	48	16	32	0	2	2	2	4	3	**N/A**
Discrete Output/Coil	16	48	16	32	3	4	4	3	5	4	**N/A**
Loop	N/A	N/A	N/A	N/A	1	1	1	2	2	2	**A.5**
Math, Calculated, or Variable Value	96	96	64	64	0	0	1	2	2	16	**A.8**
Math or Calculated Value Status	N/A	N/A	N/A	N/A	0	0	1	2	2	16	**A.9**
Set Point Programmer Value	N/A	N/A	N/A	N/A	1	1	1	1	1	1	**A.17**
Segments per Set Point Programmer	N/A	N/A	N/A	N/A	12	12	12	12	20	63	**A.19**
Totalizer	96	96	64	64	0	0	0	1	1	0	**A.11**

ATTENTION

- Values depend on each instrument's model number.
- DPR products only support Analog Inputs, Communication Values, and Math Values per this document at this time. Please reference *US1I-6149 DPR100C-DPR100D Communication Option Manual* and *EN1I-6189 DPR180/DPR250 Communication Option Manual* for details pertaining to Alarms, Digital Inputs, and Digital Outputs.

Table 3-3 Maximum Number of Registers Allowable per Request

Function Code	X Series Recorders QX and SX	Minitrend V5, Multitrend Plus V5	RSX, VPR, VRX, UDC5300	DPR100, DPR180, DPR250	DR4300, DR4500	UDC3300, UDC2300, UDC2500, UDC3200, UDC3500	Herculine Smart Actuators
1, 2	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
3, 4	192 Registers 96 Floats	128 Registers 64 Floats	127 Registers 63 Floats	64 Registers 32 Floats	82 Registers 41 Floats	22 Registers 11 Floats	32 Registers 16 Floats
5	1	1	1 Coil	Not Supported	Not Supported	Not Supported	Not Supported
6	1	1	1 Register	1 Register	1 Register	1 Register	1 Register
10h	128 Registers 64 Floats	64 Registers 32 Float	127 Registers 63 Floats	64 Registers 32 Floats	42 Floats **FLOATS ONLY** – CAN NOT WRITE INTEGER REGISTERS	1 Float **FLOAT ONLY** – CAN NOT WRITE INTEGER REGISTERS	16 Floats **FLOATS ONLY** – CAN NOT WRITE INTEGER REGISTERS

Table 3-4 Request Delay Time*

Herculine Smart Actuators	X Series Recorders QX and SX	Minitrend V5, Multitrend Plus V5	RSX, VPR, UDC5300	DPR100, DPR180, DPR250	DR4300	DR4500	UDC2300, UDC2500, UDC3200	UDC3300, UDC3500
3.5 characters + 6 - 12 ms	3.5 Characters	3.5 Characters	3.5 Character s	3.5 Characters	Version 4: 20 ms Version 5 or greater: 3.5 characters + 2 ms	Version 57 and 58: 20 ms Version 59 or greater: 3.5 characters + 2 ms	UDC2300 Version 6 or greater: 3.5 characters,ot herwise 20 ms	UDC3300 Version 9 or greater: 3.5 characters otherwise 20 ms

*The link's time delay will be the worse case for the units connected. For example, if a link has a DPR180 and a UDC3300 connected, the link must observe a request delay of 20 ms.

3.1 Function Code 01 – Read Digital Output Status

Description

Function code 01 (0X references) is used to read a Digital Output's (DO) ON/OFF status of the slave device in a binary data format. All binary data transferred using function code 01 is mapped into bytes.

The specific number of Dos available in an instrument or available via one Function Code 01 message is instrument-model specific.

Broadcast is not supported.

Query

The query message specifies the starting DO and the quantity of coils to read. Dos are addressed starting at zero: DO 1 through 16 are addressed as 0 through 15 respectively.

Query message format for function code 01

Slave Address	Function Code	Starting Address High	Starting Address Low	Number DO High	Number DO Low	CRC	CRC

Example: Read Dos number 1 to 7 from slave at address 02.

02 01 00 00 00 07 CRC CRC

Response

The DO status in the response message is packed as one DO per bit of the data field. Status is indicated as: 1 = ON; 0 = OFF. The LSB of the first data byte contains the DO addressed in the query. The other Dos follow toward the high order end of this byte, and from low order to high order in subsequent bytes.

If the returned DO quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The byte count field specifies the quantity of data bytes returned.

Response message format for function code 01

Slave Address	Function Code	Byte Count	Data	Data	…	CRC	CRC

Example: Dos number 2 and 7 are on, all others are off.

02 01 01 42 CRC CRC

In the response the status of Dos 1 – 7 is shown as the byte value 42 hex, or 0100 0010 binary. DO 8 is the MSB of this byte, and DO 1 is the LSB. Left to right, the status of DO 7 through 1 is: ON-OFF-OFF-OFF-OFF-ON-OFF. DO #8 was not requested and so bit #7 or the MSB was padded with a 0.

Table 3-5 DR4500 Digital Output Mapping

Coil Number	Instrument Function
1	Alarm Relay #1
2	Alarm Relay #1
3	Control Relay #1
4	Control Relay #2
5	Control Relay #3
6	Control Relay #4

Table 3-6 UDC2300/UDC2500/UDC3200/UDC3300 DO Mapping

Coil Number	Instrument Function
1	Control Relay **Note 1**.
2	Alarm Relay #2
3	Alarm Relay #1

Note 1. The reading of this bit is valid only for Relay Output Type configurations. Not valid for current outputs

Table 3-7 Herculine Smart Actuators Digital Output Mapping

Coil Number	Instrument Function
1	Alarm Relay #1
2	Alarm Relay #2
3	Alarm Relay #3
4	Alarm Relay #4

Table 3-8 UDC3500 Digital Output Mapping

Coil Number	Instrument Function
1	Relay #1
2	Relay #2
3	Relay #3
4	Relay #4
5	Realy # 5

3.2 Function Code 02 – Read Digital Input Status

Description

Function code 02 (1X references) is used to read a Digital Input's (DI) ON/OFF status of the slave device in a binary data format. All binary data transferred using function code 02 is mapped into bytes.

The specific number of inputs available in an instrument or available via one Function Code 02 message is instrument-model specific.

Broadcast is not supported.

Query

The query message specifies the starting input and the quantity of inputs to read. Inputs are addressed starting at zero: Input 1 through 16 are addressed as 0 through 15 respectively

Query message format for function code 02

Slave Address	Function Code	Starting Address High	Starting Address Low	Number Inputs High	Number Inputs Low	CRC	CRC

Example: Read inputs number 1 to 7 from slave at address 02.

02 02 00 00 00 07 CRC CRC

Response

The input status in the response message is packed as one input per bit of the data field. Status is indicated as: 1 = ON; 0 = OFF. The LSB of the first data byte contains the input addressed in the query. The other inputs follow toward the high order end of this byte, and from low order to high order in subsequent bytes.

If the returned input quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The byte count field specifies the quantity of data bytes returned.

Response message format for function code 02

Slave Address	Function Code	Byte Count	Data	Data	…	CRC	CRC

Example: Inputs number 2 and 7 are on, all others are off.

02 02 01 42 CRC CRC

In the response the status of inputs 1 – 7 is shown as the byte value 42 hex, or 0100 0010 binary. Input 8 is the MSB of this byte, and input 1 is the LSB. Left to right, the status of input 7 through 1 is: ON-OFF-OFF-OFF-OFF-ON-OFF. Input #8 was not requested and so bit #7 or the MSB was padded with a 0.

3.3 Function Codes 03/04 – Read Input Registers

Description

Function code 03 (4X references) or Function code 04 (3X references) is used to read the binary contents of input registers in the slave referenced in Appendix A. Function codes 3 and 4 are not restricted to inputs. They may transmit alarm status, control parameters, etc.

The specific supported registers available in an instrument or available via one Function Code 03/04 message is instrument-model specific. When a master station requests a register that is not supported by the specific device the slave will respond with zeros for that register.

If a request is made to an address that does not exist in the map in Appendix A, the instrument is to honor that request and return zeros. This behavior will greatly enhance the bandwidth on the link vs. making several different requests for non-contiguous data elements. (i.e. Consider a device that contains AI #1 and AI #3 and for some reason AI #2 is an invalid request.) The contiguous method would allow the read of AI #1 through AI #3 and the data location for AI #2 would be zeros.

Broadcast is not supported.

Query

The query message specifies the starting register and quantity of registers to be read. Registers are addressed starting at zero: registers 1-16 are addressed as 0-15.

Query message format for function code 03/04

Slave Address	Function Code	Starting Address High	Starting Address Low	Number Addresses High	Number Addresses Low	CRC	CRC

Example: Read analog inputs #1 and #2 in addresses 1800-1803 as floating point values from a slave at address 02.

02 04 18 00 00 04 CRC CRC

Response

The register data in the response message are packed as two bytes per register. For each register, the first byte contains the high order bits and the second contains the low order bits.

The floating point values require two consecutive registers. A request for a single floating point value must be for two registers. The first 16 bits of the response contain the IEEE MSB of the float value. The second 16 bits of the response contain the IEEE LSB of the float value. *(See Section 2.3.)* If the master station requests only one register at an address of a floating point value, the slave may respond with an exception with illegal data address code.

The Modbus RTU protocol has a single byte count for function codes 03 and 04, therefore the Modbus RTU protocol can only process up to 64 floating point and 127 integer values in a single request.

Response message format for function codes 03/04

Slave Address	Function Code	Byte Count	Data	Data	…	CRC	CRC

Example: Analog inputs #1 and #2 as floating point values where AI #1 = 100.0 and AI #2 = 55.32

02 04 08 42 C8 00 00 47 AE 42 5D CRC CRC

3.4 Function Code 05 – Force Single Digital Output

Description

Force a single Digital Output (DO) (0X reference) to either ON or OFF. These are the same Dos used in Function Code 01.

When broadcast, the same function forces the same DO in all attached slave devices.

Only supported by RSX, VPR, VRX, and UDC5300 instruments. These instruments do not support broadcast, and forcing can only be done in the Run mode.

Query

The query message specifies the DO to be forced. Registers are addressed starting at zero:
DO 1 is address 0.

The requested ON/OFF state is specified by a constant in the query data field. A value of FF 00 hex requests it to be ON. A value of 00 00 hex requests it to be OFF.

RSX, VPR, VRX, and UDC5300 products support a value of FF FF to release the force.

Query message format for function code 05

Slave Address	Function Code	DO Address High	DO Address Low	Force Data High	Force Data Low	CRC	CRC

Example: Force DO 6 ON in a slave at address 02.

02 05 00 06 FF 00 CRC CRC

Response

The normal response is an echo of the query, returned after the DO state has been forced.

Response message format for function code 05

Slave Address	Function Code	DO Address High	DO Address Low	Force Data High	Force Data Low	CRC	CRC

Example: Force DO 6 ON in a slave at address 02.

02 05 00 06 FF 00 CRC CRC

3.5 Function Codes 06 – Preset Single Register

Description

Presets an integer value into a single register (4X references). When broadcasted, the function presets the same register references in all attached slaves.

The specific supported registers available in an instrument via a Function Code 06 message may be instrument-model specific. However, every instrument that supports the register assignments specified in Appendix A with an access type “W” and integer and bit packed data types, supports writing to those specified registers via Function Code 06.

Query

The query message specifies the register references to be preset. Registers are addressed starting at zero: Register 1 is addressed as 0.

