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SmartSlave™ Corrosion Base Sensor Manual

Presented by:

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Description

The SmartSlave™-Corrosion Base is a 1-Wire™ sensor designed to house an IBM corrosion sensor. The SmartSlave™-Corrosion Base contains the electronics to interface the IBM corrosion sensor to a 1-Wire™ network for communication to a LinkHub-E device. This allows MMT to communicate with the SmartSlave™-Corrosion Base and receive data from the IBM corrosion sensor.

The IBM corrosion sensor is a field replaceable unit containing a corrosion sensor element, Analog-Digital Converter, temperature sensor, and various support electronics. This unit has a finite lifetime and must be replaced when depleted. See Changing the Corrosion Sensor for replacement instructions.

iButtonLink SmartSlave™ devices have a family code of 0xFE. In addition, the high twelve bits of the 1-Wire™ address contain a 0x002 specifying that this slave is produced by iButtonLink LLC. SmartSlave™'s produced by iButtonLink have a serial number of the form:

CC002xxxxxxxxFE where CC is the CRC8 of the next 7 bytes, 002 is the manufacturer code assigned to iButtonLink LLC by Maxim Integrated Products, Inc. and 0xFE is the family code indicating that the slave is NOT produced by Maxim Integrated Products, Inc.. xxxxxxxxx (36 bits) is the unique serial number for all SmartSlave™ produced by iButtonLink.

It is impossible to infer the functionally of a SmartSlave™ from the family code or manufacturer ID. A Read Memory (0xF000) command should be issued to acquire the slave characteristics byte and software version number (always the 1st and 2nd by of the first memory page).

Changing the Corrosion Sensor

Warning: Touching the corrosion sensing element with your fingers will ruin the element. Use cloth cleanroom gloves and only touch the edges of the sensor board. The element should be kept in the sealed packing material until inserted in the SmartSlave™-Corrosion Base .

The corrosion sensing element may be changed by authorized personnel. Please follow the steps below to change the corrosion sensing element.

Materials necessary:

- Replacement IBM corrosion sensor.
- #1 Phillips screwdriver.

- Thin cotton “cleanroom” gloves to be worn while handling the sensor.
- May need diagonal cutters to remove tie wraps, replacement tie wraps, or replacement double stick pads depending on the mounting of the unit.

1. Follow any necessary change management procedures before starting. This operation will disable the SmartSlave™-Corrosion Base and any sensors on the 1-Wire™ bus that follow it for the duration of the procedure. MMT will also have to have the initial value of the SmartSlave™-Corrosion Base reset for proper future measurements.
2. Locate the SmartSlave™-Corrosion Base and disconnect both RJ-45 cables from the unit. This will power off the SmartSlave™-Corrosion Base and all sensors after it on the 1-Wire™ bus.
3. Unscrew the top of the case by removing the four Phillips screws.
4. The top of the case may now be pulled off. The case top fits tightly so there may be some resistance when pulling the case top off. You should now see a circuit board inside the SmartSlave™-Corrosion Base .
5. Put on the gloves.
6. Remove any external packaging from the replacement IBM corrosion sensor.
7. Note the direction the circuit board is located in the box. There is no key to determine the direction it should be replaced in the box. The direction will affect the orientation of the IBM corrosion sensing element in the airstream, but will not otherwise affect operation.
8. Lift the circuit board out of the box by the two RJ-45 connectors. It should remove easily.
9. Turn the board over and locate the IBM corrosion sensor plugged into the SmartSlave™-Corrosion Base.
10. Remove the IBM corrosion sensor element and set it aside.
11. Insert the new IBM corrosion sensor element into the socket. Note that the socket is keyed so that the IBM corrosion sensor element may only be inserted in one direction.
12. Replace the circuit board in the case taking care to fit the IBM corrosion sensor element into the slot at the bottom of the case.
13. Replace the cover. It is a tight fit and will need to be pushed to snap on. Verify that it is seated properly on all sides.
14. Replace the four screws.
15. Reconnect the SmartSlave™-Corrosion Base to the 1-Wire network.
16. Reset the MMT initial data for the SmartSlave™-Corrosion Base so that new readings are correct.

