

Modbus Protocol for Battery Diagnostic System Universal (BDSU) For FDM Version 909

Reference Guide

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1. Modbus Communications

1.1. Connectivity to IntelliSlot 485 Using Modbus

This Guide describes how to use the Modbus communications protocol with the IntelliSlot 485 interface card. This Guide also includes information on the use of Modbus to pass information to and from the IntelliSlot 485 card via Modbus. The guide offers information about supported types, frame format, function code support and similar subjects.

1.2. Implementation Basics

Modbus protocol provides control and data acquisition, through query and response, between master and slave devices. This protocol comprises the rules for communication, controlling the message format between devices, how master and slave devices initiate communications, as well as unit identification, message-handling and error-checking.

1.3. Transmission Format

The IntelliSlot 485 interface card supports Modbus Remote Terminal Unit (RTU) transmission modes. See Table 2 below.

Modbus Remote Transmission Unit Settings for IntelliSlot 485 Interface Card

Physical Port	Transmission Mode	Baud Rate	Data Bits	Parity Bits	Stop Bits	Start Bits
EIA-485/422 2 wire	RTU	9600, 19200 or 38400	8	None	1	1

Table 1 - Modbus Remote Transmission Unit Settings for IntelliSlot 485 Interface Card

1.4. Modbus Packet Format

Each Modbus packet consists of these fields:

- Device Address
- Function Code
- Data Field(s)
- Error Check Field

1.4.1 Device Address

The address field immediately follows the beginning of the frame and consists of 8-bits (RTU). This bit indicates the user-assigned address of the slave device that is to receive the message from the attached master device.

Each slave must be assigned a unique address. Only the addressed slave will respond to a query that contains its address.

1.4.2 Function Code

The function code field tells the addressed slaves what function to perform. Function codes are designed to invoke a specific action by the slave device. The function code ranges from 1 to 127.

The IntelliSlot 485 Modbus server supports the following Modbus function codes.

Supported Modbus Function Codes

Code	Function	Description
01	Read Coils	Read from 1 to 2000 contiguous status of coils managed by the server. Coils in the response message are packed as one per bit of a byte, 1=On and 0=Off. If the requested quantity of coils are not a multiple of 8, zeros are padded in the final byte.
02	Read Discrete Inputs	Read from 1 to 2000 contiguous input status managed by the server. Discrete inputs in the response message are packed as one per bit of a byte, 1=On and 0=Off. If the requested number of inputs is not a multiple of 8, zeros are padded in the final byte.
03	Read Holding Registers	Read the contents of contiguous block of 1 to 127 holding registers. Data are packed as two bytes per register; the first byte contains the high order bits.
04	Read Input Registers	Read the contents of contiguous block of 1 to 127 Input registers. Data are packed as two bytes per register; the first byte contains the high order bits.
05	Write Single Coil	Write a single output to either On (1) or Off (0) mapped in coil section.
06	Write Single Register	Write a value into a single holding register.
15	Write Multiple Coils	Force each coil in a sequence of coils to either On or Off.
16	Write Multiple Registers	Write values back in to a block of contiguous registers (1 to 120)

Table 2 - Supported Modbus Function Codes

1.4.3 Data Fields

The data field length varies, depending on whether the message is a request or response to a packet. This field typically contains information required by the slave device to perform the command specified or to the response to a data request from the master device.

1.4.4 Error Check Field

The error check field consists of a 16-bit (2 byte) Cyclical Redundancy Check (CRC16). It allows the receiving device to detect a packet that has been corrupted by transmission errors.

1.4.5 RTU Framing

The example below shows a typical query and response from an IntelliSlot 485 interface card. The master device initiates a query asking Slave Device, with address 2, for holding registers starting at holding register 40051 (offset 50) and including next 2 registers (3 total).

Query Sample

Slave Address	Function Code	Starting Register		Number of Registers		CRC16	
		Hi Byte	Lo Byte	Hi Byte	Lo Byte	Hi Byte	Lo Byte
02	03	00	32	00	03	E5	FA

Table 3 - Query Sample

Response Sample

Slave Address	Function Code	Count: Bytes of Data	Register						CRC16	
			40051 Data		40052 Data		40053 Data		Hi Byte	Lo Byte
			Hi	Lo	Hi	Lo	Hi	Lo		
02	03	6	1	58	00	FA	00	54	1B	0D

Table 4 - Response Sample

Slave device, with address 2, responds to function code 3 with 6 bytes of hexadecimal data and ends with CRC16 checksum.