Query message format for function code 06

Slave Address	Function Code	Address High	Address Low	Preset Data High	Preset Data Low	CRC	CRC

Example: Set Loop #1 to Auto (address 00Fah) to a slave at address 02.

02 06 00 FA 00 01 CRC CRC

Response

The normal response is an echo of the query returned after the register contents have been preset.

Response message format for function code 06

Slave Address	Function Code	Address High	Address Low	Preset Data High	Preset Data Low	CRC	CRC

Example: Set Loop #1 to Auto (address 00Fah) to a slave at address 02.

02 06 00 FA 00 01 CRC CRC

3.6 Function Code 08 – Loopback Message

Description

Echoes received query message.

Query

Message can be any length up to half the length of the data buffer minus 8 bytes.

Query message format for function code 08

Slave Address	Function Code	Any data, length limited to approximately half the length of the data buffer	CRC	CRC

Example:

02 08 01 02 03 04 CRC CRC

Response

Response message format for function code 08

Slave Address	Function Code	Data bytes received	CRC	CRC

Example:

02 08 01 02 03 04 CRC CRC

3.7 Function Codes 16 (10h) – Preset Multiple Registers

Description

Presets values into a sequence of holding registers (4X references). When broadcasted, the function presets the same register references in all attached slaves.

The specific supported registers available in an instrument via a Function Code 16 (10h) message may be instrument-model specific. However, every instrument that supports the register assignments specified in Appendix A with an access type "W", supports writing to those specified registers via Function Code 16 (10h).

Query

The query message specifies the register references to be preset. Registers are addressed starting at zero: Register 1 is addressed as 0.

Query message format for function code 16 (10h)

Slave Address	Function Code	Starting Address High	Start Address Low	Number Addresses High	Number Addresses Low	Byte Count	Data	CRC	CRC

Example: Preset Variable#1 (address 1880h) to 100.0 from a slave at address 02.

02 10 18 80 00 02 04 42 C8 00 00 CRC CRC

Response

The normal response returns the slave address, function code, starting address and the quantity of registers preset.

The floating-point values require two consecutive addresses. A request to preset a single floating-point value must be for two addresses. The byte order of the floating-point number is determined by the setting of the byte swap configuration value. In this example the byte swap order is FP B. Refer to subsection 2.3. The first 16 bits of the response contain the IEEE MSB of the float value. The second 16 bits of the response contain the IEEE LSB of the float value. The Byte order is configurable See Subsection 0. If the master station requests only one address at an address of a floating-point value the slave will respond with an illegal data address exception (See Section 4) code.

Response message format for function code 16 (10h)

Slave Address	Function Code	Starting Address High	Start Address Low	Number Addresses High	Number Addresses Low	CRC	CRC

Example: Response from preset Constant #1 (address 1880h) to 100.0 from a slave at address 02.

02 10 18 80 00 02 CRC CRC

3.8 Function Code 17 (11h) – Report Device ID

Description

Function code 17 (11h) is used to report the Device Information that includes information like: Slave ID, device description, and firmware version.

Query

The query message specifies the function code only.

Query message format for function code 17 (11h)

Slave Address	Function Code	CRC	CRC

Example: Read Device ID from a slave at address 02.

02 11 CRC CRC

Response

The response is a record format describing the instrument.

Response message format for function code 17 (11h)

Slave Address	Function Code	Byte Count	Slave ID	Run Indicator Status	Device Specific Data	CRC	CRC

Slave ID – The number associated with the device.
(one byte) (byte 3)

Slave ID (hex)	Device Type
N/A	DPR100 (Does not support 11h)
18	DPR180
25	DPR250
43	DR4300
45	DR4500
23	UDC2300
26	UDC2500
32	UDC3200

Slave ID (hex)	Device Type
33	UDC3300
35	UDC3500
53	UDC5300, RSX, VPR, VRX
02	UDC6000
63	UDC6300
10	10260S
11	11280S
20	SA2001, SA2002
05	Minitrend V5, Multitrend Plus V5 QX and SX Recorders

Run Indicator Status:
(one byte) (byte 4)
00=OFF; FF=ON

+Device Specific Data:

Device Description	Model ID	Device Class ID	Device Mapping

Device Description:
16 Character ASCII Message (zero filled) (bytes 5-20).
Device Specific. Usually contains Device Tag + Version Number

Device Type	Device Description
DPR100	N/A
DPR180	DPR180 xxx.yy
DPR250	DPR250 xxx.yy
DR4300	DR4300 x.y
DR4500	DR4500 x.y
RSX	RSX x.y
VPR100/VRX100	Version 5.0 – 7.0 VPR/VRX x.y Version ≥ 8.0 VRX100 x.y
VRX150	VRX150 x.y
VRX180	VRX180/250 x.y
UDC2300	UDC2300 x.y
UDC2500	UDC2500 x.y
UDC3200	UDC3200 x.y
UDC3300	UDC3300 x.y
UDC3500	UDC3500 x.y
UDC5300	UDC5300 x.y
UDC6000	UDC6000 x.y
UDC6300	UDC6300 x.y
10260S	10260S x.y
11280S	11280S x.y
SA2001, SA2002	SA200n x.y
Minitrend V5	Minitrend nn.v v
Multitrend Plus V5	Multitrend Plus nn.v v
QX and SX	OEM Series name + OEM device name (truncated to 16 characters)

x.y = version of instrument, nn.v v = software version and revision

Model ID:
The Model Identification (Device type specific). (one byte) (byte 21)

Model ID	Description
00	None

Device Class ID:
The Device Classification. (one byte) (byte 22)

Class ID	Class
00	Generic Class (Fixed Address Mapable)
01-FF	Future

Generic Class (00) Device Mapping:
Describes the I/O and feature mapping.

Number of Records	Record #1	Record #2	Record ...	Record #n

Number of records is always 5 for the Minitrend V5 and Multitrend Plus V5.

Number of Records:
1 Byte unsigned value 00-FFh (byte 23)

Record Description:

Byte	Description
00	Type of Data Element (See Data Element Values Table Below)
01	Starting Address of Data Element Record (High)
02	Starting Address of Data Element Record (Low)
03	Number of Data Elements (High)
04	Number of Data Elements (Low)

Data Element Values Table:

Value	Description
00*	Analog Inputs
01	Analog Outputs
02*	Discrete Inputs
03*	Discrete Outputs
04	Control Loops
05	Set Point Programmers
06*	Math, Calculated Values, or Variables
07	Constants
08	Alarms
09*	Totalizers

* These data elements are the 5 data records sent from the Minitrend and the Multitrend Plus V5 recorders.

4. Modbus RTU Exception Codes

Introduction

When a master device sends a query to a slave device it expects a normal response. One of four possible events can occur from the master's query:

- *Slave device receives the query without a communication error and can handle the query normally.* It returns a normal response.
- *Slave does not receive the query due to a communication error.* No response is returned. The master program will eventually process a time-out condition for the query.
- *Slave receives the query but detects a communication error (parity, LRC or CRC).* No response is returned. The master program will eventually process a time-out condition for the query.
- *Slave receives the query without a communication error but cannot handle it (i.e., request is to a non-existent coil or register).* The slave will return with an exception response informing the master of the nature of the error (Illegal Data Address.)

The exception response message has two fields that differentiate it from a normal response:

Function Code Field:
In a normal response, the slave echoes the function code of the original query in the function code field of the response. All function codes have a most-significant bit (MSB) of 0 (their values are below 80 hex). In an exception response, the slave sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hex higher than the value would be for a normal response.

With the function code's MSB set, the master's application program can recognize the exception response and can examine the data field for the exception code.

Data Field:
In a normal response, the slave may return data or statistics in the data field. In an exception response, the slave returns an exception code in the data field. This defines the slave condition that caused the exception.

Query

Example: Internal slave error reading 2 registers starting at address 1820h from slave at slave address 02.

02 03 18 20 00 02 CRC CRC

Response

Example: Return MSB in Function Code byte set with Slave Device Failure (04) in the data field.

83 04 CRC CRC

Table 4-1 Modbus RTU Data Layer Status Exception Codes

Exception Code	Definition	Description
01	Illegal Function	The message received is not an allowable action for the addressed device.
02	Illegal Data Address	The address referenced in the function-dependent data section of the message is not valid in the addressed device.
03	Illegal Data Value	The value referenced at the addressed device location is no within range.
04	Slave Device Failure	The addressed device has not been able to process a valid message due to a bad device state.
06	Slave Device Busy	The addressed device has ejected a message due to a busy state. Retry later.
07	NAK, Negative Acknowledge	The addressed device cannot process the current message. Issue a PROGRAM POLL to obtain device-dependent error data.
09	Buffer Overflow	The data to be returned for the requested number of registers is greater than the available buffer space. *Function Code 20 only*.

A. Appendix: Register Map

What's in this appendix?

This appendix describes all paramters accessible by Function Code 03, 04, 06 and 10h. Section A.1 gives a global overview of each function and its addresses/registers. Sections A.2 through A.21 contain the details on each function and each of its parameters.

Your particular instrument may not contain all parameters shown. If you see a function that is not on your instrument, either it is not available for that instrument model or it is an option you did not purchase. If a function is not available for your instrument, that will be indicated.

A.1 Register Map Overview

Table A-1describes the global register map for Function Code 03, 04, 06 and 10h. Details on each address are in sections A.2 through A.21. Your particular instrument may not contain all functions or parameters shown. For example, some instruments contain only one or two loops, do not contain calculated values, setpoint programmers, etc.

Conversion of address (hex) number to register (decimal) number.

To convert the address number to the register number, convert the address from hexidecimal to decimal and add 40001. Registers are addressed starting at zero: registers 1 – 16 are addressed as 0 – 15.

To convert the register number to the address number, subtract 40001 from the register and convert to hex.

