SOFTWARE FUNCTIONAL REQUIREMENTS SPECIFICATION

Athena® DeviceNet Interface Module

Revision 1.40

2/26/2001

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1. Introduction

1.1 Overview

This document is the software requirements specification for the Athena DeviceNet interface module. It describes the operation of the unit, the DeviceNet network model and the communications interface to the one to eight Athena Temperature controllers over the Modbus communication link.

1.2 Document Scope

This specification describes the unit configuration, unit initialization, the DeviceNet Network Model and the interface to the Athena Temperature controllers. It describes the functionality required of the Athena DeviceNet interface module. It does not describe implementation details or specify the requirements for the PCB or enclosure.

1.3 Definitions

UCMM	–	The DeviceNet Unconnected Message Manager, a mechanism in which a device can accept messages in a peer-peer relationship.
Processor	–	The host processor that presents the network model to the DeviceNet network and provides Modbus communications to the Athena Controllers.
Network Host	–	The DeviceNet network Host (commonly a scanner card in a Programmable Controller)
Network Slave	–	A DeviceNet device which implements server functionality in a DeviceNet system
Programmable Controller	–	PLC refers to the DeviceNet Network Host.
CRC	–	Cyclical Redundancy Check
Master	–	The master of the Modbus protocol. The master initiates all communications.
RTU	–	The type of Modbus communications which transmits characters using 8-bit bytes.
Slave	–	The slave of the Modbus protocol. The slave responds to all master messages (except broadcast messages). The slave never initiates communications.

1.4 Reference Documents

- DeviceNet Specification Volume I, Release 2.0 © 1997 ODVA
- DeviceNet Specification Volume II, Release 2.0 © 1997 ODVA
- Real Time Automation Athena Hardware Specifications, Doc No. J1039-00.00-SP

1.5 Open DeviceNet Vendor Association, Inc. (ODVA)

ODVA is an independent supplier organization that manages the DeviceNet specification and supports the worldwide growth of DeviceNet.

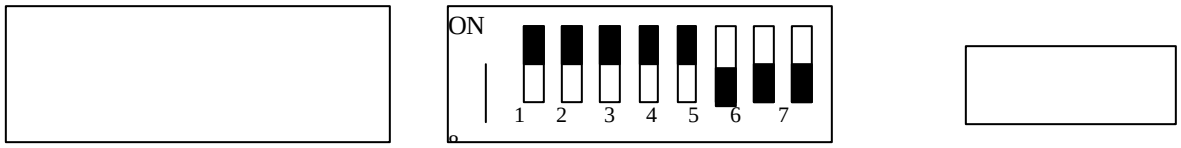
2. System Operation

2.1 Overview

The Athena DeviceNet interface provides a DeviceNet interface to up to eight Athena Temperature controllers. The interface is implemented by continuously polling the controllers using the Modbus communications protocol and presenting the data to the DeviceNet network as DeviceNet vendor specific objects of a generic DeviceNet device.

2.2 Configuration

Two dipswitches are defined for user configuration of the interface. The two dipswitches are defined as follows:



Dipswitch Set 1 - DeviceNet Address & Baudrate

Dipswitch Set 2 – Temperature Controller Enable

Figure I – Dipswitch Layout

Address (Decimal)	SW1 2^0	SW2 2^1	SW3 2^2	SW4 2^3	SW5 2^4	SW6 2^5
Default 01	ON	OFF	OFF	OFF	OFF	OFF
15	ON	ON	ON	ON	OFF	OFF
40	OFF	OFF	OFF	ON	OFF	ON

Table 1 - Dipswitch Set 1 DeviceNet Address

Baud Rate / Mode	SW7 2^6	SW8 2^7
125K	OFF	OFF
250K	ON	OFF
500K	OFF	ON
Software	ON	ON

Table 2 - Dipswitch Set 1 DeviceNet Baud Rate

Dipswitch 1 provides the DeviceNet MacId address and baud rate using the standard switch configurations found in most DeviceNet products. Switches 7 and 8 of switch set 1 allow the user to use DeviceNet software configuration tools to set the MacId address and baud rate. Factory default switch settings are 125K, Address 63.

Number Controllers	SW5	SW6	SW7	SW8
1	ON	OFF	OFF	OFF
2	OFF	ON	OFF	OFF
3	ON	ON	OFF	OFF
4	OFF	OFF	ON	OFF
5	ON	OFF	ON	OFF
6	OFF	ON	ON	OFF
7	ON	ON	ON	OFF
8	OFF	OFF	OFF	ON

Table 3 - Dipswitch Set 2 Enable Athena Controllers

Dipswitch set 2 identifies the Modbus addresses of controllers connected to the DeviceNet interface. From one to eight controllers can be enabled for communication through a single Athena DeviceNet interface module.

Front Panel Exists ?	SW4
Yes	ON
No	OFF

Table 4 - Dipswitch Set 2 Front Panel Exists

Dipswitch set 2 position 5 identifies the frequency at which the front-panel-settable-parameters are read. If the front panel does **not** exist, the parameters are read over Modbus once on start up. If the front panel does exist, one front-panel-settable-parameter is read every 10th Modbus message.

2.3 LED Operation

The unit provides two LEDs. The first LED supports the standard bicolor LED operation used in many DeviceNet products and presented in the following table:

Color	State	Indication
None	Off	No Power
Red	Solid	Unrecoverable Fault
	Flashing	Output error or configuration error
Green	Solid	Normal runtime operation
	Flashing	Device is in idle or not allocated to a master

Table 5 – DeviceNet Led Operation

The second bicolor LED provides status information regarding the interface to the Athena temperature controllers and is presented in the following table:

Color	State	Indication
None	Off	No Power
Red	Solid	No Temperature Controllers online
	Flashing	?llegal Data" error count is non-zero
Green	Solid	Normal operation – All Controllers online
	Flashing	One or more Temperature Controllers are offline

Table 6 – Temperature Controller Led Operation

2.4 Athena Controller Communications

2.4.1 Configuration

The interface to the Athena Temperature Controller shall use 9600 Baud, 8 Bits, No Parity and 1 Stop Bit. This interface is non-modifiable.

2.4.2 Broadcast Mode

The interface does not support broadcast mode using Modbus address zero.

2.4.3 RTU Mode

Only Modbus RTU communications are supported.