17. Validate proper operation of the SmartSlave™-Corrosion Base in MMT. The 1-Wire™ address of the unit will not change so no further programming is required.

Figure 1 The SmartSlave™-Corrosion Base internal PCB with the IBM corrosion sensor plugged in.

SmartSlave™-Corrosion Base Family Code and Identification

All iButtonLink Smart Slaves™ have a family code of 0xFE which designates that this slave is not made by Maxim Integrated Products, Inc. In addition, the high twelve bits of the 1-Wire™ address contain a 0x002 specifying that this slave is produced by iButtonLink, LLC. An iButtonLink SmartSlave™ has a serial number of the form:

CC002xxxxxxxxFE

where CC is the CRC8 of the next 7 bytes, 002 is the manufacturer code assigned to iButtonLink LLC by Maxim Integrated Products, Inc. and 0xFE is the family code indicating that the slave is NOT produced by Maxim Integrated Products, Inc.. xxxxxxxxx (36 bits) is the unique serial number for all SmartSlave™ produced by iButtonLink.

Each SmartSlave™-Corrosion Base has a unique serial number.

The family code and serial number determine that the slave is made by iButtonLink, LLC. However, there is no information in the serial number that indicates this sensor is a corrosion base sensor. To determine the type of iButtonLink, LLC. SmartSlave™ the master should issue

a Read Memory (0xF000) command as shown in the examples below. The first and second byte of the first memory page indicate the slave type and software version number. The first byte, byte zero, will contain a 1 if the SmartSlave™ is a SmartSlave™-Corrosion Base slave. The second byte, byte one, will contain the software version number, which is currently a 0X10 for the first version of the code.

1-Wire Hardware Configuration

The SmartSlave™-Corrosion Base interfaces via 1-Wire™ over an eight conductor UTP cable with RJ-45 terminations, commonly called "Cat-5" straight through patch cable. There are two RJ-45 cable ports on the SmartSlave™-Corrosion Base . Either, or both, may be used for interface to a 1-Wire™ network.

The SmartSlave™-Corrosion Base requires 12 volt power for normal operation. This means that either a LinkHub product must be used as the master, which is standard in all IBM MMT installations, or an MS-PWR power injector and associated power supply must be used. If 12 volt power is not present, the SmartSlave™-Corrosion Base will not respond to commands and will appear to be dead.

Programming the 1-Wire™ System for the SmartSlave™-Corrosion Base

Four steps are necessary for any 1-Wire™ transaction:

1- Initialization of the bus by a reset command.
2- Sending a ROM Function command to select a slave.
3- Sending a command to the slave.
4- Receiving data from the slave, if the command generates data.

This sequence of four steps must be executed twice to retrieve data from the SmartSlave™-Corrosion Base . The first sequence will send a command to the SmartSlave™-Corrosion Base to read the IBM corrosion sensor element. The second sequence will read the results from the SmartSlave™-Corrosion Base . There must be at least one second of delay between the two command sequences to give the SmartSlave™-Corrosion Base time to read the IBM corrosion sensor element.

Each step of these sequences will be detailed below with examples to follow.

Initialization of the bus by a reset command

All transactions on the 1-Wire™ bus begin with an initialization sequence. The initialization sequence consists of a reset pulse transmitted by the bus master followed by presence pulse(s)

transmitted by the slave(s). The presence pulse lets the bus master know that the SmartSlave™-Corrosion Base is on the bus and is ready to operate.

For iButtonLink Masters the command is "r" (reset).

The reset command returns one of the following possible values:

Response	Description
P	No error, at least one slave is on the bus.
N	No error, no slaves are present. If a SmartSlave™-Corrosion Base is expected to be present on this bus, either the wrong bus is selected , there is a wiring issue, the master is not supplying 12V power, or the SmartSlave™-Corrosion Base has failed.
S	Short, the 1-Wire™ bus is shorted. If this error is received the problem should be addressed by troubleshooting the cabling, T-Boxes, and slaves on the bus. This is most likely not an issue with the SmartSlave™-Corrosion Base
E	Undefined protocol error. This indicates that a slave did not respond properly to the reset or the master has an internal problem. If this is a consistent problem, try to power cycle the master (LinkHub) or remove slaves from the bus until the problem is found.