Table A-1 Global Register Map

Start Address (hex)	End Address (hex)	Description	See Subsection
0000	< 0040	Miscellaneous Parameters or Loop #1 Integer	A.2 or A.3
0100	013F	Loop 2 and Extended Values – UDC3500	0
0040	00FF	Loop #1 (floating point & bit packed)	A.5
0100	013F	Loop #2 Integer	
0140	01FF	Loop #2 (floating point & bit packed)	
0240	02FF	Loop #3 (floating point & bit packed)	
0340	03FF	Loop #4 (floating point & bit packed)	
0440	04FF	Loop #5 (floating point & bit packed)	
0540	05FF	Loop #6 (floating point & bit packed)	
0640	06FF	Loop #7 (floating point & bit packed)	
0740	07FF	Loop #8 (floating point & bit packed)	
0800	081C	DR4300, DR4500 Chart	A.2.2
0840	08FF	Loop #9 (floating point & bit packed)	A.5
0940	09FF	Loop #10 (floating point & bit packed)	
0A40	0AFF	Loop #11 (floating point & bit packed)	
0B40	0BFF	Loop #12 (floating point & bit packed)	
0C40	0CFF	Loop #13 (floating point & bit packed)	
0D40	0DFF	Loop #14 (floating point & bit packed)	
0E40	0EFF	Loop #15 (floating point & bit packed)	
0F40	0FFF	Loop #16 (floating point & bit packed)	

Start Address (hex)	End Address (hex)	Description	See Subsection
1040	10FF	Loop #17 (floating point & bit packed)	
1140	11FF	Loop #18 (floating point & bit packed)	
1240	12FF	Loop #19 (floating point & bit packed)	
1340	13FF	Loop #20 (floating point & bit packed)	
1440	14FF	Loop #21 (floating point & bit packed)	
1540	15FF	Loop #22 (floating point & bit packed)	
1640	16FF	Loop #23 (floating point & bit packed)	
1740	17FF	Loop #24 (floating point & bit packed)	
1800	187F	Analog Input Value (#1-#64)	A.6
1880	18BF	Communication or Constant Value (#1 - #32)	A.7
18C0	1ABF	Math or Calculated Value (#1 - #256)	A.8
1AC0	1ACF	Math or Calculated Value Status (#1 - #256)	A.9
1AD0	1AFF	Herculine Smart Actuator Values Register Map	A.20
1B00	1B7F	Totalizer Value (#1 - #64)	A.10
1B80	1B83	Totalizer Status (Bit Packed) (#1 - #64)	A.11
1B90	1B91	Shed Timer Reset	A.12
1B99	1BAB	Maintenance (HealthWatch) Values	A.13
1BE0	1BE6	Time	A.14
1BF0	1BFF	Alarm Status (Bit Packed) (#1 - #256)	A.15
1C00	1DFF	Alarm Set Point Value (#1 - #256)	A.16
1E00	1E0F	Set Point Programmer #1	A.17
1E10	1E1F	Set Point Programmer #2	
1E20	1E2F	Set Point Programmer #3	
1E30	1E3F	Set Point Programmer #4	
1E40	1E67	Smart Actuator Maintenance Data	A.22
1F00	1F3F	Set Point Programmer #1 Additional Values	A.18
1F40	1F7F	Set Point Programmer #2 Additional Values	
1F80	1FBF	Set Point Programmer #3 Additional Values	
1FC0	1FFF	Set Point Programmer #4 Additional Values	
27D0	2806	Herculine Smart Actuator Factory Data Register Map	A.21
2800	29FF	Set Point Programmer #1 Segments	A.19
2A00	2BFF	Set Point Programmer #2 Segments	
2C00	2DFF	Set Point Programmer #3 Segments	
2E00	2FFF	Set Point Programmer #4 Segments	

A.2 Miscellaneous Register Map

A.2.1 RSX, VPR, VRX, UDC5300 Miscellaneous Register Map

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
0000	40001	Instrument Mode	R/W	Bit Packed Indicators: Bit 0: 1:Diagnostic Bit 1: 1:Calibration Bit 2: 1:Maintenance/Offline mode Bit 3: 1:Program mode Bit 4: 1:Reset Unit/Force Cold Start (Write Only) Bit 5: 1:On-Line/Run mode Bit 6…15: Unused
0001	40002	Configuration Select	W	Signed 16 bit integer 0: Clear Configuration (Preserves Calibration)
0002	40003	Load Recipe or Program Number	R/W	Floating Point VRX/VPR Read: Active program number Write: Load program (write is allowed only when SPP is in Ready or At End)

A.2.2 DR4300, DR4500 Chart Record Map

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
0800	42049	Chart Speed (Hours/rev)	R	Floating Point in Engineering Units. *Note 1*
0802	42051	# Chart Divisions	R	Floating Point in Engineering Units.
0804	42053	Chart Status	R	Floating Point 0.0 = hold; 1.0 = running.
0806	42055	Pen 1	R	Floating Point 0.0 = disabled; 1.0 = enabled
0808	42057	Pen 1 High Value	R	Floating Point in Engineering Units. *Note 1*
080A	42059	Pen 1 Low Value	R	Floating Point in Engineering Units. *Note 1*
080C	42061	Pen 2	R	Floating Point 0.0 = disabled; 1.0 = enabled
080E	42063	Pen 2 High Value	R	Floating Point in Engineering Units.
0810	42065	Pen 2 Low Value	R	Floating Point in Engineering Units.
0812	42067	Pen 3	R	Floating Point 0.0 = disabled; 1.0 = enabled
0814	42069	Pen 3 High Value	R	Floating Point in Engineering Units.
0816	42071	Pen 3 Low Value	R	Floating Point in Engineering Units.
0818	42073	Pen 4	R	Floating Point 0.0 = disabled; 1.0 = enabled
081A	42075	Pen 4 High Value	R	Floating Point in Engineering Units.
081C	42077	Pen 4 Low Value	R	Floating Point in Engineering Units.

NOTE 1: The DR4300 only supports the noted registers. All registers are supported by the DR4500.

A.3 Loop Value Integer Register Map

The following table applies to the following instruments: UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, DR4300 and DR4500. This table applies to Loops 1-24 except Loops 2-24 use the addresses shown in Table A-1

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
0000	40001	PV	R	Signed 16 bit integer Prescale * 10 *Note 5*
0001	40002	RV; Remote Set Point; SP2	R	Signed 16 bit integer Prescale * 10
0002	40003	Working Set Point	R/W	Signed 16 bit integer Prescale * 10 *Note 5* On a write the instrument will update the proper set point according to the loop's currently selected set point.
0003	40004	Output	R/W	Signed 16 bit integer Prescale * 10 *Note 11*
0004	40005	Input #1	R	Signed 16 bit integer Prescale * 10
0005	40006	Input #2	R	Signed 16 bit integer Prescale * 10
0006	40007	Gain #1 (Prop Band #1 *if active*)	R/W	Signed 16 bit integer Prescale * 10
0007	40008	Direction	R	Signed 16 bit integer Prescale * 10
0008	40009	Reset #1	R/W	Signed 16 bit integer Prescale * 10 *Note 1*
0009	40010	Rate #1	R/W	Signed 16 bit integer Prescale * 10 *Note 1*
000A	40011	Cycle Time #1	R/W	Signed 16 bit integer Prescale * 10 *Note 2*
000B	40012	PV Low Range	R	Signed 16 bit integer Prescale * 10
000C	40013	PV High Range	R	Signed 16 bit integer Prescale * 10
000D	40014	Alarm #1 SP #1	R/W	Signed 16 bit integer Prescale * 10 *Note 7*
000E	40015	Alarm #1 SP #2	R/W	Signed 16 bit integer Prescale * 10 *Note 7*
000F	40016	Alarm #1 Action	R	Signed 16 bit integer Prescale * 10 *Note 6*
0010	40017	Gain #2 (Prop Band #2 *if active*)	R/W	Signed 16 bit integer Prescale * 10
0011	40018	Deadband	R/W	Signed 16 bit integer Prescale * 10
0012	40019	Reset #2	R/W	Signed 16 bit integer Prescale * 10 *Note 1*
0013	40020	Rate #2	R/W	Signed 16 bit integer Prescale * 10 *Note 1*
0014	40021	Cycle Time #2	R/W	Signed 16 bit integer Prescale * 10 *Note 2*
0015	40022	SP1; LSP #1	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0016	40023	LSP #2	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0017	40024	Alarm #2 SP #1	R/W	Signed 16 bit integer Prescale * 10 *Note 7*
0018	40025	Alarm #2 SP #2	R/W	Signed 16 bit integer Prescale * 10 *Note 7*
0019	40026	Alarm #2 Action	R	Signed 16 bit integer Prescale * 10 *Note 6*
001A	40027	SP Low Limit	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
001B	40028	SP High Limit	R/W	Signed 16 bit integer Prescale * 10 *Note 5*

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
001C	40029	Working Set Point	R/W	Signed 16 bit integer Prescale * 10 *Note 5* On a write to this register the instrument will update the proper set point according to the loop's currently selected set point. Use this register for operator set point value changes ONLY. Use SP Override for computer-generated set point values.
001D	40030	Output Low Limit	R/W	Signed 16 bit integer Prescale * 10
001E	40031	Output High Limit	R/W	Signed 16 bit integer Prescale * 10
001F	40032	Output Working Value	R/W	Signed 16 bit integer Prescale * 10
0020	40033	PV Override Value	R/W	Signed 16 bit integer Prescale * 10
0021	40034	SP Override Value	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0022	40035	Output Override Value	R/W	Signed 16 bit integer Prescale * 10
0023	40036	Ratio	R/W	Signed 16 bit integer Prescale * 10 *Note 4*
0024	40037	Bias	R/W	Signed 16 bit integer Prescale * 10 *Note 4*
0025	40038	Deviation	R	Signed 16 bit integer Prescale * 10
0026	40039	LSP #3	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0027	40040	Percent Carbon Monoxide - CO	R/W	Signed 16 bit integer Prescale*1000 *Note 3*
0028	40041	Decimal Point	R/W	Signed 16 bit integer Prescale* 1 *Note 3*
0029	40042	Alg1 Bias	R/W	Signed 16 bit integer Prescale * 10 *Note 8*
002A	40043	Alg2 Bias	R/W	Signed 16 bit integer Prescale * 10 *Note 9*
002B	40044	LSP #4	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
002C	40045	Current Output #2	R	Signed 16 bit integer Prescale * 10 *Note 5*
002d	40046	Current Output #3	R	Signed 16 bit integer Prescale * 10 *Note 5*
0038	40057	Fuzzy Enable	R/W	Unsigned 16 bit integer 0=Disable 2= Enable2 1=Enable 3=Enable12 *Note 6*
0039	40058	Shed Enable	R/W	Bit Packed Bit 0: 0:Disable 1:Enable *Note 6*
003A	40059	Auto/Manual State	R/W	Bit Packed Bit 0: 0:Manual; 1:Auto Bit 1-15: Unused *Note 12*
003B	40060	Set Point State	R/W	Unsigned 16 bit Integer 0=LSP1 3=CSP 1=LSP2 4=LSP4 2=LSP3 5=RSP *Note 12*

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
003C	40061	Remote/Local Set Point State	R/W	Bit Packed Bit 0: 0:LSP; 1:RSP Bit 1-15: Unused *Note 12*
003D	40062	Tune Set State	R/W	Unsigned 16 bit integer 0=Tune Set #1 1=Tune Set #2 2=Tune Set #3 3=Tune Set #4 *Note 3*
003E	40063	Loop Status	R	Bit Packed Bit 0: Mode: 0:Manual; 1:Auto Bit 1: Set Point: 0:SP1; 1:SP2 Bit 2: Remote/Local: 0:LSP; 1:RSP Bit 3: Tune Set: 0:Set #1; 1:Set #2 Bit 4: LSP#3 Bit 5: LSP#4 Bit 6: CSP Bit 7: UDC3500 set for Tune Set #1 Bit 8: UDC3500 set for Tune Set #3 Bit 9: UDC3500 set for Tune Set #4 Bit 10: Unused Bit 11: UDC3500 Run/Hold Status Bit 12: UDC3500 set for Any Digital Input Active Bit 13: UDC3500 set for Any Alarm Active Bit 14: UDC3500 set for Cascade Operation Bit 15: UDC3500 set for Guaranteed Soak Deviation (Out of Limit) *Note 10, Note 12*
003F	40064	Device Status	R/W	Bit 0: Emergency Manual Bit 1: Failsafe Bit 2: Working Calibration Checksum Error Bit 3: Configuration Checksum Error Bit 4: Factory Calibration Error Bit 5: Hardware Failure Bit 6:Restart After Shed Bit 7:Configuration/ Calibration Memory Changed *Note 13*

Note 1: UDC3200, UDC3300, UDC3500 uses a prescale of 100 for this parameter.

Note 2: UDC3200, UDC3300, UDC3500 uses a prescale of 1 for this parameter.

Note 3: UDC3200, UDC3300, UDC3500 only.