2.5 Continuous Access

To ensure that temperature controller data is current and provides the fastest access to temperature data the Modbus registers of each Athena Controller are continually polled by the DeviceNet interface module.

Temperature controller data is polled on two priority levels. The Floating Point register Process Value (Register 0) and the Integer register Status (Register 16387) are the highest priority registers to poll. All other integer and floating point registers are low priority registers. High priority registers are polled at a 10:1 ratio over low priority registers.

2.6 Write Register Operation

Registers are written to a temperature controller whenever *new data values* are received from the DeviceNet network. Data values can be received from either Explicit or Group 2 Server Messages. Data from explicit messages is immediately written to the controller. Data from Server Messages is compared to the current register value and only written to the controller on a change in data value.

2.7 Supported Data Types

The interface supports both the floating point and integer register sets available in Athena Controllers. Access to the floating point registers in an Athena Controller is supported for the base floating point register set, the 10X mirror register set and the 32-bit IEEE mirror register set.

Using DeviceNet Object Class 64, each controller can be independently assigned to be accessible using any one of the three available floating point register sets. The 10X register set is the default register set in the out-of-box configuration.

2.8 Memory Mapping

Athena controller registers are mapped to DeviceNet attribute id is based on the Athena Modbus register address. The DeviceNet attribute id is computed from Modbus register address using the following rules:

- 1X Registers are mapped to DeviceNet Attribute Ids directly using the 1X Register address
- 10X Registers are mapped to DeviceNet Attribute Ids using the 10X Register address minus 1000
- Integer Registers are mapped to DeviceNet Attribute Ids using the Integer Register address minus 16384
- IEEE Registers are mapped to DeviceNet Attribute Ids using the IEEE Register address minus 8000
- If the adjusted Modbus Register address is less than or equal to 64, the DeviceNet attribute Id is equal to the Modbus Register address
- Modbus Register addresses for values greater than 16384 are mapped to DeviceNet attribute Ids by subtracting the Modbus Register address minus 16384 and adding 65.

The actual register set mapped to the Temperature Controller Object Class 65 is selected by the access selected for a controller in DeviceNet Object Class 64. For example, if 1X register access is selected address 30 is mapped to DeviceNet attribute Id 30 in Object Class 65. If 10X register access is selected address 1030 is mapped to attribute Id 30. If IEEE register access is selected address 8030 is mapped to attribute Id 30.

Some examples follow:

Modbus Register	Description	DeviceNet Attribute
0	Floating Point Process Value	Object Class 65, Attribute 0
16387	Status Byte	Object Class 65, Attribute 68
30	1X Input Filter	Object Class 65, Attribute 30
1030	10X Input Filter	Object Class 65, Attribute 30
8030	IEEE Input Filter	Object Class 65, Attribute 30

Table 7 – Modbus Register Mapping

See the definitions of DeviceNet vendor specification Class 65 for more details.

3. DeviceNet Interface

3.1 Overview

DeviceNet™ is a low cost and open industrial network which links industrial devices (such as limit switches, photoelectric sensors and motor starters) to machine controllers over the Controller Area Network (CAN). DeviceNet eliminates expensive hardwiring and provides improved communication between devices as well as important device level diagnostics. To establish a connection over DeviceNet a device implements an Unconnected Message Manager port (UCMM) to establish DeviceNet communications. Refer to the DeviceNet Specification for more details regarding communications over this port.

This section describes the DeviceNet Network Device Model which completely describes the interface from the DeviceNet network point-of-view.

3.2 Configuration

The unit supports Athena ?actory" configuration parameters and user configuration parameters.

The unit supports the standard DeviceNet MacId and baud rate selections. MacId and baud rate can be selected from user accessible Dipswitches or through DeviceNet configuration software.

All configuration data is stored in non-volatile memory.

3.3 Initialization

The unit provides standard duplicate MacId detection processing during power on initialization.

3.4 UnConnected Message Manager (UCMM) Operation

The unit supports allocation of the DeviceNet Group 2 Master/Slave connection set and up to three additional explicit message connections through the UCMM port when configured as a UCMM capable device.

3.5 Group 2 Slave Operation

The unit supports allocation of the DeviceNet Group 2 Master/Slave connection set through the Group 2 Unconnected message port.

3.6 Certification

The unit is to be certified as a compliant DeviceNet device through an ODVA certified testing facility.

3.7 DeviceNet Led Indicator

A DeviceNet Health/Status Combo Led is provided as defined in ODVA Volume II Specifications. See section 2.3 for a description of the DeviceNet Led state table.