Sending a ROM Function command to select a particular slave, or group of slaves.

Once the bus master has detected a presence pulse generated by the reset command, it can issue one of the four ROM function commands. All ROM function commands are 8-bits long. The ROM command to use depends on the number of slaves on the bus and if the 1-Wire™ addresses of each slave are known.

If there is exactly one slave on the bus

If the SmartSlave™-Corrosion Base is the only slave on the bus, a Skip ROM [CCh] is the easiest way to address the slave. A Skip ROM command says that all slaves on the bus should be selected. This is only valid if there is exactly one slave on the bus.

The proper command on an iButtonLink, LLC. master is as follows:
bCC

The "b" tells the master to enter "byte mode" where hexadecimal character pairs are sent to the 1-Wire™ bus. The master echoes the response from the bus. The response should be the same. Table 1 contains an example Skip ROM command sequence.

Table 1 Example of Skip ROM command to select slave

Full Command	Send: ***rbCC***	
Response	***P***	Response to reset "r". Slave is present.

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	CC	When in byte mode, characters received by the Link are returned..
Breakdown of command as follows:		
Reset	Send ***r*** Receive ***P***	
Byte mode	Send ***b*** No characters are returned in response.	
Skip ROM Function Command	Send ***CC*** Receive ***CC***	

Please note that the LinkHub-E master used at IBM MMT sites contains an 1-Wire™ ID chip that will respond as a second slave. Therefore, the Skip ROM command will not work on a LinkHub-E unless a channel mask is applied.

Please note that most commands entered into the master are case sensitive. It is important to match the case used in the examples exactly.

If the received data returned from the link does not match the above example, then the command has not been sent to the bus properly due to noise, a slave error, a short, or other external condition. The command should be retried and if the failure continues the bus should be repaired.

If there are multiple slaves on the bus and the address of the SmartSlave™-Corrosion Base is known

If there are multiple slaves and the address of the slave of interest is known, then a Match ROM [55h] ROM function command is the best choice. To use the Match ROM command, the 1-Wire™ address byte order must be reversed. Please see the examples below.

Table 2 Example of using the Match ROM function to select a slave

1-Wire™ address to be selected as labeled	1E0021B1000001FE	
1-Wire™ address to be selected split into bytes	1E 00 21 B1 00 00 01 FE	
1-Wire™ address to be selected with bytes in reverse order	FE 01 00 00 B1 21 00 1E	
1-Wire™ address to be selected as used in master commands	FE010000B121001E	
Full Command	Send: ***rb55FE010000B121001E***	
Response	***P***	Response to reset “r”. Slave is

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	55FE010000B121001E	present. When in byte mode, characters received by the Link are returned.
Breakdown of command as follows:		
Reset	Send ***r*** Receive ***P***	
Byte mode	Send ***b*** No characters are returned in response.	
Match ROM Function Command	Send ***55*** Receive ***55***	
1-Wire™ address reversed	Send: ***FE010000B121001E*** Receive: ***FE010000B121001E***	

If there are multiple slaves on the bus and the address of the SmartSlave™-Corrosion Base is NOT known

There are multiple ways to get the address of a 1-Wire™ slave. In the IBM environment, the three easiest ways are:

1. Inspect the physical sensor. All production sensors will contain a label with a barcode. You may scan the barcode to get the address or read the text below the barcode.
2. Connect the slave to the master and issue the "f" command, for first, which will print out the first 1-Wire™ slave address on the bus. Type the "n" command, for next, to show the next 1-Wire™ slave address. If you slave is the only device on the bus and the master does not have an ID chip, you will get one result. If your master has an ID chip, then remove your slave and execute the same "f" and "n" command. Look at the difference and the missing ID is the one you need.
3. Look in MMT for an unassigned sensor attached to the bus in question. One of the unassigned sensors will be the sensor you are trying to find. Note that all SmartSlave™-Corrosion Base units have an ID that ends with FE.

Making the SmartSlave™-Corrosion Base do something – sending a device command.