Note 4: UDC3200, UDC3300, UDC3500 Ratio and Bias are CSP parameters.

Note 5: In the UDC3200, UDC3300, or UDC3500, if the input type is configured as Carbon and the input algorithm is configured for one of the carbon selections, the prescale value is derived from the configured decimal point.

Note 6: Not supported by UDC2300 or UDC3300

Note 7: UDC2300, UDC2500, UDC3300, UDC3200 Loop 1 Address only.

Note 8: In the UDC3200, UDC3300, or UDC3500, if the Algorithm 1 type is configured for weighted average, RH, Summer, Sq. Root Mult-Div, Sq Root Mult, Mult-Div, Mult, Carbon A-D, FCC, Dew Point, or Oxygen, the prescale value is derived from the configured decimal point.

Note 9: In the UDC3300, or UDC3500 if the Algorithm 2 type is configured for weighted average, A-B/C, Sq Root Mult-Div, Sq Root Mult, Mult-Div, Mult, or Dew Point, the prescale value is derived from the configured decimal point.

Note 10: If bits 2, 4, 5 and 6 are set, then disregard bit 1.

Note 11: UDC3500/UDC3200: Positional Proportional Control slidewire input or Three Position Step Control slidewire feedback

Note 12: UDC2300, UDC2500, UDC3200, UDC3300, UDC3500 only.

Note 13: UDC2500, UDC3200, UDC3500 only. Writing any value to this register via Function Code 6 clears bits 6 and 7 only. UDC3500 writing to 013F clears bits 6 and 7 for loop2.

A.4 Loop 2 and Extended Value Integer Register Map – UDC3500

The following table applies to the following instrument: **UDC3500** – **Loop2 and Exended range**.

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
0100	40257	PV	R	Signed 16 bit integer Prescale * 10 *Note 5*
0101	40258	RV	R	Signed 16 bit integer Prescale * 10
0102	40259	Working Set Point	R/W	Signed 16 bit integer Prescale * 10 *Note 5* On a write the instrument will update the proper set point according to the loop's currently selected set point.
0103	40260	Output	R/W	Signed 16 bit integer Prescale * 10 *Note 11*
0104	40261	Input #3	R	Signed 16 bit integer Prescale * 10
0105	40262	Input #4	R	Signed 16 bit integer Prescale * 10
0106	40263	Gain #5 (Prop Band #5 *if active*)	R/W	Signed 16 bit integer Prescale * 10
0107	40264	Direction	R	Signed 16 bit integer Prescale * 10
0108	40265	Reset #5	R/W	Signed 16 bit integer Prescale * 10 *Note 1*
0109	40266	Rate #5	R/W	Signed 16 bit integer Prescale * 10 *Note 1*
010A	40267	Cycle Time #1	R/W	Signed 16 bit integer Prescale * 10 *Note 2*
010B	40268	PV Low Range	R	Signed 16 bit integer Prescale * 10
010C	40269	PV High Range	R	Signed 16 bit integer Prescale * 10
010D	40270	Alarm #3 SP #1	R/W	Signed 16 bit integer Prescale * 10 *Note 7*
010E	40271	Alarm #3 SP #2	R/W	Signed 16 bit integer Prescale * 10 *Note 7*
010F	40272	Alarm #3 Action Bit 0 – AL3SP1 0=Low or Begin 1=High or End Bit 1 – AL3SP2 0=Low or Begin 1=High or End	R	Signed 16 bit integer Prescale * 10 *Note 6*
0110	40273	Gain #6 (Prop Band #6 *if active*)	R/W	Signed 16 bit integer Prescale * 10
0111	40274	Deadband	R/W	Signed 16 bit integer Prescale * 10
0112	40275	Reset #6	R/W	Signed 16 bit integer Prescale * 10 *Note 1*
0113	40276	Rate #6	R/W	Signed 16 bit integer Prescale * 10 *Note 1*
0114	40277	Cycle Time #2	R/W	Signed 16 bit integer Prescale * 10 *Note 2*
0115	40278	LSP #1	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0116	40279	LSP #2	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0117	40280	Alarm #4 SP #1	R/W	Signed 16 bit integer Prescale * 10 *Note 7*
0118	40281	Alarm #4 SP #2	R/W	Signed 16 bit integer Prescale * 10 *Note 7*

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
0119	40282	Alarm #4 Action Bit 0 – AL4SP1 0=Low or Begin 1=High or End Bit 1 – AL4SP2 0=Low or Begin 1=High or End	R	Signed 16 bit integer Prescale * 10 *Note 6*
011A	40283	SP Low Limit	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
011B	40284	SP High Limit	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
011C	40285	Working Set Point	R/W	Signed 16 bit integer Prescale * 10 *Note 5* On a write to this register the instrument will update the proper set point according to the loop's currently selected set point. Use this register for operator set point value changes ONLY. Use SP Override for computer-generated set point values.
011D	40286	Output Low Limit	R/W	Signed 16 bit integer Prescale * 10
011E	40287	Output High Limit	R/W	Signed 16 bit integer Prescale * 10
011F	40288	Output Working Value	R/W	Signed 16 bit integer Prescale * 10
0120	40289	PV Override Value	R/W	Signed 16 bit integer Prescale * 10
0121	40290	SP Override Value	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0122	40291	Output Override Value	R/W	Signed 16 bit integer Prescale * 10
0123	40292	Ratio	R/W	Signed 16 bit integer Prescale * 10 *Note 4*
0124	40293	Bias	R/W	Signed 16 bit integer Prescale * 10 *Note 4*
0125	40294	Deviation	R	Signed 16 bit integer Prescale * 10
0126	40295	LSP #3	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0127	40296	Input 5	R/W	Signed 16 bit integer Prescale*1000 *Note 3*
0128	40297	Loop #2 Decimal Point	R/W	Signed 16 bit integer Prescale* 1 *Note 3*
0129	40298	Alg1 Bias	R/W	Signed 16 bit integer Prescale * 10 *Note 8*
012A	40299	Alg2 Bias	R/W	Signed 16 bit integer Prescale * 10 *Note 9*
012B	40300	LSP #4	R/W	Signed 16 bit integer Prescale * 10 *Note 5*
0138	40313	Fuzzy Enable	R/W	Unsigned 16 bit integer 0=Disable 2= Enable2 1=Enable 3=Enable12 *Note 6*
0139	40314	Shed Enable	R/W	Bit Packed Bit 0: 0:Disable 1:Enable *Note 6*

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
013A	40315	Auto/Manual State	R/W	Bit Packed Bit 0: 0:Manual; 1:Auto Bit 1-15: Unused *Note 12*
013B	40316	Set Point State	R/W	Unsigned 16 bit integer 0=SP1 2=SP3 1=SP2 3=SP4 *Note 12*
013C	40317	Remote/Local Set Point State	R/W	Bit Packed Bit 0: 0:LSP; 1:RSP Bit 1-15: Unused *Note 12*
013D	40318	Tune Set State	R/W	Unsigned 16 bit integer 0=Tune Set #1 1=Tune Set #2 2=Tune Set #3 3=Tune Set #4
013E	40319	Loop Status	R	Bit Packed Bit 0: Mode: 0:Manual; 1:Auto Bit 1: Set Point: 0:SP1; 1:SP2 Bit 2: Remote/Local: 0:LSP; 1:RSP Bit 3: Tune Set: 0:Set #1; 1:Set #2 Bit 4: LSP3 Bit 5: LSP4 Bit 6: CSP Bit 7: UDC3500 set for Tune Set #1 Bit 8: UDC3500 set for Tune Set #3 Bit 9: UDC3500 set for Tune Set #4 Bit 10: Unused Bit 11: UDC3500 Run/Hold Status Bit 12: UDC3500 set for Any Digital Input Active Bit 13: UDC3500 set for Any Alarm Active Bit 14: UDC3500 set for Cascade Bit 15: UDC3500 set for Guaranteed Soak Deviation (Out of Limit) *Note 10, Note 12*

*Note 1 :*UDC3200, UDC3300, UDC3500 uses a prescale of 100 for this parameter.

Note 2: UDC3200, UDC3300, UDC3500 uses a prescale of 1 for this parameter.

Note 3: UDC3200, UDC3300, UDC3500 only.

Note 4: UDC3200, UDC3300, UDC3500 Ratio and Bias are CSP parameters.

Note 5: In the UDC3500, if the input type is configured as Carbon and the input algorithm is configured for one of the carbon selections, the prescale value is derived from the configured decimal point.

Note 6: Not supported by UDC2300 or UDC3300

Note 7: UDC2300, UDC2500, UDC3300, UDC3200 Loop 1 Address only.

Note 8: In the UDC3200, UDC3300, or UDC3500, if the Algorithm 1 type is configured for weighted average, RH, Summer, Sq. Root Mult-Div, Sq Root Mult, Mult-Div, Mult, Carbon A-D, FCC, Dew Point, or Oxygen, the prescale value is derived from the configured decimal point.

Note 9: In the UDC3300, or UDC3500 if the Algorithm 2 type is configured for weighted average, A-B/C, Sq Root Mult-Div, Sq Root Mult, Mult-Div, Mult, or Dew Point, the prescale value is derived from the configured decimal point.

Note 10: If bits 2, 4, 5 and 6 are set, then disregard bit 1.

Note 11: UDC3500: Positional Proportional Control slidewire input or Three Position Step Control slidewire feedback

Note 12: UDC2300, UDC2500, UDC3200, UDC3300, UDC3500 only.

A.5 Loop Value Register Map

This table contains addresses of Loop #1; see Table A-1 on page 27 for addresses of other loops.

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
0040	40065	PV	R	Floating Point in Engineering Units.
0042	40067	RV; Remote Set Point; SP2	R	Floating Point in Engineering Units. RSX, VPR, VRX, UDC5300 allow writing this value when SP2 is local (not connected)
0044	40069	Working Set Point	R	Floating Point in Engineering Units. RSX, VRX, VPR, UDC5300,: R/W On a write to this register the instrument will update the proper set point according to the loop's currently selected set point.
0046	40071	Output	R/W	Floating Point in Engineering Units. UDC2500, UDC3200, UDC3500 Read Only
0048	40073	Input #1	R	Floating Point in Engineering
004A	40075	Input #2	R	Floating Point in Engineering Units.
004C	40077	Gain #1 (Prop Band #1 *if active*)	R/W	Floating Point For loop #2 this cell is UDC330 Gain #3 or UDC3500 Gain #5
004E	40079	Direction	R	Floating Point 0.0=Direct; 1.0=Reverse
0050	40081	Reset #1	R/W	Floating Point in Repeats/Minute or Minutes/Repeat. For loop #2 this cell is UDC3300 Reset #3 or UDC3500 Reset #5
0052	40083	Rate #1	R/W	Floating Point in Minutes For loop #2, this cell is UDC3300 rate #3 or UDC3500 rate #5
0054	40085	Cycle Time #1	R/W	Floating Point in Seconds. Read-only for UDC2300, UDC3300. For loop #2 this cell is UDC3300 Cycle Time #3 or UDC3500 Cycle Time #5
0056	40087	PV Low Range	R	Floating Point in Engineering Units.
0058	40089	PV High Range	R	Floating Point in Engineering Units.
005A	40091	Alarm #1 SP #1	R/W	Floating Point in Engineering Units. *Note 2*
005C	40093	Alarm #1 SP #2	R/W	Floating Point in Engineering Units. *Note 2*
005E	40095	unused		
0060	40097	Gain #2 (Prop Band #2 *if active*)	R/W	Floating Point For loop #2 this cell is UDC3300 Gain #4 or UDC3500 Gain #6