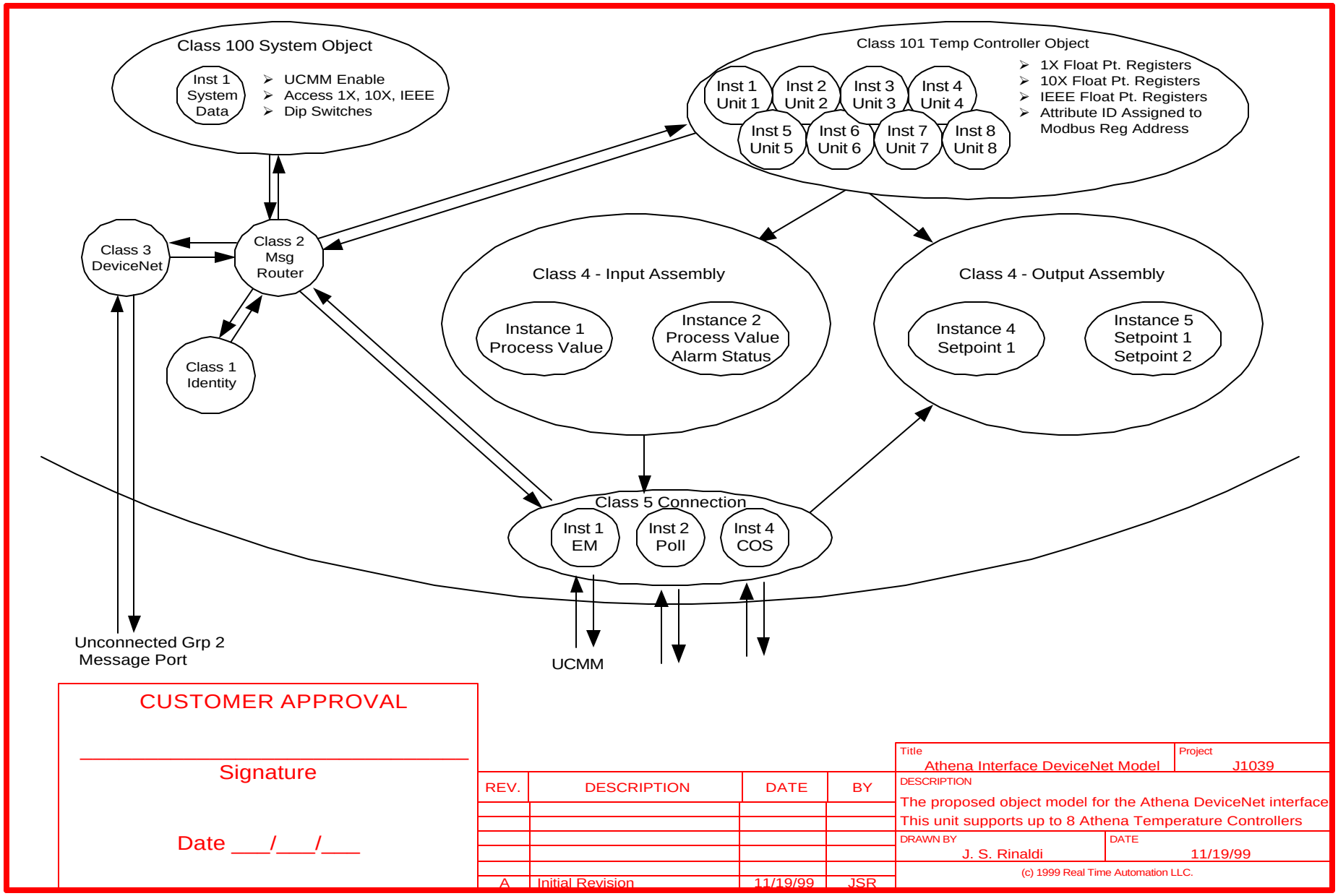


Figure 2 – Graphical View of the DeviceNet Network Model

3.8 Identity Object (01_{HEX} - 1 Instance)

The Identity Object provides descriptive information.

3.8.1 Class Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get

3.8.2 Instance Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Vendor Number	UINT	580_{DEC}	Get
2	Device Type	UINT	00_{HEX}	Get
3	Product Code Number	UINT	63326_{DEC}	Get
4	Product Major Revision Product Minor Revision	USINT USINT	1 0	Get
5	Status	WORD	See Below	Get
6	Serial Number	UDINT	Unique 32 Bit Value	Get
7	Product Name	String of USINT	?emperature Controllers”	Get
64	Fault Last Function Fault Last Error	USINT USINT	0 0	Get

3.8.3 Status Word

Bit	Bit = 0	Bit = 1
0	Not Owned	Owned
1	Unused	Unused
2	No configuration since the last Out of Box reset.	The device has been configured since the last Out of Box reset.
3 – 15	Unused	Unused

3.8.4 Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
05_{HEX}	No	Yes	Reset

3.8.5 Fault Last Function

Code	Function
1	Duplicate Mac ID Check
2	Memory
3	Timers

Code	Function
5	CAN Message Queue
6	System Test
7	Memory Test

4	CAN

3.8.6 Fault Last Error

Code	Error
0x01	Out of Memory
0x02	Duplicate Mac ID Check
0x03	CAN Bus Off
0x04	CAN Initialization
0x05	CAN Overrun
0x06	CAN Message Queue Overrun
0x07	LED Test
0x08	EEPROM Test
0x09	Memory Test

Code	Error
0x0A	Timer Test
0x0B	CAN Test
0x0C	Non-Existent Timer State
0x0D	Non-Existent Timer Reset
0x0E	Non-Existent Timer Change
0x0F	Non-Existent Timer Release
0x10	Extra Timers
0x11	Extra CAN Connections
0x12	Unused Memory Allocated

3.9 Message Router Object (02_{HEX} - 1 Instance)

3.9.1 Class Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get

3.9.2 Instance Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Object List	String of USINT	1,2,3,4,5,0x2B,0x64, 0x65	Get

3.9.3 Common Services

Service Code	Implemented for		Service Name
	Class Level	**Instance Level**	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single

3.10 DeviceNet Object (03_{HEX} - 1 Instance)

3.10.1 Class Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	2	Get

3.10.2 Instance Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Mac ID	USINT	63	Get / Set[1]
2	Baud Rate	USINT	0	Get / Set[2]
3	Bus Off Interrupt	BOOL	0	Get / Set
4	Bus Off Counter	USINT	0	Get / Set
5	**Structure of:** Allocation Choice Byte Master? Mac ID	 BYTE USINT	 0xFF 0	 Get Get
6	MAC ID Switch Changed	BOOL	0	Get
7	Baud Rate Switch Changed	BOOL	0	Get
8	MAC ID Switch Value	USINT	63	Get
9	Baud Rate Switch Value	USINT	0	Get

3.10.3 Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

[1] When switches are used to set the MacID, the attribute is **not** settable over the DeviceNet network.
[2] When switches are used to set the Baud Rate, the attribute is **not** settable over the DeviceNet network.

3.11 Assembly Object (04_{HEX} – 4 Instances)

3.11.1 Class Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	2	Get
2	Max Instance	UINT	5	Get

3.11.2 Instance 1 Attributes

The Instance 1 input assembly provides only the Process Value for the selected Controllers. The process data values are ordered from lowest to highest temperature controller address. The size of the assembly is the size of the process data values; either 2 bytes or 4 bytes. The process values for controllers configured for 1X and 10X operation is 2 bytes while the process values for controllers configured for IEEE is 4 bytes.

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
3	Polled Input Data	UINT or DINT	0	Get

3.11.2.1 Instance 1 - Input Assembly

Byte	Description
1	1st Controller Process Value
	2nd Controller Process Value
	…
	8th Controller Process Value

3.11.2.2 Instance 1 - Input Assembly Example

For this example, Controllers 2, 4 and 5 are connected and enabled for operation over DeviceNet. Controllers 2 and 4 are enabled for 1X operation while controller 5 is enabled for IEEE operation.