Register values: 40051 = 158 (hex) = 344 (decimal)
 40052 = FA (hex) = 250 (decimal)
 40053 = 54 (hex) = 84 (decimal)

2. Status and Coil

2.1. Battery Entity

Data Description	Status	Coil	# of Bits	Notes
Battery Discharging Battery 1 - 32	10001-10032		1	Active on Alarm

Table 5 - Battery Entity for Status and Coil

2.2. String Entity (Cells 1-32)

Data Description	Status	Coil	# of Bits	Notes
High Ambient Temperature String 1 - 32	10033-10064		1	Active on Alarm
Low Ambient Temperature String 1 - 32	10065-10096		1	Active on Alarm
Low Ambient Temperature Probe Two String 1 - 32	10097-10128		1	Active on Alarm
High Ambient Temperature Probe Two String 1 - 32	10129-10160		1	Active on Alarm
Low Overall Voltage String 1 - 32	10161-10192		1	Active on Alarm
High Overall Voltage String 1 - 32	10193-10224		1	Active on Alarm
High Battery String Current String 1 - 32	10225-10256		1	Active on Alarm
Low Battery String Float Current String 1 - 32	10257-10288		1	Active on Alarm
High Battery String Float Current String 1 - 32	10289-10320		1	Active on Alarm
High Battery String Ripple Current String 1 - 32	10321-10352		1	Active on Alarm
Battery String Discharge Detected String 1 - 32	10353-10384		1	Active on Alarm

Table 6 - String Entity for Status and Coil (Cells 1-32)

String Entity (Cells 1-32) (Continued)

Data Description	Status	Coil	# of Bits	Notes
Maximum Discharge Time Exceeded String 1 - 32	10385-10416		1	Active on Alarm
Discharge Low Overall Voltage String 1 - 32	10417-10448		1	Active on Alarm
Discharge Low Cell Voltage String 1 - 32	10449-10480		1	Active on Alarm
Discharge High Battery String Current String 1 - 32	10481-10512		1	Active on Alarm
Excessive Cell to Cell Temperature Deviation String 1 - 32	10513-10544		1	Active on Alarm
Excessive Cell to Ambient Temperature Deviation String 1 - 32	10545-10576		1	Active on Alarm
Thermal Runaway Detected String 1 - 32	10577-10608		1	Active on Alarm
Battery String Equalize String 1 - 32	10609-10640		1	Active on Alarm
Battery String Offline String 1 - 32	10641-10672		1	Active on Alarm
Thermal Runaway Cell to Ambient Temperature Event String 1 - 32	13233-13264		1	Active on Alarm
Thermal Runaway Cell to Cell Temperature Event String 1 - 32	13265-13296		1	Active on Alarm
Thermal Runaway Charger Current Level One Event String 1 - 32	13297-13328		1	Active on Alarm
Thermal Runaway Charger Current Level Two Event String 1 - 32	13329-13360		1	Active on Alarm
Ground Fault Detected String 1 - 32	14041-14072		1	Active on Alarm

Table 6 - String Entity for Status and Coil (Cells 1-32) (Continued)

2.3. Cell Entity (Cells 1-320)

Data Description	Status	Coil	# of Bits	Notes
Low Cell Voltage Cell 1 - 320	10673-10992		1	Active on Alarm
High Cell Voltage Cell 1 - 320	10993-11312		1	Active on Alarm
Low Cell Temperature Cell 1 - 320	11313-11632		1	Active on Alarm
High Cell Temperature Cell 1 - 320	11633-11952		1	Active on Alarm
Low Internal Resistance Cell 1 - 320	11953-12272		1	Active on Alarm
High Internal Resistance Cell 1 - 320	12273-12592		1	Active on Alarm
High Intercell Resistance Cell 1 - 320	12593-12912		1	Active on Alarm
Discharge Low Cell Voltage Cell 1 - 320	12913-13232		1	Active on Alarm
Intertier Resistance High Cell 1 - 320	13361-13680		1	Active on Alarm

Table 7 - Cell Entity for Status and Coil 1-320 (Cells 1-320)