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
0062	40099	Deadband	R/W	Floating Point
0064	40101	Reset #2	R/W	Floating Point in Repeats/Minute or Minutes/Repeat. For loop #2 this cell is UDC3300 Reset #4 or UDC3500 Reset #6
0066	40103	Rate #2	R/W	Floating Point in Minutes For loop #2 this cell is UDC3300 rate #4 or UDC3500 rate #6
0068	40105	Cycle Time #2	R/W	Floating Point in Seconds. Read-only UDC2300, UDC3300. For loop #2 this cell is UDC3300 Cycle Time #4 or UDC3500 Cycle Time #6
006A	40107	LSP #1	R/W	Floating Point in Engineering Units.
006C	40109	LSP #2	R/W	Floating Point in Engineering Units.
006E	40111	Alarm #2 SP #1	R/W	Floating Point in Engineering Units. *Note 2*
0070	40113	Alarm #2 SP #2	R/W	Floating Point in Engineering Units. *Note 2*
0072	40115	unused		
0074	40117	SP Low Limit	R/W	Floating Point in Engineering Units.
0076	40119	SP High Limit	R/W	Floating Point in Engineering Units.
0078	40121	Working Set Point	R/W	Floating Point in Engineering Units. On a write to this register the instrument will update the proper set point according to the loop's currently selected set point. NOTE: Use this register for operator set point value changes ONLY. Use SP Override for computer-generated set point values. DR4300, DR4500: READ ONLY
007A	40123	Output Low Limit	R/W	Floating Point in Engineering Units.
007C	40125	Output High Limit	R/W	Floating Point in Engineering Units.
007E	40127	Output Working Value	R/W	Floating Point in Engineering Units.
0080	40129	PV Override Value	R/W	Floating Point in Engineering Units. UDC2300, UDC2500, UDC3200, UDC3300, UDC3500 ONLY
0082	40131	SP Override Value	R/W	Floating Point in Engineering Units. UDC2300, UDC2500, UDC3200, UDC3300, UDC3500 ONLY
0084	40133	Output Override Value	R/W	Floating Point in Engineering Units. UDC2300, UDC2500, UDC3200, UDC3300, UDC3500 ONLY

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
0086	40135	Ratio	R/W	Floating Point in Engineering Units. Note 1.
0088	40137	Bias	R/W	Floating Point in Engineering Units. Note 1.
008A	40139	Deviation	R	Floating Point in Engineering Units.
008C	40141	LSP #3	R/W	Floating Point in Engineering Units.
008E	40143	LSP #4	R/W	Floating Point in Engineering Units.
0090	40145	Gain #3	R/W	Floating Point in Engineering Units. UDC3500 ONLY For loop #2 this cell is Gain #7
0092	40147	Reset #3	R/W	Floating Point in Engineering Units. UDC3500 ONLY For loop #2 this cell is Reset #7
0094	40149	Rate #3	R/W	Floating Point in Engineering Units. UDC3500 ONLY For loop #2 this cell is Rate #7
0096	40151	Gain #4	R/W	Floating Point in Engineering Units. UDC3500 ONLY For loop #2 this cell is Gain #8
0098	40153	Reset #4	R/W	Floating Point in Engineering Units. UDC3500 ONLY For loop #2 this cell is Reset #8
009A	40155	Rate #4	R/W	Floating Point in Engineering Units. UDC3500 ONLY For loop #2 this cell is Rate #8
009C	40157	PV/SP Switch 3 to 4	R/W	Floating Point in Engineering Units. UDC3500 ONLY
009E	40159	ALG1 Bias	R/W	Floating Point in Engineering Units UDC3200, UDC3300, UDC3500 ONLY
00A0	40161	ALG2 Bias	R/W	Floating Point in Engineering Units UDC3200, UDC3300, UDC3500 ONLY
00A2	40163	Aux Output	R	Floating Point in Engineering Units UDC2500, UDC3200, UDC3500 ONLY UDC3500: Current Output 2
00A4	40165	Setpoint Ramp Time	R/W	Floating Point in Engineering Units UDC2500, UDC3200, UDC3500 ONLY
00A6	40167	Setpoint Ramp Setpoint	R/W	Floating Point in Engineering Units UDC2500, UDC3200, UDC3500 ONLY
00A8	40169	Input 1 Ratio	R/W	Floating Point in Engineering Units. UDC2500, UDC3200, UDC3500 ONLY

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
00AA	40171	Input 1 Bias	R/W	Floating Point in Engineering Units. UDC2500, UDC3200, UDC3500 ONLY
00AC	40173	Input 2 Ratio	R/W	Floating Point in Engineering Units. UDC2500, UDC3200, UDC3500 ONLY
00AE	40175	Input 2 Bias	R/W	Floating Point in Engineering Units. UDC2500, UDC3200, UDC3500 ONLY
00B0	40177	SP/PV Switch 1 to 2	R/W	Floating Point in Engineering Units. UDC2500, UDC3200, UDC3500 ONLY
00B2	40179	SP/PV Switch 2 to 3	R/W	Floating Point in Engineering Units. UDC3500 ONLY
00B4	40181	Input 3 Ratio	R/W	Floating Point in Engineering Units. UDC3500 ONLY
00B6	40183	Input 3 Bias	R/W	Floating Point in Engineering Units. UDC3500 ONLY
00B8	40185	Input 4 Ratio	R/W	Floating Point in Engineering Units. UDC3500 ONLY
00BA	40187	Input 4 Bias	R/W	Floating Point in Engineering Units. UDC3500 ONLY
00BC	40189	Input 5 Ratio	R/W	Floating Point in Engineering Units. UDC3500 ONLY
00BE	40191	Input 5 Bias	R/W	Floating Point in Engineering Units. UDC3500 ONLY
00C0	40193	Current 1 Output	R	Floating Point in Engineering Units. UDC2500, UDC3200, UDC3500 ONLY
00C2	40195	Current 3 Output	R	Floating Point in Engineering Units. UDC3500 ONLY
00F6	40247	Fuzzy Enable	R/W	Unsigned 16 bit integer 0=Disable 1=Enable 2=Enable2 – UDC3500 ONLY 3=Enable12 – UDC3500 ONLY
00F8	40249	Shed Enable	R/W	Bit Packed Bit 0: 0:Disable 1:Enable
00FA	40251	Auto/Manual State	R/W	Bit Packed Bit 0: 0:Manual; 1:Auto Bit 1-15: Unused

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
00FB	40252	Set Point State	R/W	Unsigned 16 bit integer 0=SP1 1=SP2 2=SP3 3=SP4
00FC	40253	Remote/Local Set Point State	R/W	Bit Packed Bit 0: 0:LSP; 1:RSP Bit 1-15: Unused
00FD	40254	Tune Set State	R/W	Unsigned 16 bit integer 0=Tune Set #1 1=Tune Set #2 2=Tune Set #3 3=Tune Set #4 – UDC3500 Only
00FE	40255	Loop Status	R	Bit Packed Bit 0: Mode: 0:Manual; 1:Auto Bit 1: Set Point: 0:SP1; 1:SP2 Bit 2: Remote/Local: 0:LSP; 1:RSP Bit 3: Tune Set: 0:Set #1; 1:Set #2 Bit 4: LSP3 Bit 5: LSP4 Bit 6: CSP Bit 7: UDC3500 set for Tune Set #1 Bit 8: UDC3500 set for Tune Set #3 Bit 9: UDC3500 set for Tune Set #4 Bit 10: Unused Bit 11: UDC3500 Run/Hold Status Bit 12: UDC3500 set for Any Digital Input Active Bit 13: UDC3500 set for Any Alarm Active Bit 14: UDC3500 set for Cascade Bit 15: UDC3500 set for Guaranteed Soak Deviation (Out of Limit) *Note 3*

Note 1: UDC2300/UDC2500/UDC3200/UDC3300/UDC3500 Ratio and Bias are CSP parameters.
Note 2: UDC3300 Loop 1 Addresses only.
Note 3: If bits 2, 4, 5 and 6 are set; then disregard bit 1.
Note4: UDC3500/UDC3200: Positional Proportional Control Slidewire input or Three Position Step Control Slidewire feedback

A.6 Analog Input Value Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1800	46145	Analog Input #1	R	Floating Point in Engineering Units. Number of Inputs vary according to model numbers
1802	46147	Analog Input #2	R	
1804	46149	Analog Input #3	R	
1806	46151	Analog Input #4	R	
1808	46153	Analog Input #5	R	
180A	46155	Analog Input #6	R	
180C	46157	Analog Input #7	R	
180E	46159	Analog Input #8	R	
1810	46161	Analog Input #9	R	
1812	46163	Analog Input #10	R	
1814	46165	Analog Input #11	R	
1816 : 187E	46167 : 46271	Analog Input #12 : Analog Input #64	R R	

A.7 Communication or Constant Value Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1880	46273	Communication Value #1	R/W	Floating Point in Engineering Units. DR4500: Input 1 Bias
1882	46275	Communication Value #2	R/W	Floating Point in Engineering Units. DR4500: Input 2 Bias
1884	46277	Communication Value #3	R/W	Floating Point in Engineering Units. DR4500: Input 3 Bias
1886	46279	Communication Value #4	R/W	Floating Point in Engineering Units. DR4500: Input 4 Bias
1888	46281	Communication Value #5	R/W	Floating Point in Engineering Units.
188A	46283	Communication Value #6	R/W	:
188C	46285	Communication Value #7	R/W	:
188E	46287	Communication Value #8	R/W	:
1890	46289	Communication Value #9	R/W	:
1892	46291	Communication Value #10	R/W	:
1894	46293	Communication Value #11	R/W	:
1896	46295	Communication Value #12	R/W	:
1898	46297	Communication Value #13	R/W	:
189A	46299	Communication Value #14	R/W	:
189C	46301	Communication Value #15	R/W	:
189D : 18BE	46303 : 46335	Communication Value #16 : Communication Value #32	R/W R/W	: : :

A.7.1 Extended Comms for X Series recorders

Address (hex)	Register (decimal)	Channel Number	Access	Notes
2440	49281	Communication Value #33	R/W	Floating Point in Engineering Units.
2442	49283	Communication Value #34	R/W	:
2444	49285	Communication Value #35	R/W	:
2446	49287	Communication Value #36	R/W	:
2448	49289	Communication Value #37	R/W	:
244A	49291	Communication Value #38	R/W	:
244C	49293	Communication Value #39	R/W	:
244E	49295	Communication Value #40	R/W	:
2450	49297	Communication Value #41	R/W	:
2452	49299	Communication Value #42	R/W	:
2454	49301	Communication Value #43	R/W	:
2456	49303	Communication Value #44	R/W	:
2458	49305	Communication Value #45	R/W	:
245A	49307	Communication Value #46	R/W	:
245C	49309	Communication Value #47	R/W	:
245E : 24BE	49311 : 49407	Communication Value #48 : Communication Value #96	R/W : R/W	: : :

