MultiHop Register Parameters Guide (End Users)

Contents

1 Input and Output Registers

Inputs			Outputs	
Register	**Input #**		**Register**	**Output #**
40001	1		40501	1
40002	2		40502	2
40003	3		40503	3
40004	4		40504	4
40005	5		40505	5
40006	6		40506	6
40007	7		40507	7
40008	8		40508	8
40009	9		40509	9
40010	10		40510	10
40011	11		40511	11
40012	12		40512	12
40013	13		40513	13
40014	14		40514	14
40015	15		40515	15
40016	16		40516	16

2 Modbus Register Configuration

The factory default settings for the inputs, outputs, and device operations can be changed by the user through the device Modbus registers. To change parameters, the data radio network must be set to Modbus mode and the data radio must be assigned a valid Modbus slave ID. The following sections provide the basic parameter descriptions and register locations. For more information about registers, refer to the MultiHop Product Manual, Banner part number 151317.

Generic input or output parameters are grouped together based on the device input or output number: input 1, input 2, output 1 etc. Operation type specific parameters (discrete, counter, analog 4 to 20 mA) are grouped together based on the I/O type number: analog 1, analog 2, counter 1, etc.

Not all inputs or outputs may be available for all models. To determine which specific I/O is available on your model, refer to the Modbus Input/Output Register Maps listed in the device's data sheet.

40000s Standard Physical Inputs

Registers x0001 through x0016 are the results registers for inputs 1 through 16. For a list of the active results registers for your MultiHop radio, refer to your product's data sheet.

40100s and 40600s Remap Registers

Use these remap registers to map any I/O registers to a contiguous location to allow for easier access from a host system.

40600s. Registers 40601 through 40616 contain the index of registers that are remapped.

40100s. Registers 40101 through 40116 contain the values of the remapped registers.

Register Remapping
Use the Register Remapping screen to map registers to a contiguous location.
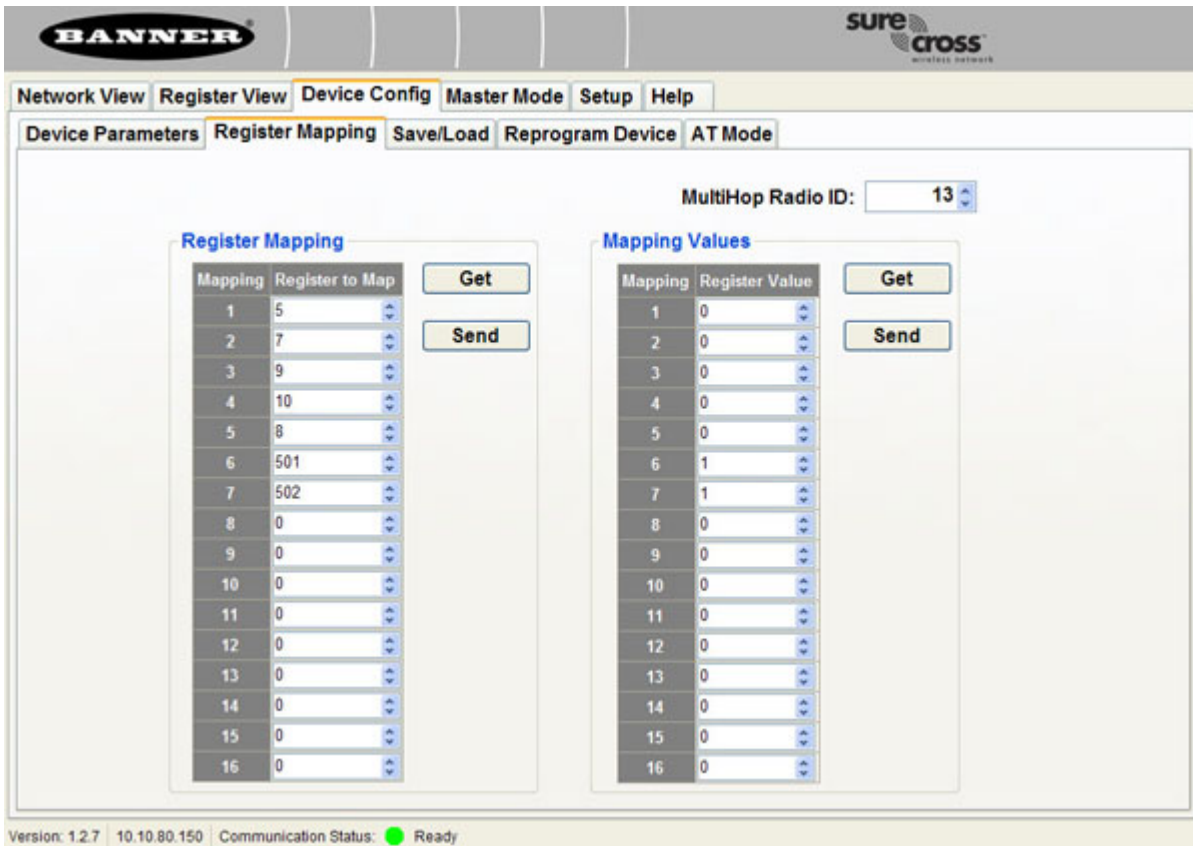
Before making any changes to the screen, select the desired MultiHop Radio ID.