2.4. Cell Entity (Cells 321-360)

Data Description	Status	Coil	# of Bits	Notes
Low Cell Voltage Cell 321 - 360	13681-13720		1	Active on Alarm
High Cell Voltage Cell 321 - 360	13721-13760		1	Active on Alarm
Low Cell Temperature Cell 321 - 360	13761-13800		1	Active on Alarm
High Cell Temperature Cell 321 - 360	13801-13840		1	Active on Alarm
Low Internal Resistance Cell 321 - 360	13841-13780		1	Active on Alarm
High Internal Resistance Cell 321 - 360	13881-13920		1	Active on Alarm
High Intercell Resistance Cell 321 - 360	13921-12860		1	Active on Alarm
Discharge Low Cell Voltage Cell 321 - 360	13961-14000		1	Active on Alarm
Intertier Resistance High Cell 321 - 360	14001-14040		1	Active on Alarm

Table 8 - Cell Entity for Status and Coil (Cells 321-360)

3. Input and Holding

3.1. Battery Measurement and Control

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
System Status 1	30385		1		1 = Normal Operation 2 = StartUp 8 = Normal with Warning 16 = Normal with Alarm 32 = Abnormal Operation

Table 9 - Battery Measurement and Control for Input and Holding

3.2. Battery Entity (Batteries 1-32)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Battery Name Battery 1 - 32	30386-31057		21		Each 16-bit register is a single Unicode character of a null terminated string
Battery Time Remaining Battery 1 - 32	31058-31121		2		Units : sec
Battery Discharge Time Battery 1 - 32	31122-31185		2		Units : sec
Battery Rating Battery 1 - 32	31186-31217		1		Units : AH
Ordinal Position of Battery Battery 1 - 32	31218-31249		1		

Table 10 - Battery Entity for Input and Holding (Batteries 1-32)

3.3. String Entity (Strings 1-32)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Battery String Name String 1 - 32	31250-31921		21		Each 16-bit register is a single Unicode character of a null terminated string
String Ambient Temperature 1 String 1 - 32	31922-31953		1	Scale : x / 10	Units : deg C
String Ambient Temperature 2 String 1 - 32	31954-31985		1	Scale : x / 10	Units : deg C
String Ambient Temperature 1 String 1 - 32	31986-32017		1	Scale : x / 10	Units : deg F
String Ambient Temperature 2 String 1 - 32	32018-32049		1	Scale : x / 10	Units : deg F
String Overall Voltage String 1 - 32	32050-32081		1	Scale : x / 10	Units : VDC
String Current String 1 - 32	32082-32113		1		Units : A DC
Float Current String 1 - 32	32114-32145		1		Units : mA DC
Ripple Current String 1 - 32	32146-32177		1		Units : A AC
Total Active Alarms on a Battery String String 1 - 32	32178-32209		1		
Discharge State String 1 - 32	32210-32241		1		0 = Not In Progress 1 = In Progress
Battery String Time-To-Go String 1 - 32	32242-32305		2		Units : min
Amp-Hours Remaining in Battery String String 1 - 32	32306-32337		1		Units : AH
Battery String Discharge Time String 1 - 32	32338-32401		2		Units : sec

Table 11 - String Entity for Input and Holding (Strings 1-32)

String Entity (Strings 1-32) (Continued)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Low Ambient Temperature Global Threshold String 1 - 32	32402-32433		1	Scale : x / 10	Units : deg C
Low Ambient Temperature Global Threshold String 1 - 32	32434-32465		1	Scale : x / 10	Units : deg F
High Ambient Temperature Global Threshold String 1 - 32	32466-32497		1	Scale : x / 10	Units : deg C
High Ambient Temperature Global Threshold String 1 - 32	32498-32529		1	Scale : x / 10	Units : deg F
Battery String Overall Voltage Low Threshold String 1 - 32	32530-32561		1	Scale : x / 10	Units : VDC
Battery String Overall Voltage High Threshold String 1 - 32	32562-32593		1	Scale : x / 10	Units : VDC
Battery String Current High Threshold String 1 - 32	32594-32625		1		Units : A DC
Battery String Float Current Low Threshold String 1 - 32	32626-32657		1		Units : mA DC
Battery String Float Current High Threshold String 1 - 32	32658-32689		1		Units : mA DC
Battery String Ripple Current High Threshold String 1 - 32	32690-32721		1		Units : A AC

Table 10 - String Entity for Input and Holding (Strings 1-32) (Continued)