A.8 Math, Calculated Value, or Variable Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
18C0	46337	Math Value #1	R	Floating Point in Engineering Units. Smart Actuator: Position
18C2	46339	Math Value #2	R	Floating Point in Engineering Units. Smart Actuator: NCS Calibration Voltage
18C4	46341	Math Value #3	R	Floating Point in Engineering Units.
18C6	46343	Math Value #4	R	:
18C8	46345	Math Value #5	R	:
18CA	46347	Math Value #6	R	:
18CC	46349	Math Value #7	R	:
18CE	46351	Math Value #8	R	:
18D0	46353	Math Value #9	R	:
18D2	46355	Math Value #10	R	:
18D4	46357	Math Value #11	R	:
18D6	46359	Math Value #12	R	:
18D8	46361	Math Value #13	R	:
18DA	46363	Math Value #14	R	:
18DC	46365	Math Value #15	R	:
18DE	46367	Math Value #16	R	:
18E0	46369	Math Value #17	R	:
18E2	46371	Math Value #18	R	:
18E4	46373	Math Value #19	R	:
18E6	46375	Math Value #20	R	:
18E8	46377	Math Value #21	R	:
18EA	46379	Math Value #22	R	:
18EC	46381	Math Value #23	R	:
18EE	46383	Math Value #24	R	:
18F0	46385	Math Value #25	R	:
18F2	46387	Math Value #26	R	:
18F4	46389	Math Value #27	R	:
18F6	46391	Math Value #28	R	:
18F8	46393	Math Value #29	R	:
18FA	46395	Math Value #30	R	:
18FC	46397	Math Value #31	R	:
18FE : 1ABE	46399 : 46847	Math Value #32 : Math Value #256	R : R	: : :

A.9 Math or Calculated Value Status Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1AC0	46849	Math Status #1-#16	R	Bit Packed: Bit 0: Math #1 Status : Bit 15: Math #16 Status 0: Math OFF 1: Math ON
1AC1	46850	Math Status #17-#32	R	Bit Packed Bit 0: Math #17 Status : Bit 15: Math #32 Status 0: Math OFF 1: Math ON
:	:	:	:	:
1ACF	46864	Math Status #240 - #256	R	:

A.10 Totalizer Value Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1B00	46913	Totalizer Value #1	R	Floating Point in Engineering Units.
1B02	46915	Totalizer Value #2	R	:
1B04	46917	Totalizer Value #3	R	:
1B06	46919	Totalizer Value #4	R	:
1B08	46921	Totalizer Value #5	R	:
1B0A	46923	Totalizer Value #6	R	:
:	:	:		:
1B7E	47039	Totalizer Value #64	R	:

ATTENTION

To reset totalizer to a specific value, write that value to these registers (i.e., to reset totalizer #1 to zero write 0.0 to register 46913).

A.11 Totalizer Status Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1B80	47041	Totalizer Status #1 - #16	R	Bit Packed Bit 0: Totalizer #1 Status Bit 1: Totalizer #2 Status : Bit 15: Totalizer #16 Status 0: Totalizer OFF 1: Totalizer ON
1B81	47042	Totalizer Status #17 - #32	R	Bit Packed Bit 0: Totalizer #17 Status Bit 1: Totalizer #18 Status : Bit 15: Totalizer #32 Status 0: Totalizer OFF 1: Totalizer ON
1B82	47043	Totalizer Status #33 - #48	R	:
1B83	47044	Totalizer Status #49 - #64	R	:

A.12 Shed Timer Reset Register

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1B90	47057	Reset Shed Timer Loop 1	W	Signed 16 bit integer Write this address to clear an infinite shed condition. (Shedtime = 0) Data is ignored. *NOTE: UDC3300/UDC2300/UDC2500/UDC3200/ UDC3500 ONLY*
1B91	47058	Reset Shed Timer Loop 2	W	Signed 16 bit integer Write this address to clear an infinite shed condition. (Shedtime = 0) Data is ignored. *NOTE: UDC3300, UDC3500 ONLY*

A.13 Maintenance (HealthWatch) Value Register Map

This table applies to the UDC3300 Expanded and UDC3500 models only.

Address (hex)	Register (decimal)	Channel Number	Acces s	Notes
1B99	47064	Maintenance Reset Type	W	Unsigned 16-bit Integer 0: None 6: Counter 2 1: Timer 1 7: Counter 3 2: Timer 2 8: All Counters 3: Timer 3 9: All Timers & Counters 4: All Timers 10: Ambient Temp 5: Counter 1
1B9A	47065	Timer 1 Configuration UDC3300 only	R/W	Unsigned 16-bit Integer 0: Disable 6: Manual Loop 1 1: Last Reset 7: Guaranteed soak 2: Alarm 1 SP1 8: Sooting 3: Alarm 1 SP2 9: DI1 Closed 4: Alarm 2 SP1 10:DI2 Closed 5: Alarm 2 SP2 11: Manual Loop 2
1B9A	47065	Timer 1 Configuration UDC3500 only	R/W	Unsigned 16-bit Integer 0: Disable 9: Alarm 4 SP2 1: Last Reset 10: Manual Loop 1 2: Alarm 1 SP1 11: Guaranteed soak 3: Alarm 1 SP2 12: Sooting 4: Alarm 2 SP1 13: DI1 Closed 5: Alarm 2 SP2 14: DI2 Closed 6: Alarm 3 SP1 15: DI2 Closed 7: Alarm 3 SP2 16: DI2 Closed 8: Alarm 4 SP1 17: Manual Loop 2
1B9B	47066	Timer 2 Configuration	R/W	Same as Timer 1 Configuration
1B9C	47067	Timer 3 Configuration	R/W	Same as Timer 1 Configuration
1B9D	47068	Counter 1 Configuration UDC3300 only	R/W	Unsigned 16-bit Integer 0: Disable 6: DI1 1: Manual Loop 1 7: DI2 2: Alarm 1 SP1 8: Output1 Relay x 1K 3: Alarm 1 SP2 9: Output2 Relay x 1K 4: Alarm 2 SP1 10:Guaranteed soak 5: Alarm 2 SP2 11: Power cycle

Address (hex)	Register (decimal)	Channel Number	Acces s	Notes
1B9D	47068	Counter 1 Configuration UDC3500 only	R/W	Unsigned 16-bit Integer 0: Disable 14: Output1 Relay x 1K 1: Manual Loop 1 15: Output2 Relay x 1K 2: Alarm 1 SP1 16: Output3 Relay x 1K 3: Alarm 1 SP2 17: Output4 Relay x 1K 4: Alarm 2 SP1 18: Output4 Relay x 1K 5: Alarm 2 SP2 19:Guaranteed soak 6: Alarm 3 SP1 20: Power cycle 7: Alarm 3 SP2 21: PV Range Loop 1 8: Alarm 4 SP1 22: Failsafe Loop 1 9: Alarm 4 SP2 23: Tune Loop 1 10: DI1 Closed 24: Manual Loop 2 11: DI2 Closed 25: PV Range Loop 2 12: DI3 Closed 26: Failsafe Loop 2 13: DI4 Closed 27: Tune Loop2
1B9E	47069	Counter 2 Configuration	R/W	Same as Counter 1 Configuration
1B9F	47070	Counter 3 Configuration	R/W	Same as Counter 1 Configuration
1BA0	47071	Timer 1 Days	R	Signed 16 bit integer
1BA1	47072	Timer 1 Hours	R	Signed 16 bit integer
1BA2	47073	Timer 1 Minutes	R	Signed 16 bit integer
1BA3	47074	Timer 2 Days	R	Signed 16 bit integer
1BA4	47075	Timer 2 Hours	R	Signed 16 bit integer
1BA5	47076	Timer 2 Minutes	R	Signed 16 bit integer
1BA6	47077	Timer 3 Days	R	Signed 16 bit integer
1BA7	47078	Timer 3 Hours	R	Signed 16 bit integer
1BA8	47079	Timer 3 Minutes	R	Signed 16 bit integer
1BA9	47080	Counter 1	R	Signed 16 bit integer
1BAA	47081	Counter 2	R	Signed 16 bit integer
1BAB	47082	Counter 3	R	Signed 16 bit integer

A.14 Time Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1BE0	47137	Hours	R/W	0 to 23
1BE1	47138	Minutes	R/W	0 to 60
1BE2	47139	Seconds	R/W	0 to 60
1BE3	47140	Month	R/W	1 to 12
1BE4	47141	Day	R/W	1 to 31
1BE5	47142	Year	R/W	00 to 99 *VPR, VRX: accepts the values 0 – 37, 70 – 99, and 1970 – 2037. The values read are always in the range of 1970 to 2037. 0 – 37 represents 2000 – 2037, 70 – 99 represents 1970 – 1999* *DR4500: accepts 0-99 or 1970 – 2037 and ignores the century.* *UDC3500: accepts 05-99*
1BE6	47143	Week Day	R/W	0 to 6 (0 = Sunday) DR4500: R/W VPR/VRX, UDC3500: ignored

ATTENTION

Clock registers must be written in a single transaction. They can be written in one transaction of registers 47137 through 47142 or one transaction of registers 47137 through 47143.

A.15 Alarm Status Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1BF0	47153	Alarm Status #1 - #16	R	Bit Packed Bit 0: Alarm #1 Status Bit 1: Alarm #2 Status Bit 2: UDC3500 Alarm #3 Status Bit 3: UDC3500 Alarm #4 Status : Bit 15: Alarm #16 Status 0: Alarm OFF 1: Alarm ON
1BF1	47154	Alarm Status #17 - #32	R	Bit Packed Bit 0: Alarm #17 Status Bit 1: Alarm #18 Status : Bit 15: Alarm #32 Status 0: Alarm OFF 1: Alarm ON
1BF2	47155	Alarm Status #33 - #48	R	Bit Packed Bit 0: Alarm #33 Status Bit 1: Alarm #34 Status : Bit 15: Alarm #48 Status 0: Alarm OFF 1: Alarm ON
1BF3	47156	Alarm Status #49 - #64	R	:
1BF4	47157	Alarm Status #65 - #80	R	:
1BF5 : 1BFF	47158 : 47168	Alarm Status #81 - #96 : Alarm Status #240 - #256	R : R	: : :

A.16 Alarm Set Point Value Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1C00	47169	Alarm Set Point Value #1	R/W	Floating Point in Engineering Units. DR4300, DR4500, UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, 10260S, 11280S: Alarm #1 SP1
1C02	47171	Alarm Set Point Value #2	R/W	Floating Point in Engineering Units. DR4300, DR4500, UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, 10260S, 11280S: Alarm #1 SP2
1C04	47173	Alarm Set Point Value #3	R/W	Floating Point in Engineering Units. DR4300, DR4500, UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, 10260S, 11280S: Alarm #2 SP1
1C06	47175	Alarm Set Point Value #4	R/W	Floating Point in Engineering Units. DR4300, DR4500, UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, 10260S, 11280S: Alarm #2 SP2
1C08	47177	Alarm Set Point Value #5	R/W	Floating Point in Engineering Units. 10260S, 11280S: Alarm #3 SP1
1C0A	47179	Alarm Set Point Value #6	R/W	Floating Point in Engineering Units. 10260S, 11280S: Alarm #3 SP2
1C0C	47181	Alarm Set Point Value #7	R/W	Floating Point in Engineering Units. 10260S, 11280S: Alarm #4 SP1
1C0E	47183	Alarm Set Point Value #8	R/W	Floating Point in Engineering Units. 10260S, 11280S: Alarm #4 SP2
1C10	47185	Alarm Set Point Value #9	R/W	Floating Point in Engineering Units.
1C12	47187	Alarm Set Point Value #10	R/W	:
1C14	47189	Alarm Set Point Value #11	R/W	:
1C16	47191	Alarm Set Point Value #12	R/W	:
1C18	47193	Alarm Set Point Value #13	R/W	:
1C1A	47195	Alarm Set Point Value #14	R/W	:
1C1C	47197	Alarm Set Point Value #15	R/W	:
1C1E	47199	Alarm Set Point Value #16	R/W	:
:	:	:		:
1DFE	47679	Alarm Set Point Value #256	R/W	This is the same as Alarm 3 Value Pen 64 for X Series recorders.
:	:	:		:
:	:	:		Register continues for X Series recorders:
:	:	:		:
207E	48319	Alarm Set Point Value #576	R/W	This is the same as Alarm 6 Value Pen 96 for X Series recorders.