Register Mapping

In the Register to Map column, enter the registers to be remapped. These registers are remapped to 601 through 616. In the example shown, registers 5, 7, 9, 10, 8, 501, and 502 are remapped to registers 601 through 607.

Mapping Values

The values of the mapped registers will be in registers 101 through 116. In the example shown, the values of registers 5, 7, 9, 10, 8, 501, and 502 are stored in registers 101 through 107. Note that we are writing a 1 (one) to registers 106 and 107 (registers 501 and 502).

40500s Standard Physical Outputs

Registers x0501 through x0516 are the results registers for outputs 1 through 16. For a list of the active results registers for your Multi-Hop radio, refer to your product's data sheet.

41000s Input Parameters

Data radio inputs have the following generic parameters. These are not global parameters but are associated only with a particular input. There are currently 16 separate inputs possible; the factory default settings are defined in the I/O specifications.

Parameters for Input 1 are at 41001 through 41008. Parameters for input 2 are at 41051 through 41058. Each following input is offset from the previous one by 50 registers.

		4xxxx Registers	Parameters
Input Parameters	Input 1	1001–1008	1xx1 Enable
	Input 2	1051–1058	1xx2 Sample Interval (high word)

		4xxxx Registers	Parameters
	Input 3	1101–1108	1xx3 Sample Interval (low word)
	Input 4	1151–1158	1xx8 Out-of-Sync Enable
	Input 5	1201–1208	
	Input 6	1251–1258	
	Input 7	1301–1308	
	Input 8	1351–1358	
	Input 9	1401–1408	

1xx1 Enable. A 1 enables the input and a 0 to disable the particular input.

1xx2 Sample Interval (High Word). The sample interval (rate) is a 32-bit value (requires two Modbus registers) that represents how often the data radio samples the input. The register value is the number of time units. For example, a Modbus register value of 125 (for a 900MHz device) represents a sample interval of 5 seconds (125 x .040 seconds = 5 seconds). A unit of time for a 900 MHz data radio is 40 milliseconds. A unit of time for a 2.4 GHz data radio is 20 milliseconds.

1xx3 Sample Interval (Low Word). See Sample Interval (High Word).

1xx4 through 1xx7. See *Switch Power Input Parameters*.

1xx8 Out-of-Sync Enable. Set to one (1) to enable the input to continue operating when the device is out of sync with the master radio. Set to zero (0) to disable the input when the device is not synchronized to the master radio. The default value is one (1).