String Entity (Strings 1-32) (Continued)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Cell Voltage Low Global Threshold String 1 - 32	32722-32753		1	Scale : x / 1000	Units : VDC
Cell Voltage High Global Threshold String 1 - 32	32754-32785		1	Scale : x / 1000	Units : VDC
Cell Temperature Low Global Threshold String 1 - 32	32786-32817		1	Scale : x / 10	Units : deg C
Cell Temperature Low Global Threshold String 1 - 32	32818-32849		1	Scale : x / 10	Units : deg F
Cell Temperature High Global Threshold String 1 - 32	32850-32881		1	Scale : x / 10	Units : deg C
Cell Temperature High Global Threshold String 1 - 32	32882-32913		1	Scale : x / 10	Units : deg F
Internal Resistance Low Global Threshold String 1 - 32	32914-32945		1		Units : microOhm
Internal Resistance High Global Threshold String 1 - 32	32946-32977		1		Units : microOhm
Intercell Resistance High Global Threshold String 1 - 32	32978-33009		1		Units : microOhm
Intertier Resistance High Global Threshold String 1 - 32	33010-33041		1		Units : microOhm
Cell to Cell Temperature Deviation Threshold String 1 - 32	39027-39058		1	Scale : x / 10	Units : deg C

Table 10 - String Entity for Input and Holding (Strings 1-32) (Continued)

String Entity (Strings 1-32) (Continued)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Cell to Cell Temperature Deviation Threshold String 1 - 32	39059-39090		1	Scale : x / 10	Units : deg F
Cell to Ambient Temperature Deviation Threshold String 1 - 32	39091-39122		1	Scale : x / 10	Units : deg C
Cell to Ambient Temperature Deviation Threshold String 1 - 32	39123-39154		1	Scale : x / 10	Units : deg F
Cell to Cell Temperature Deviation Threshold String 1 - 32	33042-33073		1	Scale : x / 10	Units : deg C
Cell to Cell Temperature Deviation Threshold String 1 - 32	33074-33105		1	Scale : x / 10	Units : deg F
Cell to Ambient Temperature Deviation Threshold String 1 - 32	33106-33137		1	Scale : x / 10	Units : deg C
Cell to Ambient Temperature Deviation Threshold String 1 - 32	33138-33169		1	Scale : x / 10	Units : deg F
Installation Date String 1 - 32	33170-33233		2		Seconds since Unix Time Epoch (UTC)
Cell/Monobloc Rating String 1 - 32	33234-33265		1		Units : AH
Discharge Low Cell Voltage Threshold String 1 - 32	33266-33297		1	Scale : x / 1000	Units : VDC
Discharge Low Overall Voltage Threshold String 1 - 32	33298-33329		1	Scale : x / 10	Units : VDC
Discharge Battery String Current High Threshold String 1 - 32	33330-33361		1		Units : A DC

Table 10 - String Entity for Input and Holding (Strings 1-32) (Continued)

String Entity (Strings 1-32) (Continued)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Discharge Maximum Time String 1 - 32	33362-33393		1		Units : min
Startup Date String 1 - 32	33394-33457		2		Seconds since Unix Time Epoch (UTC)
Battery String Commissioned Status String 1 - 32	33458-33489		1		0 = Not Commissioned 1 = Commissioned
Battery String Alarm Reset or Acknowledge 1 String 1 - 32		43490-43521	1		2 = Reset 4 = Acknowledge
Cell to Cell Temperature Deviation Threshold String 1 - 32	39027-39058		1	Scale : x / 10	Units : deg C
Cell to Cell Temperature Deviation Threshold String 1 - 32	39059-39090		1	Scale : x / 10	Units : deg F
Cell to Ambient Temperature Deviation Threshold String 1 - 32	39091-39122		1	Scale : x / 10	Units : deg C
Cell to Ambient Temperature Deviation Threshold String 1 - 32	39123-39152		1	Scale : x / 10	Units : deg F
Ordinal Position of String String 1 - 32	33522-33553		1		
Index of Parent Battery String 1 - 32	33554-33585		1		

Table 11 - String Entity for Input and Holding (Strings 1-32) (Continued)