A.16.1 Alarm Status

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1980	6529	Alarm Status, Pen 1 (start address)	R	
1981	6530	Alarm Status, Pen 2	R	
1982	6531	Alarm Status, Pen 3	R	
1983	6532	Alarm Status, Pen 4	R	
1984	6533	Alarm Status, Pen 5	R	
1985	6534	Alarm Status, Pen 6	R	
1986	6535	Alarm Status, Pen 7	R	
1987	6536	Alarm Status, Pen 8	R	
1988	6537	Alarm Status, Pen 9	R	
1989 : 19DF	6538 : 6624	Alarm Status, Pen 10 : Alarm Status, Pen 96 (end address)	R R R	

A.17 Set Point Programmer Value Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1E00	47681	Set Point Programmer Output	R	Floating Point in Engineering Units.
1E02	47683	Current Segment Number	R	Floating Point; 1...Max Segment # A write changes the segment number.
1E04	47685	Program Elapsed Time	R	Floating Point in Seconds -or- Time Units Includes or runs when in Hold *Note 1, 2*
1E06	47687	Program Active Time	R	Floating Point in Seconds -or- Time Units Excludes or stops when in Hold *Note 1, 2*
1E08	47689	Segment Time Remaining	R	Floating Point in Seconds -or- Time Units
1E0A	47691	Current Segment Events (Bit Packed)	R	Bit Packed Bit 0: Event #1 : Bit 15: Event #16 0: Event OFF 1: Event ON *Note 1, 2*
1E0B	47692	Status	R	Bit Packed Bit 0: 1=Ready 1: 1=Run 2: 1=Hold 3: 1=End 4: 1=Time Units in Seconds 5: 1=Time Units in Minutes 6: 1=Time Units in Hours UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, DR4300, DR4500,: 7: Ramp Units 0: Time 1: Rate UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, DR4300, DR4500,: 8: If bit 7 Set 0: EU/Hour 1: EU/Minute Bit 9: Guaranteed Soak State Bit 12-15: Program Selected #1 to #4 UDC3500
1E0C	47693	Start	W	Signed 16 bit integer Write to location Starts Profile; Data ignored *Note 3*

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1E0D	47694	Hold	W	Signed 16 bit integer Write to location Holds Profile; Data ignored *Note 4*
1E0E	47695	Advance	W	Signed 16 bit integer Write to location Advances Profile; Data ignored *Note 1, 2*
1E0F	47696	Reset	W	Signed 16 bit integer Write to location Resets Profile; Data ignored *Note 1*

NOTE 1: Not implemented in DR4300, DR4500

NOTE 2: Not implemented in UDC2300, UDC2500, UDC3200, UDC3300, UDC3500

NOTE 3: UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, require data to be a value of 1.

NOTE 4: UDC2300, UDC2500, UDC3200, UDC3300, UDC3500, require data to be a value of 0.

A.18 Set Point Programmer Additional Values Register Map

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1F3A	47995	Time Units	R/W	Bit Packed Bit 0: seconds 1: minutes 2: hours 3-15: Unused *Notes 2, 4*
1F3B	47996	Ramp Units	R/W	Bit Packed Bit 0: 0:Time; 1:Rate Bit 1-15: Unused *Note 4*
1F3D	47998	Program End Segment (Program 1 only)	R/W	Bit Packed Bit 0: 1: 2 1: 1: 4 2: 1: 6 3: 1: 8 4: 1: 10 5: 1: 12 6: 1: 14 7: 1: 16 8: 1: 18 9: 1: 20 *Note 1*
1F3E	47999	Program Termination State	R/W	Bit Packed Bit 0: 0: Last SP (Hold at last SP in program) 1: F'SAFE (Manual mode, failsafe output) 1-15: Unused *Note 1*
1F3F	48000	Program State at Program End	R/W	Bit Packed Bit 0: 0: Disabl; 1: Hold 1-15: Unused *Note 1*
1F40	48001	Engineering Units for Ramp Segments	R/W	Bit Packed Bit 0: 0: Hrs:Mins 0: 1: Degrees/Min 1: 1: Degrees/Hour 2-15: Unused *Note 1*

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1F41	48002	Program Start Segment 1-16	W	Bit Packed Bit 0: 1 = Start Segment 1 1: 1 = Start Segment 2 2: 1 = Start Segment 3 3: 1 = Start Segment 4 4: 1 = Start Segment 5 5: 1 = Start Segment 6 6: 1 = Start Segment 7 7: 1 = Start Segment 8 8: 1 = Start Segment 9 9: 1 = Start Segment 10 10: 1 = Start Segment 11 11: 1 = Start Segment 12 12: 1 = Start Segment 13 13: 1 = Start Segment 14 14: 1 = Start Segment 15 15: 1 = Start Segment 16 *Note 1*
1F43	48004	Program Start Segment 17-20	W	Bit Packed Bit 0: 1 = Start Segment 17 1: 1 = Start Segment 18 2: 1 = Start Segment 19 3: 1 = Start Segment 20 *Note 1*
1F41 1F43	48002 48004	Program Start Segment 1-20 1F41- Write bits 1-16 1F43- Write bits 17-20 1F41 and 1F43- Read Integer value	R	Unsigned 16-bit Integer 1 = Start Segment 1 2 = Start Segment 2 3 = Start Segment 3 4 = Start Segment 4 5 = Start Segment 5 6 = Start Segment 6 7 = Start Segment 7 8 = Start Segment 8 9 = Start Segment 9 10 = Start Segment 10 11 = Start Segment 11 12 = Start Segment 12 13 = Start Segment 13 14 = Start Segment 14 15 = Start Segment 15 16 = Start Segment 16 17 = Start Segment 17 18 = Start Segment 18 19 = Start Segment 19 20 = Start Segment 20 *Note 1*
1F42	48003	Program Recycles	R/W	Unsigned 16-bit Integer 0 to 99 *Note 3*

Address (hex)	Register (decimal)	Channel Number	Access	Notes
1F44	48005	Program End Segment UDC3500 Only for Program Number 1 - 4	R W	Unsigned 16-bit Integer End segment 1 to End segment 20 Bit Packed 2 = Soak Segment 2 4 = Soak Segment 4 6 = Soak Segment 6 8 = Soak Segment 8 10 = Soak Segment 10 12 = Soak Segment 12 14 = Soak Segment 14 16 = Soak Segment 16 18 = Soak Segment 18 20 = Soak Segment 20 (Odd numbers are illegal)
1F45	48006	Program Number UDC3500 Only	R/W	UDC3500 Program #1 - #4 Enhanced Setpoint Program Only

Note 1: UDC2300, UDC2500, UDC3200, UDC3300, UDC3500 *Only*
Note 2: UDC2300, UDC2500, UDC3200, UDC3300, UDC3500 *does not support seconds*
Note 3: UDC2300 does not permit writing to this register
Note4: UDC2300, UDC2500, UDC3200, UDC3300, UDC3500 *read only*

A.19 Set Point Programmer Segment Map

A profile can contain up to 64 segments depending on the instrument. Each segment is made up of 8 registers. The segment mapping for setpoint programmer #1 is shown below.

Start Address	End Address	Description
2800	2807	Set Point Programmer #1 Segment 1
2808	280F	Set Point Programmer #1 Segment 2
2810 : 29F8	2817 : 29FF	Set Point Programmer #1 Segment 3 **:** Set Point Programmer #1 Segment 64

A.19.1 Segment Register Map

The table below describes the registers that are part of a setpoint programmer segment. To determine the actual register address for a parameter within a segment, add the register offset to the start address of the segment.

Register Offset within Segment	Parameter Name	Access	Notes
0	Ramp Segment	R/W	Bit Packed Bit 0: 1 = ramp segment; 0=soak segment Bit 1: 1 = guaranteed soak enabled 0 = guaranteed soak disabled Bit 2: 1 = guaranteed soak enabled PV#2 0 = guaranteed soak disabled PV#2 Bit 0 is ignored in the hold mode. Writing to this register is not permissible in the run mode. VPR, VRX ONLY
1	Events	R/W	Bit Packed Bit 0: Event #1 : : Bit 15: Event #16 0: Event OFF 1: Event ON Writing to this register is only permissible in reset or ready mode. VPR, VRX ONLY
2	Time or Rate	R/W	Floating Point in time units configured for the set point programmer Writing to this register is not permissible in the run mode. VPR, VRX ONLY
4	Ramp or Soak value	R/W	Floating Point Writing to this register is not permissible in the run mode. VPR, VRX ONLY
6	Soak value for auxiliary output (use “Time or Rate” for duration)	R/W	Floating Point Writing to this register is not permissible in the run mode. VPR, VRX ONLY

A.19.2 Example For Determining a Segment Register

To change the ramp value in segment #8 of setpoint programmer #2, the register address is determined as follows.

Step 1: Use Table A-1 to determine the start address for setpoint program #2 profile. The value is 2A00 Hex.

Step 2: Calculate the offset address for segment 8 in a profile. This is calculated as:

Segment #8 offset address = (segment number – 1) * 8

= (8-1) * 8

= 56 or 38 Hex

Step 3: Use the table above to determine the register offset for the ramp value. The value is 4.

Step 4: Calculate the address by adding the results of steps 1, 2, and 3 to determine the register address.