Byte	Description
1	Controller 2 Process Value LSB
2	Controller 2 Process Value MSB
3	Controller 4 Process Value LSB
4	Controller 4 Process Value MSB
5	Controller 5 Process Value LSB
6	Controller 5 Process Value
7	Controller 5 Process Value
8	Controller 5 Process Value MSB

3.11.3 Instance 2 Attributes

The Instance 2 input assembly provides both the Process Value and the Controller status byte for the selected Controllers. The data is ordered from lowest to highest temperature controller address. The size of the assembly is the size of the process data values (either 2 bytes or 4

bytes) plus 2 bytes for the status multiplied by the number of controllers. An additional zero is included in the assembly following each status byte to preserve word boundary for the process values in the programmable controller.

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
3	Polled Input Data	UINT or DINT	0	Get

3.11.3.1 Instance 2 - Input Assembly

Byte	Description
1	1st Controller Process Value
	1st Controller Status
	Zero
	2nd Controller Process Value
	2nd Controller Status
	Zero
	…
	8th Controller Process Value
	8th Controller Status
	Zero

3.11.3.2 Instance 2 - Input Assembly Example

For this example, Controllers 1, 2 and 3 are connected and enabled for operation over DeviceNet. Controllers 2 and 3 are enabled for 1X operation while controller 1 is enabled for IEEE operation.

Byte	Description
1	Controller 1 Process Value LSB
2	Controller 1 Process Value
3	Controller 1 Process Value
4	Controller 1 Process Value MSB
5	Controller 1 Status
6	Zero
7	Controller 2 Process Value LSB
8	Controller 2 Process Value MSB
9	Controller 2 Status
10	Zero
11	Controller 3 Process Value LSB
12	Controller 3 Process Value MSB
13	Controller 3 Status
14	Zero

3.11.4 Instance 4 Attributes

The Instance 4 output assembly contains only the Process Setpoint (RAM) for the selected Controllers. The setpoints are ordered from lowest to highest temperature controller address. The size of the assembly is the size of the Setpoint (either 2 bytes or 4 bytes) multiplied by the number of controllers.

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule

3	Polled Output Data	UINT or DINT	0	Set

3.11.4.1 Instance 4 - Output Assembly

Byte	Description
1	1st Controller RAM Setpoint
	2nd Controller RAM Setpoint
	…
	8th Controller RAM Setpoint

3.11.4.2 Instance 4 - Output Assembly Example

For this example, Controllers 4, 5 and 6 are connected and enabled for operation over DeviceNet. Controllers 4 and 5 are enabled for 1X operation while controller 6 is enabled for IEEE operation.

Byte	Description
1	Controller 4 RAM Setpoint LSB
2	Controller 4 RAM Setpoint MSB
3	Controller 5 RAM Setpoint LSB
4	Controller 5 RAM Setpoint MSB
5	Controller 6 RAM Setpoint LSB
6	Controller 6 RAM Setpoint
7	Controller 6 RAM Setpoint
8	Controller 6 RAM Setpoint MSB

3.11.5 Instance 5 Attributes

The Instance 5 output assembly contains both the first and second Process Setpoints (RAM) for the selected Controllers. The setpoints are ordered from lowest to highest temperature controller address. The size of the assembly is the size of the two Setpoints (either 2 bytes or 4 bytes each) multiplied by the number of controllers.

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
3	Polled Output Data	UINT or DINT	0	Set

3.11.5.1 Instance 5 - Output Assembly

Byte	Description
	1st Controller RAM Setpoint 1
	1st Controller RAM Setpoint 2
	2nd Controller RAM Setpoint 1
	2nd Controller RAM Setpoint 2
	…
	8th Controller RAM Setpoint 1
	8th Controller RAM Setpoint 2

3.11.5.2 Instance 5 - Output Assembly Example

For this example, Controllers 4, 5 and 6 are connected and enabled for operation over DeviceNet. Controllers 4 and 5 are enabled for 1X operation while controller 6 is enabled for IEEE operation.

Byte	Description
1	Controller 4 RAM Setpoint 1 LSB
2	Controller 4 RAM Setpoint 1 MSB
3	Controller 4 RAM Setpoint 2 LSB
4	Controller 4 RAM Setpoint 2 MSB
5	Controller 5 RAM Setpoint 1 LSB
6	Controller 5 RAM Setpoint 2 MSB
7	Controller 5 RAM Setpoint 1 LSB
8	Controller 5 RAM Setpoint 2 MSB
9	Controller 6 RAM Setpoint 1 LSB
10	Controller 6 RAM Setpoint 1
11	Controller 6 RAM Setpoint 1
12	Controller 6 RAM Setpoint 1 MSB
13	Controller 6 RAM Setpoint 2 LSB
14	Controller 6 RAM Setpoint 2
15	Controller 6 RAM Setpoint 2
16	Controller 6 RAM Setpoint 2 MSB

3.11.6 Common Services

Service Code	Implemented for		Service Name
	Class Level	**Instance Level**	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

3.12 Connection Object (05_{HEX} - 3 Instances)

3.12.1 Class Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get

3.12.2 Instance (1 – 2) Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value		Access Rule
			Instance 1	Instance 2**	
1	State	USINT	0 = NonExistent 3 = Established 5 = Deferred Delete	0 = NonExistent 1 = Configuring 3 = Established 4 = Timed Out	Get
2	Instance Type	USINT	0	1	Get
3	Transport Trigger	USINT	83_{HEX}	82_{HEX}	Get
4	Produced Connection ID	UINT	$10xxxxxx011_{BIN}$ xxxxxx = Node Address	$01111xxxxxx_{BIN}$ xxxxxx = Node Address	Get
5	Consumed Connection ID	UINT	$10xxxxxx100_{BIN}$ xxxxxx = Node Address	$10xxxxxx100_{BIN}$ xxxxxx = Node Address	Get
6	Initial Comm. Character	USINT	21_{HEX}	01_{HEX}	Get
7	Produced Connection Size	UINT	0 – 8	4	Get
8	Consumed Connection Size	UINT	0 - 8	4	Get
9	Expected Packet Rate	UINT	2000 msec	0	Get / Set
12	Watchdog Timeout Action	USINT	4 = Deferred Delete	0 = Timeout	Get
13	Produced Connection Path Length	UINT	0	0	Get
14	Produced Connection Path	USINT Array	NULL	NULL	Get
15	Consumed Connection Path Length	UINT	0	0	Get
16	Consumed Connection Path	USINT Array	NULL	NULL	Get

*Instance 1 is an Explicit Message Connection.
**Instance 2 is a Polled I/O Message Connection.