Switch Power Input Parameters

These are not global parameters but are associated only with a particular input. There are currently 16 separate inputs possible; the factory default settings are defined in the I/O specifications.

Parameters for Input 1 are at 41001 through 41007. Parameters for input 2 are at 41051 through 41057. Each following input is offset from the previous one by 50 registers.

		4xxxx Registers	Parameters
Switch Power Input Parameters	Input 1	1004–1007	1xx4 Switch Power Enable
	Input 2	1054–1057	1xx5 Switch Power Warm-up
	Input 3	1104–1107	1xx6 Switch Power Voltage
	Input 4	1154–1157	1xx7 Extended Input Read
	Input 5	1204–1207	
	Input 6	1254–1257	
	Input 7	1304–1307	
	Input 8	1354–1357	
	Input 9	1404–1407	

1xx4 Switch Power Enable Mask. The bit mask can select any number of switch power outputs 1 through 4. Switch power enable works with the warm-up and voltage parameters to define the switch power output. Some devices have only two switch power outputs. Refer to your model's data sheet to confirm which switch power outputs are active for your MultiHop radio.

Value	Switch Power #
0x0	None
0x1	SP1

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Value	Switch Power #
0x2	SP2
0x3	SP1 and SP2
0x4	SP3
0x8	SP4
0xC	SP3 and SP4

1xx5 Switch Power Warm-up. When the data radio supplies power to external sensors, the Switch Power Warm-up parameter defines how long power is applied to the external sensor before the input point is examined for changes. The register value is the number of time units. A unit of time for a 900 MHz data radio is 40 milliseconds. A unit of time for a 2.4 GHz data radio is 20 milliseconds.

1xx6 Switch Power Voltage. The Switch Power Voltage parameter defines the output voltage of the switch power output. This parameter applies only to inputs using switched power. If switch power is not used with an input, use the Continuous Voltage parameter to control the voltage.

Output Voltage	Parameter Value
0V	255
5V	204
7V	125
10V	69
15V	32
20V	12
24V	03

1xx7 Extended Input Read. The Extended Input Read is a bit field parameter that allows multiple inputs to be sampled with the same switch power parameters. If the bit field is set to 0x000F, the first four inputs are sampled after the switch power parameters are satisfied. If this parameter is set in the input 1 configuration registers, set inputs 2 through 4 to zero.

42000s Output Parameters

The following characteristics are configurable for each output. Parameters for Output 1 start at 42001 through 42004. Parameters for output 2 start at 42051 through 42054. Each following output is offset from the previous one by 50 registers.

		4xxxx Registers	Parameters
Output Parameters	Output 1	2001–2004	2xx1 Enable
	Output 2	2051–2054	2xx2 Flash Output Enable
	Output 3	2101–2104	2xx3 Flash Index
	Output 4	2151–2154	2xx4 Out of Sync Enable
	Output 5	2201–2204	
	Output 6	2251–2254	
	Output 7	2301–2304	
	Output 8	2351–2354	
	Output 9	2401–2404	

2xx1 Enable. Set to 1 to enable the output; set to 0 to disable the output.

2xx2 Flash Output Enable. The Flash Output Enable, Flash Index, and Output Flash Pattern registers are all used to set up flashing patterns for indicator lights connected to the data radio. Set the Flash Output Enable register to 1 to enable the ability to select an output flash pattern; set to 0 to disable this feature. Select the output pattern using the Flash Index and Output Flash Pattern registers.

2xx3 Flash Index. The Flash Index can have values 1, 2, 3, or 4. For a particular output, the Flash Index 1 through 4 select a certain output pattern as defined in registers 44401, 44411, 44421, or 44431.

2xx4 Out of Sync Enable. Set to one (1) to enable the output to continue operating when the device is out of sync with the master radio. Set to zero (0) to disable the output when the device is not synchronized to the master radio. The default value is one (1).