Register address = Setpoint program #2 profile base address
+ Segment 8 offset address
+ Ramp value register offset

= 2A00 + 38 + 4

= 2A3C

A.20 Herculine Smart Actuator Value Register Map

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
1AD0	46865	Position	R	FP 0-100% or 0-90 Degrees of Travel
1AD2	46867	Input	R	Floating Point 0-100%
1AD4	46869	Output	R	Floating Point 0-100%
1AD6	46871	Remote Setpoint	R/W	Floating Point 0-100%
1AD8	46873	Input Low Range	R/W	Floating Point 0-100%
1ADA	46875	Input High Range	R/W	Floating Point 0-100%
1ADC	46877	Relay #1 SP1	R/W	Floating Point 0-100%
1ADE	46879	Relay #1 SP2	R/W	Floating Point 0-100%
1AE0	46881	Relay #2 SP1	R/W	Floating Point 0-100%
1AE2	46883	Relay #2 SP2	R/W	Floating Point 0-100%
1AE4	46885	Relay #3 SP1	R/W	Floating Point 0-100%
1AE6	46887	Relay #3 SP2	R/W	Floating Point 0-100%
1AE8	46889	Relay #4 SP1	R/W	Floating Point 0-100%
1AEA	46891	Relay #4 SP2	R/W	Floating Point 0-100%
1AEC	46893	Deadband	R/W	Floating Point 0.2-5.0%
1AEE	46895	Deviation	R	Floating Point 0-100%
1AF0	46897	Reserved for future		
1AF2	46899	Reserved for future		
1AF4	46901	Reserved for future		
1AF6	46903	Reserved for future		
1AF8	46905	Reserved for future		
1AFA	46907	Reserved for future		
1AFC	46909	Alarm Status	R	Bit Packed Actuator Alarm / Relay Status Bit 0 : Alarm / Relay 1 Bit 1 : Alarm / Relay 2 Bit 2 : Alarm / Relay 3 Bit 3 : Alarm / Relay 4 Bit 4 : Unused Bit 5 : Stall Alarm Bit 6 : Rivitz Failure Bit 7 : Unused 0 : Alarm Off; 1 : Alarm On
1AFD	46910	Mode Status	R/W	Bit Packed Actuator Mode Status Bit 0: Auto / Man Mode (0=Man; 1=Auto) Bit 1 – 3 : Unused Bit 4: Man Front Panel (0=Man; 1=Auto) Bit 5: Man Ext Switch (0=Man; 1=Auto) Bit 6 – 7 : Unused

1AFE	46911	System Status	R	Bit Packed System Status Failures Bit 0 : FailSafe Bit 1 : RamTest Bit 2 : Config Checksum Bit 3 : Working Calibration Checksum Bit 4 : SeeTest Bit 5 : EE Fail 0 = OK; 1 = Failure
1AFF	46912	Reserved for future		

A.21 Herculine Smart Actuator Factory Data Register Map

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
27D0	50193	Tag Name	R	ASCII string (3 Registers)
27D3	50196	Date of Manufacture	R	ASCII string (3Registers)
27D6	50199	Date Last Repaired	R	ASCII string (3 Registers)
27D9	50202	Date Last Calibrated	R	ASCII string (3 Registers)
27DC	50205	Actuator Serial Number	R	ASCII string (9 Registers)
27ED	50222	Actuator Model Number	R	ASCII string (13 Registers) 10260S, 11280S ASCII string (14 Registers) SA2001, SA2002

A.22 Herculine Smart Actuator Maintenance Data Register Map

Address (hex)	Register (decimal)	Parameter Name	Access	Notes
1E40	47745	Temperature	R	Temperature in degrees F
1E42	47747	Temperature Hi	R	Temperature in degrees F
1E44	47749	Temperature Lo	R	Temperature in degrees F
1E46	47751	Cycles	R	Floating Point 0 – 99,990,0000 counts
1E48	47753	Relay1 Cycles	R	Floating Point 0 – 99,990,0000 counts
1E4A	47755	Relay2 Cycles	R	Floating Point 0 – 99,990,0000 counts
1E4C	47757	Relay3 Cycles	R	Floating Point 0 – 99,990,0000 counts
1E4E	47759	Relay4 Cycles	R	Floating Point 0 – 99,990,0000 counts
1E50	47761	Region0 Counts	R	Floating Point 0 – 99,990,0000 counts
1E52	47763	Region1 Counts	R	Floating Point 0 – 99,990,0000 counts
1E54	47765	Region2 Counts	R	Floating Point 0 – 99,990,0000 counts
1E56	47767	Region3 Counts	R	Floating Point 0 – 99,990,0000 counts
1E58	47769	Region4 Counts	R	Floating Point 0 – 99,990,0000 counts
1E5A	47771	Region5 Counts	R	Floating Point 0 – 99,990,0000 counts
1E5C	47773	Region6 Counts	R	Floating Point 0 – 99,990,0000 counts
1E5E	47775	Region7 Counts	R	Floating Point 0 – 99,990,0000 counts
1E60	47777	Region8 Counts	R	Floating Point 0 – 99,990,0000 counts
1E62	47779	Region9 Counts	R	Floating Point 0 – 99,990,0000 counts
1E64	47781	Total Degrees Travelled	R	Floating Point 0 – 99,990,0000 degrees
1E66	47783	Accumulated Stall Time	R	Floating Point 0 – 6000 minutes

B. Appendix: CRC-16 Calculation

See following function:

```
extern void calculate_CRC(unsigned char *message, int length, unsigned char *CRC)
{
unsigned char CRCHi, CRCLo, TempHi, TempLo;

static const unsigned char table[512] = {
0x00, 0x00, 0xC0, 0xC1, 0xC1, 0x81, 0x01, 0x40, 0xC3, 0x01, 0x03, 0xC0, 0x02, 0x80, 0xC2, 0x41,
0xC6, 0x01, 0x06, 0xC0, 0x07, 0x80, 0xC7, 0x41, 0x05, 0x00, 0xC5, 0xC1, 0xC4, 0x81, 0x04, 0x40,
0xCC, 0x01, 0x0C, 0xC0, 0x0D, 0x80, 0xCD, 0x41, 0x0F, 0x00, 0xCF, 0xC1, 0xCE, 0x81, 0x0E, 0x40,
0x0A, 0x00, 0xCA, 0xC1, 0xCB, 0x81, 0x0B, 0x40, 0xC9, 0x01, 0x09, 0xC0, 0x08, 0x80, 0xC8, 0x41,
0xD8, 0x01, 0x18, 0xC0, 0x19, 0x80, 0xD9, 0x41, 0x1B, 0x00, 0xDB, 0xC1, 0xDA, 0x81, 0x1A, 0x40,
0x1E, 0x00, 0xDE, 0xC1, 0xDF, 0x81, 0x1F, 0x40, 0xDD, 0x01, 0x1D, 0xC0, 0x1C, 0x80, 0xDC, 0x41,
0x14, 0x00, 0xD4, 0xC1, 0xD5, 0x81, 0x15, 0x40, 0xD7, 0x01, 0x17, 0xC0, 0x16, 0x80, 0xD6, 0x41,
0xD2, 0x01, 0x12, 0xC0, 0x13, 0x80, 0xD3, 0x41, 0x11, 0x00, 0xD1, 0xC1, 0xD0, 0x81, 0x10, 0x40,
0xF0, 0x01, 0x30, 0xC0, 0x31, 0x80, 0xF1, 0x41, 0x33, 0x00, 0xF3, 0xC1, 0xF2, 0x81, 0x32, 0x40,
0x36, 0x00, 0xF6, 0xC1, 0xF7, 0x81, 0x37, 0x40, 0xF5, 0x01, 0x35, 0xC0, 0x34, 0x80, 0xF4, 0x41,
0x3C, 0x00, 0xFC, 0xC1, 0xFD, 0x81, 0x3D, 0x40, 0xFF, 0x01, 0x3F, 0xC0, 0x3E, 0x80, 0xFE, 0x41,
0xFA, 0x01, 0x3A, 0xC0, 0x3B, 0x80, 0xFB, 0x41, 0x39, 0x00, 0xF9, 0xC1, 0xF8, 0x81, 0x38, 0x40,
0x28, 0x00, 0xE8, 0xC1, 0xE9, 0x81, 0x29, 0x40, 0xEB, 0x01, 0x2B, 0xC0, 0x2A, 0x80, 0xEA, 0x41,
0xEE, 0x01, 0x2E, 0xC0, 0x2F, 0x80, 0xEF, 0x41, 0x2D, 0x00, 0xED, 0xC1, 0xEC, 0x81, 0x2C, 0x40,
0xE4, 0x01, 0x24, 0xC0, 0x25, 0x80, 0xE5, 0x41, 0x27, 0x00, 0xE7, 0xC1, 0xE6, 0x81, 0x26, 0x40,
0x22, 0x00, 0xE2, 0xC1, 0xE3, 0x81, 0x23, 0x40, 0xE1, 0x01, 0x21, 0xC0, 0x20, 0x80, 0xE0, 0x41,
0xA0, 0x01, 0x60, 0xC0, 0x61, 0x80, 0xA1, 0x41, 0x63, 0x00, 0xA3, 0xC1, 0xA2, 0x81, 0x62, 0x40,
0x66, 0x00, 0xA6, 0xC1, 0xA7, 0x81, 0x67, 0x40, 0xA5, 0x01, 0x65, 0xC0, 0x64, 0x80, 0xA4, 0x41,
0x6C, 0x00, 0xAC, 0xC1, 0xAD, 0x81, 0x6D, 0x40, 0xAF, 0x01, 0x6F, 0xC0, 0x6E, 0x80, 0xAE, 0x41,
0xAA, 0x01, 0x6A, 0xC0, 0x6B, 0x80, 0xAB, 0x41, 0x69, 0x00, 0xA9, 0xC1, 0xA8, 0x81, 0x68, 0x40,
0x78, 0x00, 0xB8, 0xC1, 0xB9, 0x81, 0x79, 0x40, 0xBB, 0x01, 0x7B, 0xC0, 0x7A, 0x80, 0xBA, 0x41,
0xBE, 0x01, 0x7E, 0xC0, 0x7F, 0x80, 0xBF, 0x41, 0x7D, 0x00, 0xBD, 0xC1, 0xBC, 0x81, 0x7C, 0x40,
0xB4, 0x01, 0x74, 0xC0, 0x75, 0x80, 0xB5, 0x41, 0x77, 0x00, 0xB7, 0xC1, 0xB6, 0x81, 0x76, 0x40,
0x72, 0x00, 0xB2, 0xC1, 0xB3, 0x81, 0x73, 0x40, 0xB1, 0x01, 0x71, 0xC0, 0x70, 0x80, 0xB0, 0x41,
0x50, 0x00, 0x90, 0xC1, 0x91, 0x81, 0x51, 0x40, 0x93, 0x01, 0x53, 0xC0, 0x52, 0x80, 0x92, 0x41,
0x96, 0x01, 0x56, 0xC0, 0x57, 0x80, 0x97, 0x41, 0x55, 0x00, 0x95, 0xC1, 0x94, 0x81, 0x54, 0x40,
0x9C, 0x01, 0x5C, 0xC0, 0x5D, 0x80, 0x9D, 0x41, 0x5F, 0x00, 0x9F, 0xC1, 0x9E, 0x81, 0x5E, 0x40,
0x5A, 0x00, 0x9A, 0xC1, 0x9B, 0x81, 0x5B, 0x40, 0x99, 0x01, 0x59, 0xC0, 0x58, 0x80, 0x98, 0x41,
0x88, 0x01, 0x48, 0xC0, 0x49, 0x80, 0x89, 0x41, 0x4B, 0x00, 0x8B, 0xC1, 0x8A, 0x81, 0x4A, 0x40,
0x4E, 0x00, 0x8E, 0xC1, 0x8F, 0x81, 0x4F, 0x40, 0x8D, 0x01, 0x4D, 0xC0, 0x4C, 0x80, 0x8C, 0x41,
0x44, 0x00, 0x84, 0xC1, 0x85, 0x81, 0x45, 0x40, 0x87, 0x01, 0x47, 0xC0, 0x46, 0x80, 0x86, 0x41,
0x82, 0x01, 0x42, 0xC0, 0x43, 0x80, 0x83, 0x41, 0x41, 0x00, 0x81, 0xC1, 0x80, 0x81, 0x40, 0x40,
  };
        CRCHi = 0xff;
        CRCLo = 0xff;

        while(length)
        {
                TempHi = CRCHi;
                TempLo = CRCLo;
                CRCHi = table[2 * (*message ^ TempLo)];
                CRCLo = TempHi ^ table[(2 * (*message ^ TempLo)) + 1];
                message++;
                length--;
        };
        CRC [0] = CRCLo;
        CRC [1] = CRCHi;
        return;
}
```

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