3.4. Cell Entity (Cells 1-320)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Cell Voltage Cell 1 - 320	33586-33905		1	Scale : x / 1000	Units : VDC
Cell Temperature Cell 1 - 320	33906-34225		1	Scale : x / 10	Units : deg C
Cell Temperature Cell 1 - 320	34226-34545		1	Scale : x / 10	Units : deg F
Internal Resistance Value Cell 1 - 320	34546-34865		1		Units : microOhm
Intercell Resistance Value Cell 1 - 320	34866-35185		1		Units : microOhm
Cell Voltage Low Threshold Cell 1 - 320	35186-35505		1	Scale : x / 1000	Units : VDC
Cell Voltage High Threshold Cell 1 - 320	35506-35825		1	Scale : x / 1000	Units : VDC
Cell Temperature Low Threshold Cell 1 - 320	35826-36145		1	Scale : x / 10	Units : deg C
Cell Temperature Low Threshold Cell 1 - 320	36146-36465		1	Scale : x / 10	Units : deg F
Cell Temperature High Threshold Cell 1 - 320	36466-36785		1	Scale : x / 10	Units : deg C
Cell Temperature High Threshold Cell 1 - 320	36786-37105		1	Scale : x / 10	Units : deg F
Internal Resistance Low Threshold Cell 1 - 320	37106-37425		1		Units : microOhm
Internal Resistance High Threshold Cell 1 - 320	37426-37745		1		Units : microOhm

Table 12 - Cell Entity for Input and Holding (Cells 1-320)

Cell Entity (Cells 1-320) (Continued)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Intercell Resistance High Threshold Cell 1 - 320	37746-38065		1		Units : microOhm
Ordinal Position of Cell Cell 1 - 320	38066-38385		1		
Index of Parent String Cell 1 - 320	38386-38705		1		
Index of Parent Battery Cell 1 - 320	38706-39025		1		

Table 12 - Cell Entity for Input and Holding (Cells 1-320) (Continued)

3.5. Cell Entity (Cells 321-360)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Cell Voltage Cell 321 - 360	39155-39194		1	Scale : x / 1000	Units : VDC
Cell Temperature Cell 321 – 360	39195-39234		1	Scale : x / 10	Units : deg C
Cell Temperature Cell 321 – 360	39235-39274		1	Scale : x / 10	Units : deg F
Internal Resistance Value Cell 321 – 360	39275-39314		1		Units : microOhm
Intercell Resistance Value Cell 321 – 360	39315-39354		1		Units : microOhm
Cell Voltage Low Threshold Cell 321 – 360	39355-39394		1	Scale : x / 1000	Units : VDC
Cell Voltage High Threshold Cell 321 – 360	39395-39434		1	Scale : x / 1000	Units : VDC
Cell Temperature Low Threshold Cell 321 – 360	39435-39474		1	Scale : x / 10	Units : deg C
Cell Temperature Low Threshold Cell 321 – 360	39475-39514		1	Scale : x / 10	Units : deg F

Table 13 - Cell Entity for Input and Holding (Cells 321-360)

Cell Entity (Cells 321-360) (Continued)

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Cell Temperature High Threshold Cell 321 - 360	39515-39554		1	Scale : x / 10	Units : deg C
Cell Temperature High Threshold Cell 321 – 360	39555-39594		1	Scale : x / 10	Units : deg F
Internal Resistance Low Threshold Cell 321 – 360	39595-39634		1		Units : microOhm
Internal Resistance High Threshold Cell 321 – 360	39635-39674		1		Units : microOhm
Intercell Resistance High Threshold Cell 321 – 360	39675-39714		1		Units : microOhm
Ordinal Position of Cell Cell 321 – 360	39715-39754		1		
Index of Parent String Cell 321 – 360	39755-39794		1		
Index of Parent Battery Cell 321 - 360	39795-39834		1		

Table 13 - Cell Entity for Input and Holding (Cells 321-360) (Continued)

3.6. Device Status and Control

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
Group Status 1	39026		1		1 = Normal Operation 2 = StartUp 4 = Unknown - No System Support for System Status 8 = Normal with Warning 16 = Normal with Alarm 32 = Abnormal Operation 64 = Unknown - Communication Failure

Table 14 - Device Status and Control for Input and Holding

3.7. UXCM Device

Data Description	Input	Holding	# of Reg	Scale	Notes/Units
System Date and Time	39998	49998	2		Seconds since Unix Time Epoch (UTC)

Table 15 - Linker Device for Input and Holding