42950s Default Output Parameters

Several device conditions may be used to send outputs to their default state. Use these properties to define the device's default output conditions.

2951 Enable Default Out Of Sync. When a radio is "out of sync," it is not communicating with its parent radio. Set this value to 1 to enable the default condition when the device is not communicating with its parent radio. Set to 0 to disable.

2952 Enable Default Communication Timeout. A "communication timeout" refers to the communication between the host system and this radio. Set this register to 1 to enable the default condition when the host has not communicated with this radio for the period of time defined by the Communication Default IO Timeout.

2953 Communication Default I/O Timeout (100 ms/Count). This parameter defines the host timeout period in 100 millisecond increments. If a host does not communicate within this timeout period, the device outputs are set to the default values.

2954 Enable Default on Power Up. Setting this parameter to 1 sends the device outputs to their default condition when the radio is powered up. Set to 0 to disable this feature.

43000s Discrete Input Parameters

The Discrete Input Configuration parameters configure certain aspects of the data radio's discrete inputs. Parameters for Discrete Input 1 start at 43001 through 43004. Parameters for Discrete Input 2 start at 43021 through 43024. Each following input is offset from the previous one by 20 registers.

		4xxxx Registers	Parameters
Discrete Input Parameters	Discrete IN 1	3001–3009	30x1 PNP/NPN
	Discrete IN 2	3021–3029	30x2 Sample High
	Discrete IN 3	3041–3049	30x3 Sample Low
	Discrete IN 4	3061–3069	30x4 Enable Latch on Change of State
			30x7 Enable Discrete Input Time Active Counter
			30x8-30x9 Discrete Input Time Active Count

3xx1 PNP or NPN. Set to 1 to define the input as a PNP (sourcing) input. Set to 0 to define the input as an NPN (sinking) input.

3xx2 Sample High. The default value is 0, which disables this feature. The value range is 1 through 255. The Sample High parameter refers to the number of samples (1 through 255) a discrete input must be detected high (1) before it is considered to be a change of state.

3xx3 Sample Low. The default value of 0 disables this feature. The value range is 1 through 255. The Sample Low parameter refers to the number of samples (1 through 255) a discrete input must be detected low (0) before it is considered to be a change of state.

3xx4 Enable Latch on Change of State. Writing a 1 to this register causes a data "push" (data transmitted to the master radio) on Change of State.

3xx7 Enable Discrete Input Time Active Counter. The time active counter counts the time a discrete input is in the active state. Set to one (1) to enable the time counter; set to zero (0) to disable the counter. By default, this counter is enabled.

3xx8 and 3xx9 Discrete Input Time Active Count. These two registers contain the counter value. Register 3xx8 contains the high portion of the active counter and 3xx9 contains the low portion of the active counter. The counter stores a time value in 100 ms increments. This value is reset to zero when the power cycles off.

43300s Analog Input Parameters

The following characteristics are configurable for each of the analog inputs. Analog Input parameters for Input 1 start at 43301 through 43307. Analog Input parameters for Input 2 start at 43321 through 43327. Each following input is offset from the previous one by 20 registers.

		4xxxx Registers	Parameters
Analog Input Pa-rameters	Analog IN 1	3301–3320	33x1 Max Analog Value
	Analog IN 2	3321–3340	33x2 Min Analog Value
	Analog IN 3	3341–3360	33x3 Enable Register Full Scale
	Analog IN 4	3361–3380	33x4 Degrees C/F
			33x5 Temperature Double
			33x6 Thermocouple Type Select
			33x7 Temperature Resolution Select
			33x8 Threshold
			33x9 Hysteresis
			33x0 Delta
			33x6 Sample High
			33x7 Sample Low
			33x8 Change of State Push Enable
			33x9 Median Filter Enable
			33x0 Tau Filter Settings

33x1 Maximum Analog Value. The Maximum Analog Value register stores the maximum allowed analog value. The specific units of measure apply to the register value. For example, the register may contain 20000, for 20 mA, or for a voltage input the register may contain 8000, for 8 volts.