Now that the bus has been reset and the SmartSlave™-Corrosion Base has been selected as in the previous examples, it is now time to tell the SmartSlave™-Corrosion Base to do something. There are two basic functions available: 1) tell the SmartSlave™-Corrosion Base to read and convert the data from the IBM corrosion sensor and 2) tell the SmartSlave™-Corrosion Base to display the results.

Tell the SmartSlave™-Corrosion Base to read and convert data from the IBM corrosion sensor

To tell the slave to read the IBM corrosion sensor, the Convert [B4h] command must be sent to the SmartSlave™-Corrosion Base . This will cause the SmartSlave™-Corrosion Base to read the values of both the temperature sensor and the Analog/Digital converter on the IBM corrosion sensor and store the result in local RAM on the SmartSlave™-Corrosion Base . This process takes a little less than one second so the SmartSlave™-Corrosion Base will not respond for second after this command is issued. Two examples are below.

Table 3 Example of telling the SmartSlave™-Corrosion Base to read the IBM corrosion sensor

1-Wire™ address to be converted as labeled	1E0021B1000001FE	
1-Wire™ address to be converted split into bytes	1E 00 21 B1 00 00 01 FE	
1-Wire™ address to be converted with bytes in reverse order	FE 01 00 00 B1 21 00 1E	
1-Wire™ address to be converted as used in master commands	FE010000B121001E	
Full Command	Send: ***rb55FE010000B121001EB4***	
Response	***P*** ***55FE010000B121001EB4***	Response to reset "r". Slave is present. When in byte mode, characters received by the Link are returned.
Breakdown of command as follows:		
Reset	Send ***r*** Receive ***P***	
Byte mode	Send ***b*** No characters are returned in response.	
Match ROM Function Command	Send ***55*** Receive ***55***	
1-Wire™ address reversed	Send: ***FE010000B121001E*** Receive: ***FE010000B121001E***	
Send Convert command	Send: ***B4*** Receive: ***B4***	
Send a <CR> to end Byte mode	A <CR><LF> pair is returned.	
Wait one second before additional commands.		

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Table 4 Tell the SmartSlave™-Corrosion Base to read the IBM Corrosion Sensor if it is the only slave on the bus

Full Command	Send: ***rbCCB4***	
Response	***P*** ***CCB4***	Response to reset "r". Slave is present. When in byte mode, characters received by the Link are returned.
Breakdown of command as follows:		
Reset	Send ***r*** Receive ***P***	
Byte mode	Send ***b*** No characters are returned in response.	
Match ROM Function Command	Send ***55*** Receive ***55***	
1-Wire™ address reversed	Send: ***FE010000B121001E*** Receive: ***FE010000B121001E***	
Send Convert command	Send: ***B4*** Receive: ***B4***	
Send a <CR> to end Byte mode	A <CR><LF> pair is returned.	
Wait one second before additional commands.		

Tell the SmartSlave™-Corrosion Base to send the data from the IBM corrosion sensor to the master

The Read Memory Page command tells the SmartSlave™-Corrosion Base to return data to the master. 32 bytes of data are returned. The format of the data returned from the Read Memory Page command is listed in Table 5.

Table 5 Data return format from F0 Read Memory Page command

Example String:		sent b55FE010000B121001EF000m Received: P Received: 55FE010000B121001EF000 0110000000C05EE7A099D50C00000000000000000000000000000000015009CC7	
Word	Byte	Example	Contents
0	0	01	IBL Slave type (always 1 for the SmartSlave™-Corrosion Base