3.12.3 Instance 4 Attributes (Change of State/Cyclic Acknowledged)

Attribute ID	**Name**	**DeviceNet Data Type**	**Data Value**		**Access Rule**
			Change of State	Cyclic	
1	State	USINT	0 = NonExistent 1 = Configuring 3 = Established 4 = Timed Out	0 = NonExistent 1 = Configuring 3 = Established 4 = Timed Out	Get
2	Instance Type	USINT	1	1	Get
3	Transport Trigger	USINT	12_{HEX}	02_{HEX}	Get
4	Produced Connection ID	UINT	$01101xxxxxx_{BIN}$ xxxxxx = Node Address	$01101xxxxxx_{BIN}$ xxxxxx = Node Address	Get
5	Consumed Connection ID	UINT	$10xxxxxx010_{BIN}$ xxxxxx = Node Address	$10xxxxxx010_{BIN}$ xxxxxx = Node Address	Get
6	Initial Comm. Character	USINT	01_{HEX}	01_{HEX}	Get
7	Produced Connection Size	UINT	Varied	Varied	Get
8	Consumed Connection Size	UINT	0	0	Get
9	Expected Packet Rate	UINT	0	0	Get / Set
12	Watchdog Timeout Action	USINT	0 = Timeout	0 = Timeout	Get
13	Produced Connection Path Length	UINT	0	0	Get
14	Produced Connection Path	USINT Array	NULL	NULL	Get
15	Consumed Connection Path Length	UINT	4	4	Get
16	Consumed Connection Path	USINT Array	20h 3Bh 24h 01h	20h 3Bh 24h 01h	Get

3.12.4 Instance 4 Attributes (Change of State/Cyclic Unacknowledged)

Attribute ID	**Name**	**DeviceNet Data Type**	**Data Value**		**Access Rule**
			Change of State	Cyclic	
1	State	USINT	0 = NonExistent 1 = Configuring 3 = Established 4 = Timed Out	0 = NonExistent 1 = Configuring 3 = Established 4 = Timed Out	Get
2	Instance Type	USINT	1	1	Get
3	Transport Trigger	USINT	12_{HEX}	02_{HEX}	Get
4	Produced Connection ID	UINT	$01101xxxxxx_{BIN}$ xxxxxx = Node Address	$01101xxxxxx_{BIN}$ xxxxxx = Node Address	Get
5	Consumed Connection ID	UINT	$FFFF_{HEX}$	$FFFF_{HEX}$	Get
6	Initial Comm. Character	USINT	$0F_{HEX}$	$0F_{HEX}$	Get
7	Produced Connection Size	UINT			Get
8	Consumed Connection Size	UINT	0	0	Get
9	Expected Packet Rate	UINT	0	0	Get / Set
12	Watchdog Timeout Action	USINT	0 = Timeout	0 = Timeout	Get
13	Produced Connection Path Length	UINT	0	0	Get
14	Produced Connection Path	USINT Array	NULL	NULL	Get
15	Consumed Connection Path Length	UINT	0	0	Get
16	Consumed Connection Path	USINT Array	NULL	NULL	Get

3.12.5 Instance 16 - 255 Attributes (UCMM Explicit Connections)[3]

Attribute ID	Name	DeviceNet Data Type	Data Value		Access Rule
			Group 1 Message	Group 3 Message	
1	State	USINT	0 = NonExistent 3 = Established 5 = Deferred Delete	0 = NonExistent 3 = Established 5 = Deferred Delete	Get
2	Instance Type	USINT	0	0	Get
3	Transport Trigger	USINT	83_{HEX}	83_{HEX}	Get
4	Produced Connection ID	UINT	$0ggggxxxxxx_{BIN}$ gggg = Master Message ID xxxxxx = Slave Node Address	$11gggxxxxxx_{BIN}$ ggg = Master Message ID xxxxxx = Slave Node Address	Get
5	Consumed Connection ID	UINT	$0ggggxxxxxx_{BIN}$ gggg = Slave Message ID xxxxxx = Master Node Address	$11gggxxxxxx_{BIN}$ ggg = Slave Message ID xxxxxx = Master Node Address	Get
6	Initial Comm. Character	USINT	00_{HEX}	33_{HEX}	Get
7	Produced Connection Size	UINT	64	64	Get
8	Consumed Connection Size	UINT	64	64	Get
9	Expected Packet Rate	UINT	2000 msec	2000 msec	Get / Set
12	Watchdog Timeout Action	USINT	4 = Deferred Delete	4 = Deferred Delete	Get
13	Produced Connection Path Length	UINT	0	0	Get
14	Produced Connection Path	USINT Array	NULL	NULL	Get
15	Consumed Connection Path Length	UINT	0	0	Get
16	Consumed Connection Path	USINT Array	NULL	NULL	Get

3.12.6 Common Services

[3] The connection instance number is returned to the DeviceNet Master in the successful response to an Allocate UCMM connection request. Valid connection instances are 16 – 255 decimal.

Service Code	Implemented for		Service Name
	Class Level	**Instance Level**	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single
$0D_{HEX}$	No	Yes*	Apply_Attributes
05_{HEX}	No	Yes**	Reset

*Apply Attributes is only supported for I/O Connections. It changes the Connection State to established.
**Reset is only supported for I/O Connections. It resets the watchdog timer for the connection.