33x2 Minimum Analog Value. The Minimum Analog Value register stores the minimum allowed analog value. The specific units of measure apply to register value. For example, the register may contain 4000, for 4 mA, or for a voltage input the register may contain 2000, for 2 volts.

33x3 Enable Register Full Scale. Set to 1 to enable a linear range from 0 to 65535 for specified input range. For a 4 to 20 mA input, a value of 0 represents 4 mA and 65535 represents 20 mA. Set this parameter to 0 to store input readings in unit-specific data. For example, the register data representing a 15.53 mA reading is 15530. For units of current (0 to 20 mA inputs), values are stored as µA (micro Amps) and voltage values are stored as mV (millivolts).

33x4 Select Degrees F or Degrees C. Set this parameter to 1 to represent temperature units in degrees Fahrenheit. Set this parameter to 0 to represent temperature units in degrees Celsius. (Only used for thermocouple inputs.)

33x5 Temperature Scaling. Set to 1 to store temperatures the same way as the DX80 devices (measured temp × 20) represent temperature. Set to 0 to store temperature values in tenths of a degree (measured temp × 10). For example, if the measured temperature is 20.5 degrees, using temperature scaling set to 1 would store the temperature value as 410; using temperature scaling set to 0 would store the temperature as 205. (Only used for thermocouple inputs.)

33x6 Select Thermocouple Type. Write the listed value to this register to select a thermocouple type. (Only used for thermocouple inputs.)

Value	Thermocouple Type	Value	Thermocouple Type	Value	Thermocouple Type
0	B	5	J	10	P
1	C	6	K	11	R
2	D	7	L	12	S
3	E	8	M	13	T
4	G	9	N	14	U

33x7 Select Temperature Resolution. Thermocouples and RTDs may record temperatures in either high resolution (tenths of a degree) or low resolution (whole degree). Write a 0 to select high resolution (default) or a 1 to select low resolution. Choosing high or low resolution changes the range of temperatures that can be written to the register. (Only used for thermocouple inputs.)

33x8 and 33x9 Hysteresis and Threshold. Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for a sensor input. The hysteresis value establishes how much below the active threshold (ON point) an analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range.
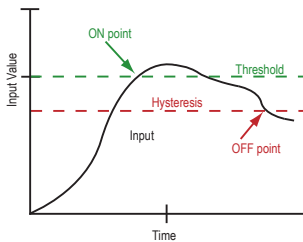
In the example shown graphically, the input is considered on at 15 mA. To consider the input off at 13 mA, set the hysteresis to 2 mA. The input will be considered off when the value is 2 mA less than the threshold.

33x0 Delta. The delta parameter defines the change required between sample points of an analog input before a change of state has occurred. To turn off this option, set the Delta value to 0.

33x6 and 3xx7 Sample High and Sample Low. For analog inputs, the sample high parameter defines the number of consecutive samples the input signal must be above the threshold before a signal is considered active. Sample low defines the number of consecutive samples the input signal must be below the threshold before a signal is considered deactivated. The sample high and sample low parameters are used to avoid unwanted input transitions.

33x8 Change of State Push Enable. Set to one (1) to enable push registers for this input. When the analog input changes state, the register value will be pushed to the master radio if this register is configured to be a push register.

33x9 Median Filter Enable. Set to zero (0) to turn off the median filter. Set to one (1) to turn on the median filter.

33x0 Tau Filter. Set to zero (0) to turn off the tau filter. Set to 1 (weakest filter) through 4 (maximum filter) to turn on the tau filter.

43500s Counter Input Parameters

The following characteristic is configurable for the counter input. Counter Input parameters for Counter Input 1 start at 43501 through 43505. Counter Input parameters for Counter Input 2 start at 43521 through 43525. Each following counter input is offset from the previous one by 20 registers.