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			)
	1	10	Slave software version number (two nibbles … high nibble is version number, low nibble is minor release number. The initial release of the SmartSlave™-Corrosion Base contains an 0x9 (high nibble of 1, low nibble of 0)
1	2	00	Raw Reading from LTC2485 A/D (LSB)
	3	00	Raw Reading from LTC2485 A/D .
2	4	C0	Raw Reading from LTC2485 A/D .
	5	5E	Raw Reading from LTC2485 A/D (MSB)
3	6	E7	Raw temperature reading from LTC2485 (LSB)
	7	A0	Raw temperature reading from LTC2485.
4	8	99	Raw temperature reading from LTC2485 .
	9	D5	Raw Temperature reading from LTC2485 (MSB)
5	10	0C	Most recent Vdd reading for SmartSlave™-Corrosion Base (LSB) in millivolts
	11	00	Most recent Vdd reading for SmartSlave™-Corrosion Base (MSB) in millivolts
6	12	00	Raw temperature reading from TMP112 (LSB)
	13	00	Raw temperature reading from the TMP112 (MSB)
7	14	00	Unused
	15	00	Unused
8	16	00	Unused
	17	00	Unused
9	18	00	Unused
	19	00	Unused
10	20	00	Unused
	21	00	Unused
11	22	00	Conversion status. Must be zero for a valid conversion.
	23	00	Conversion status. Must be zero for a valid conversion.
12	24	00	Power up time (BCD)
	25	00	Power up time (BCD)
13	26	00	Power up time (BCD)
	27	00	Power up time (BCD)
14	28	00	Power up time (BCD) Hours
	29	00	Power up time (BCD) Day of week
15	30	15	Power up time (BCD) Seconds
	31	00	Power up time (BCD) Minutes
16	32	9C	CRC16 of preceding 32 bytes (LSB)
	33	C7	CRC16 of preceding 32 bytes (MSB)

Please see http://cds.linear.com/docs/Datasheet/2485fc.pdf for descriptions of the LTC data.

A spreadsheet is available that converts the values read from the ADC to a voltage value. The spreadsheet contains three example conversions.

The following two examples show a complete Read Memory Page command sequence.

Table 6 Read Memory Page command example using Skip ROM Selection. Usable if only one slave on the bus.

If a convert command immediately proceeded this command, wait one second.		
Full Command	Send: ***rbCCF000m***	
Response	***P*** ***CCF000*** 0110000000C05EE7A099D50C 00000000000000000000000000 0000000000150009CC7	Response to reset "r". Slave is present. When in byte mode, characters received by the Link are returned. Return data is sent from F000m command.
Breakdown of command as follows:		
Reset	Send ***r*** Receive ***P***	
Byte mode	Send ***b*** No characters are returned in response.	
Match ROM Function Command	Send ***CC*** Receive ***CC***	
Send Convert command	Send: ***F000m*** Receive: ***F000***0110000000C05EE7A099D50C00 000000000000000000000000000000000150009CC7	
Send a <CR> to end Byte mode	A <CR><LF> pair is returned.	
Wait one second before additional commands.		

Table 7 Read Memory Command example using Match ROM selection

If a convert command immediately proceeded this command, wait one second.	

1-Wire™ address to be converted as labeled	1E0021B1000001FE	
1-Wire™ address to be converted split into bytes	1E 00 21 B1 00 00 01 FE	
1-Wire™ address to be converted with bytes in reverse order	FE 01 00 00 B1 21 00 1E	
1-Wire™ address to be converted as used in master commands	FE010000B121001E	
Full Command	Send: ***rb55FE010000B121001EF000m***	
Response	***P*** ***55FE010000B121001EF000*** 0110000000C05EE7A099D50C 00000000000000000000000000 0000000000015009CC7	Response to reset "r". Slave is present. When in byte mode, characters received by the Link are returned. Return data is sent from F000m command.
Breakdown of command as follows:		
Reset	Send ***r*** Receive ***P***	
Byte mode	Send ***b*** No characters are returned in response.	
Match ROM Function Command	Send ***55*** Receive ***55***	
1-Wire™ address reversed	Send: ***FE010000B121001E*** Receive: ***FE010000B121001E***	
Send Convert command	Send: ***F000m*** Receive: ***F000***0110000000C05EE7A099D50C00 00000000000000000000000000000000000015009CC7	
Send a <CR> to end Byte mode	A <CR><LF> pair is returned.	
Wait one second before additional commands.		

Errata

If a reset is issued in the middle of a 1-Wire transaction when the SmartSlave™-Corrosion Base is selected, a presence pulse will not be issued by the SmartSlave™-Corrosion Base . This will

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be fixed in future versions of the code. Two possible workarounds are: 1) Always have the SmartSlave™-Corrosion Base on a network with another type of slave, 2) Issue the reset twice.

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