3.13 Acknowledge Handler Object ($2B_{HEX}$ - 1 Instance)

3.13.1 Class Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get

3.13.2 Instance Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Acknowledge Timer	UINT	16	Get/Set
2	Retry Limit	USINT	1	Get/Set
3	COS Producing Connection Instance	UINT	4	Get

3.13.3 Common Services

Service Code	Implemented for		Service Name
	Class Level	**Instance Level**	
$0E_{HEX}$	Yes	Yes	Get Attribute Single
10_{HEX}	No	Yes	Get Attribute Single

3.14 System Object (64_{HEX} - 1 Instance)

3.14.1 Class Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get

3.14.2 Instance Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Controller 1 Access (0-1X, 1-10X, 2-IEEE)	USINT	1	Get/Set
2	Controller 2 Access (0-1X, 1-10X, 2-IEEE)	USINT	1	Get/Set
3	Controller 3 Access (0-1X, 1-10X, 2-IEEE)	USINT	1	Get/Set
4	Controller 4 Access (0-1X, 1-10X, 2-IEEE)	USINT	1	Get/Set
5	Controller 5 Access (0-1X, 1-10X, 2-IEEE)	USINT	1	Get/Set
6	Controller 6 Access (0-1X, 1-10X, 2-IEEE)	USINT	1	Get/Set
7	Controller 7 Access (0-1X, 1-10X, 2-IEEE)	USINT	1	Get/Set
8	Controller 8 Access (0-1X, 1-10X, 2-IEEE)	USINT	1	Get/Set
10	Dip Switch 1	USINT	0	Get
11	Dip Switch 2	USINT	0	Get
12	Input Assembly Number	USINT	1	Get/Set
13	Input Assembly Size	USINT	Varies	Get
14	Output Assembly Number	USINT	4	Get/Set
15	Output Assembly Size	USINT	Varies	Get
16	COS Deadband (10X units)	UINT	20	Get/Set
17	Illegal Data error counter	USINT	0-255	Get

3.14.3 Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get Attribute Single
10_{HEX}	No	Yes	Get Attribute Single

3.15 Temperature Controller Object (65_{HEX} - 8 Instances)

The Temperature Controller object maintains a copy of all Integer and Floating Point registers for all enabled temperature controllers. The attribute ids of the Temperature Controller object correspond to the Modbus Register address of each data value. There is one instance for each of the eight temperature controllers.

The DeviceNet data types for each controller instance are either Integer or Double Integer. The data type size for each instance corresponds to the access type selected for the controller in the controller configuration object.

3.15.1 Class Attributes

Attribute ID	**Name**	**DeviceNet Data Type**	**Data Value**	**Access Rule**
1	Revision	UINT	1	Get

3.15.2 Instance Attributes

Attribute ID	Name	Description	Controllers	DeviceNet Data Type	Access rule
0	Process Value	Sensor Span, -32768 = Low Error +32767 = High Error	16C/18C/ 25C/1ZC	INT or DINT	Get
1	Setpoint (EEPROM)	Setpoint Low Limit - Setpoint High Limit	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
2	Setpoint (RAM)	Setpoint Low Limit - Setpoint High Limit	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
3	Second Setpoint (EEPROM)	Setpoint Low Limit - Setpoint High Limit	16C/18C/ 25C	INT or DINT	Get/Set
4	Second Setpoint (RAM)	Setpoint Low Limit - Setpoint High Limit	16C/18C/ 25C	INT or DINT	Get/Set
5	Remote Analog Setpoint	Remote Setpoint Limits	16C/18C/ 25C	INT or DINT	Get
6	Recipe Setpoint	Setpoint Low Limit - Setpoint High Limit	16C/18C/ 25C/1ZC	INT or DINT	Get
7	Output 1 Deadband	Thermocouple or RTD Input Types Negative sensor span to positive sensor span Linear Input Types -1999 - 9999 (see note 1)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
8	Output 1 Hysteresis	Thermocouple or RTD Input Types 1 - span of sensor Linear Input Types 1 - 9999 (see note 1)	16C/28C/ 25C/1ZC	INT or DINT	Get/Set
9	Output 1 Proportional Band	Thermocouple or RTD Input Types 0.6 - span of sensor Linear Input Types 1 - sensor span (max at 9999 see note 1)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
10	Output 2 Proportional Band	Thermocouple or RTD Input Types 0.6 - span of sensor	16C/18C/ 25C/1ZC	INT or DINT	Get/Set

		Linear Input Types 1 - sensor span (max at 9999)(see note 1)			
11	Rate/Derivative Action	0.0 - 0.9, 1 - 2400	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
12	Reset/Integral Action	0.0 - 0.9, 1 - 9600	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
13	Manual Reset/Integral Action	-100 - 100	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
14	Output 2 Deadband	Thermocouple or RTD Input Types Negative sensor span to positive sensor span Linear Input Types -1999 - 9999 (see note 1)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
15	Output 2 Hysteresis	Thermocouple or RTD Input Types 1 - span of sensor Linear Input Types 1 - 9999 (see note 1)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
16 – 23	Soak Level 1 – Soak Level 8	Setpoint Low Limit - Setpoint High Limit	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
24	Holdback Band	Thermocouple or RTD Input Types 0 = off 0.1 - 100 degrees F 0.1 - 55.6 degrees C/K Linear Input Types 0 = off 1 - 100 (see note 1)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
25	Input Bias	Thermocouple or RTD Input Types -1000 - 1000 degrees F -556 - 556 degrees C and K Linear Input Types -1000 - 1000 (see note 1)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
26	Linear Input Low Scale	-1999 - 9999 (see note 1)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
27	Linear Input High Scale	-1999 - 9999 (see note 1)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
28	Lower Setpoint Limit	Sensor low limit - sensor high limit	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
29	Upper Setpoint Limit	Sensor low limit - sensor high limit	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
30	Input Filter	1 - 100 (each unit represents 0.1 second of filter time)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
31	Output 1 Process Alarm Setpoint	Sensor Low Limit - Sensor High Limit	16C/1ZC	INT or DINT	Get/Set
32	Output 1 Deviation Alarm Setpoint	1 - Span of sensor	16C/1ZC	INT or DINT	Get/Set
33	Output 2 Process Alarm Setpoint	Sensor Low Limit - Sensor High Limit	16C/1ZC	INT or DINT	Get/Set
34	Output 2 Deviation Alarm Setpoint	1 - Span of sensor	16C/1ZC	INT or DINT	Get/Set
35	Display Filter	1 - 100 (each unit represents 0.1 second of filter time)	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
36	Alarm 1 Process Setpoint	Sensor Low Limit - Sensor High Limit	16C/18C/ 25C	INT or DINT	Get/Set
37	Alarm 1 Deviation Setpoint	1 - Span of Sensor	16C/18C/ 25C	INT or DINT	Get/Set
38	Alarm 2 Process Setpoint	Sensor Low Limit - Sensor High Limit	16C/18C/ 25C	INT or DINT	Get/Set

39	Alarm 2 Deviation Setpoint	1 - Span of sensor	16C/18C/ 25C	INT or DINT	Get/Set
40	Highest Reading	Sensor Low Limit to Sensor High Limit	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
41	Lowest Reading	Sensor Low Limit to Sensor High Limit	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
42	TC Zero Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
43	TC Span Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
44	RTD Zero Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
45	RTD Span Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
46	Low-Voltage Zero Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
47	Low-Voltage Span Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
48	High-Voltage Zero Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
49	High-Voltage Span Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
50	Current Zero Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
51	Current Span Calibration		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
52	Auxiliary Output Scale Low	Sensor Low Limit to Sensor High Limit	16C/18C/ 25C	INT or DINT	Get/Set
53	Auxiliary Output Scale High	Sensor Low Limit to Sensor High Limit	16C/18C/ 25C	INT or DINT	Get/Set
54	RAS Scale Low	-1999 – 9999	16C/18C/ 25C	INT or DINT	Get/Set
55	RAS Scale High	-1999 – 9999	16C/18C/ 25C	INT or DINT	Get/Set
56	Active Setpoint	Setpoint Low Limit - Setpoint High Limit or –1999 – 9999 when RAS is active.	16C/18C/ 25C/1ZC	INT or DINT	Get/Set
57	RTD Decimal Zero Cal		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
58	RTD Decimal Span Cal		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
59	2nd Hi Volt Zero Cal		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
60	2nd Hi Volt Span Cal		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
61	0-100mV Zero Cal		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
62	0-100mV Span Cal		16C/18C/ 25C/1ZC	INT or DINT	Get/Set
63	Watchdog Disable		1ZC	INT or DINT	Get/Set
64	CJC Counts		1ZC	INT or DINT	Get/Set
65	Controller Type	2 = 16C 3 = 18C/25C 4 = 1ZC	16C/18C/ 25C/1ZC	INT	Get
66	Software Version	Six digit integer value representing software version in the form of XX.XX.XX. e.g. 013100 is equal to Version 01.31.00	16C/18C/ 25C/1ZC	INT	Get
67	Communications Version	Six digit integer value representing software version in the form of XX.XX.XX. e.g. 013100 is equal to Version 01.31.00	16C/18C/ 25C/1ZC	INT	Get

68	Status Byte	Data is an 8 bit value of which the bit assignments are as follow: X Process Input Err X RAS Error 0 Always Zero X Loop Break X Alarm 1 Active X Alarm 2 Active X O1 (ALARM) Active X O2 (Alarm) Active If a bit at a location marked as ?' is set, then the condition is TRUE and vice versa. For example, a value of 12 in the data field means that both alarm1 and alarm2 are active and everything else is inactive.	16C/18C/ 25C/1ZC	INT	Get
69	Operating Mode	1 = Manual 2 = Standby 3 = Normal (Automatic) 4 = Autotune 5 = Recipe Run 6 = Recipe Hold	16C/18C/ 25C/1ZC	INT	Get/Set
70	Access Level	1 = Lockout 2 = Setpoint 3 = Setpoint Plus 4 = User 5 = Configuration 6 = Factory	16C/18C/ 25C	INT	Get/Set
71	Contact/Digital Input State	0 = Switch Open 1 = Switch Closed	16C/18C/ 25C	INT	Get
72	Output 1 Output Percent	0 – 100	16C/18C/ 25C/1ZC	INT	Get
73	Output 2 Output Percent	0 – 100	16C/18C/ 25C/1ZC	INT	Get
74	Manual Control Output 1 %	0 – 100	16C/18C/ 25C/1ZC	INT	Get/Set
75	Manual Control Output 2 %	0 – 100	16C/18C/ 25C/1ZC	INT	Get/Set
76	Autotune Damping	1 = Low 2 = Normal 3 = High	16C/18C/ 25C/1ZC	INT	Get/Set
77	Recipe Option	0 = Disabled 1 = Single Step 2 = Multi-Step	16C/18C/ 25C/1ZC	INT	Get/Set
78	Single Setpoint Ramp Time	1 – 9999	16C/18C/ 25C/1ZC	INT	Get/Set
79 - 86	Ramp Time 1 to Ramp Time 8	0 – 9999	16C/18C/ 25C/1ZC	INT	Get/Set
87 – 94	Ramp Event 1 to Ramp Event 8	0 = Disabled 1 = Event 1 On 2 = Event 1 Off 3 = Event 2 On 4 = Event 2 Off	16C/18C/ 25C	INT	Get/Set
95 - 102	Soak Time 1 to Soak Time 8	0 – 9999	16C/18C/ 25C/1ZC	INT	Get/Set
103 – 110	Soak Event 1 – Soak Event 8	0 = Disabled 1 = Event 1 On 2 = Event 1 Off 3 = Event 2 On 4 = Event 2 Off	16C/18C/ 25C	INT	Get/Set
111	Recycle Number	0 – 99, 100 = Continuous	16C/18C/	INT	Get/Set

			25C/1ZC		
112	Termination State	0 = Last Setpoint 1 = Default Setpoint 2 = Recipe to Standby Mode	16C/18C/ 25C/1ZC	INT	Get/Set
113	Power Fail Resume Enable	1 = Resume Off 2 = Resume On	16C/18C/ 25C/1ZC	INT	Get/Set
114	Input Type	0 = B TC 1 = C TC 2 = E TC 3 = J TC 4 = K TC 5 = N TC 6 = NNM TC 7 = R TC 8 = S TC 9 = T TC 10 = Platinum TC 11 = RTD 12 = RTD Decimal 13 = 0–20mA Linear 14 = 4-20mA Linear 15 = 0-10mV Linear 16 = 0-50mV Linear 17 = 0-100mV Linear 18 = 10-50mV Linear 19 = 0-1V Linear 20 = 0-5V Linear 21 = 0-10V Linear 22 = 1-5V Linear	16C/18C/ 25C/1ZC	INT	Get/Set
115	Output 1 Type	1 = Inactive/Disabled 2 = PID 3 = (Invalid Value) 4 = On/Off 5 = Alarm 3.15.2.1.1.1.1 1 = Inactive/Disabled 2 = PID 3 = (Invalid Value) 4 = On/Off 5 = (Invalid Value)	16C/18C/ 25C/1ZC	INT	Get/Set
116	Output 1 Action	1 = Direct 2 = Reverse	16C/18C/ 25C/1ZC	INT	Get/Set
117	Output 1 Alarm Action	1 = Off 2 = Normal 3 = Latched 4 = Event	16C/1ZC	INT	Get/Set
118	Output 1 Alarm Operation	1 = Process High 2 = Process Low 3 = Deviation High 4 = Deviation Low 5 = Normal Band 6 = Inverse Band	16C/1ZC	INT	Get/Set
119	Output 1 Alarm Delay	0 – 9999	16C/1ZC	INT	Get/Set
120	Output 1 Alarm Inhibit	0 – 9999	16C/1ZC	INT	Get/Set
121	Output 1 Cycle Time	0 = 0.2 Seconds, 1 – 120 Seconds	16C/18C/ 25C/1ZC	INT	Get/Set
122	Output 1 Low Limit	0 – 100	16C/18C/ 25C/1ZC	INT	Get/Set

123	Output 1 High Limit	0 – 100	16C/18C/ 25C/1ZC	INT	Get/Set
124	Output 2 Type	1 = Inactive/Disabled 2 = PID 3 = (Invalid Value) 4 = On/Off 5 = Alarm	16C/18C/ 25C/1ZC	INT	Get/Set
125	Output 2 Action	1 = Direct 2 = Reverse	16C/18C/ 25C/1ZC	INT	Get/Set
126	Output 2 Alarm Action	1 = Off 2 = Normal 3 = Latched 4 = Event	16C/1ZC	INT	Get/Set
127	Output 2 Alarm Operation	1 = Process High 2 = Process Low 3 = Deviation High 4 = Deviation Low 5 = Normal Band 6 = Inverse Band	16C/1ZC	INT	Get/Set
128	Output 2 Alarm Delay	0 – 9999	16C/1ZC	INT	Get/Set
129	Output 2 Alarm Inhibit	0 – 9999	16C/1ZC	INT	Get/Set
130	Output 2 Cycle Time	0 = 0.2 Seconds, 1 – 120 Seconds	16C/18C/ 25C/1ZC	INT	Get/Set
131	Output 2 Low Limit	0 – 100	16C/18C/ 25C/1ZC	INT	Get/Set
132	Output 2 High Limit	0 – 100	16C/18C/ 25C/1ZC	INT	Get/Set
133	TC/RTD Decimal Position	0, 1	16C/18C/ 25C/1ZC	INT	Get/Set
134	Linear Decimal Position	0 – 3	16C/18C/ 25C/1ZC	INT	Get/Set
135	Display Unit	1 = Fahrenheit 2 = Celsius 3 = Kelvin	16C/18C/ 25C/1ZC	INT	Get/Set
136	Display Blanking	9 = Off, 10 – 9999	16C/18C/ 25C/1ZC	INT	Get/Set
137	Alarm 1 Action	1 = Off 2 = Normal 3 = Latched 4 = Event	16C/18C/ 25C	INT	Get/Set
138	Alarm 1 Operation	1 = Process High 2 = Process Low 3 = Deviation High 4 = Deviation Low 5 = Normal Band 6 = Inverse Band	16C/18C/ 25C	INT	Get/Set
139	Alarm 1 Delay	0 – 9999	16C/18C/ 25C	INT	Get/Set
140	Alarm 1 Inhibit	0 – 9999	16C/18C/ 25C	INT	Get/Set
141	Alarm 2 Action	1 = Off 2 = Normal 3 = Latched		INT	Get/Set
142	Alarm 2 Operation	1 = Process High 2 = Process Low 3 = Deviation High 4 = Deviation Low		INT	Get/Set

		5 = Normal Band 6 = Inverse Band			
143	Alarm 2 Delay	0 – 9999		INT	Get/Set
144	Alarm 2 Inhibit	0 – 9999		INT	Get/Set
145	Communication Protocol	1 = Athena Plus 2 = SPI 3 = Arburg 4 = Modbus		INT	Get
146	Communication ID	1 – 255		INT	Get/Set
147	Communication Baud Rate	2 = 300 Baud 3 = 600 Baud 4 = 1200 Baud 5 = 2400 Baud 6 = 4800 Baud 7 = 9600 Baud		INT	Get/Set
148	Parity	0 = None 1 = Even 2 = Odd		INT	Get/Set
149	IEEE Register Byte Ordering	0 = Non-Modicon Format 1 = Modicon Format		INT	Get/Set
150	Output 1 Failsafe Output Percent	0 – 100		INT	Get/Set
151	Output 2 Failsafe Output Percent	0 – 100		INT	Get/Set

152	Loop Break Time	3 = off, 4 – 9600		INT	Get/Set
153	Installed Option Card	1 = Comm Option		INT	Get
154	Auxiliary Output Variable	1 = Process Value 2 = Setpoint		INT	Get/Set
155	Contact/Digital Switch Function	1 = Disabled 2 = Second Setpoint Select 3 = Standby Select 4 = Run/Hold Switch		INT	Get/Set
156	Autotune State	0 = Success 1 = Aborted 2 = Error: No PID Output 3 = Error: No Deviation 4 = Error: No Output 5 = Error: Timed Out 6 = Error: Bad Tune 7 = Waiting For PV To Settle 8 = Reverse Tune In Progress 9 = Direct Tune In Progress		INT	Get
157	Recipe State	0 = Done 1 = Aborted 2 = Error: Empty Recipe 3 = Error: No Deviation 4 = Recipe On Hold 5 = Ramping 6 = Soaking 7 = Ramp Holdback 8 = Soak Holdback		INT	Get
158	Current Recipe Segment	0 – 8		INT	Get
159	Resume Exhaustion Flag	0 = FALSE (Resume Block Available) 1 = TRUE (Resume Block Exhausted)		INT	Get
160	LED Status Indicator	Data is an 8 bit value of which the bit assignments are as follow: Bit # Assignment 0 Unused 1 Unused 2 Function 2 On 3 Function 1 On 4 Alarm 2 On 5 Alarm 1 On 6 Output 2 Active 7 Output 1 Active Bit number 0 is the least significant bit while 7 is the most significant. When a bit is set, then the corresponding condition is true. For example, the value of 12 indicates that only the F1 and F2 LEDs are set while all other LEDs are cleared.		INT	Get

3.15.3

3.15.4 Common Services

Service Code	**Implemented for**		**Service Name**
	Class Level	**Instance Level**	
$0E_{HEX}$	Yes	Yes	Get Attribute Single
10_{HEX}	No	Yes	Set Attribute Single