		4xxxx Registers	Parameters
Counter Input Parameters	Counter IN 1	3501–3505	35x1 Frequency/Event Counter
			35x2 Enable Read Counter State

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		4xxxx Registers	Parameters
			35x3 Set Preset Value
			35x4 and 35x5 Counter Preset Value

35x1 Enable Frequency/Event Counter. A counter input can be defined to calculate the frequency of the input in hertz or as a counter that increments with every input change (event counter) from 0 to 1 (for PNP inputs). Set this parameter to 1 to configure the input to calculate frequency. Set to 0 to configure the counter to count input changes, e.g. an event counter or totalizer. Because the counter is reset to zero when power is cycled to the device, it is up to the host system to save count data.

35x2 Enable-Read Counter State. Manufacturing/test register only

35x3 Set Preset Value. Writing this value to 1 signals the data radio to preset the counter with the value stored in Modbus registers 43504 and 43505. When the task is complete, the value is written to 0.

35x4 and 35x5 Counter Preset Value. Registers 43504 (high word) and 43505 (low word) contain the 32-bit value for presetting the counter. Write the 'Counter Preset Value' registers first, then use the 'Set Preset Value' register to execute the counter preset.

43600s H-Bridge Output Parameters

The Power Output Configuration parameters provide the basic operation for each power output. These parameters are not associated to specific inputs. Parameters for H-bridge 1 start at 43604 through 43609. Parameters for H-bridge 2 start at 43624 through 43629. Each following switch power is offset from the previous one by 20 registers.

		4xxxx Registers	Parameters
H-Bridge Output Parameters	H-Bridge 1	3604–3609	36x4 Enable H-Bridge
			36x5 H-Bridge Warmup Cap Time
			36x6 H-Bridge Active Current Time
			36x7–36x8 H-Bridge Switches
			36x9 H-Bridge Booster Enabled When Active

36x4 Enable H-Bridge. Enable (1) or disable (0) the h-bridge inputs as needed. Disable the h-bridge inputs when using SDI-12 devices.

36x5 H-Bridge Warm Up Cap Time. Similar to the switch power warm up time, the h-bridge capacitor warm up time is the time allotted, in 40 millisecond increments, to charge the capacitor used to activate the h-bridge and latching solenoid.

36x6 H-Bridge Active Current Time. Set how long, in 40 millisecond increments, the capacitor is switched into and supplying power to the solenoid circuit.

36x7-36x8 H-Bridge Switches. Use these two parameters as a bit mask to set the ON and OFF conditions of the h-bridge switch.

	DO4	DO3	DO2	DO1	SP4	SP3	SP2	SP1
36x7 Rising Switch (ON)	0	0	1	0	0	0	0	1
36x8 Falling Switch (OFF)	0	0	0	1	0	0	1	0

36x9 H-Bridge Booster Enabled When Active. To use this parameter, contact the applications engineers at Banner Engineering Corp. This parameter leaves the boost voltage on while the capacitor discharges into the solenoid. While this can supply more power to the solenoid circuit, it may also brown-out the radio device.

43600s Switch Power Output Parameters

Efficient power management technology enables some FlexPower devices to include an internal power supply, called switch power (SP), that briefly steps up to power sensors requiring 5, 10, or 15V power (ideally, 4–20 mA loop-powered sensors). When the switch power output cycles on, the voltage is boosted to the voltage needed to power the sensor for a specific warmup time. This warmup timedenotes how long the sensor must be powered before a reliable reading can be taken. After the warmup time has passed, the input reads the

sensor, then the switch power shuts off to prolong battery life. The switch power voltage, warm-up time, and sample interval are configurable parameters.

The Power Output Configuration parameters provide the basic operation for each power output. These parameters are not associated to specific inputs. Parameters for SP 1 start at 43601 through 43603. Parameters for SP 2 start at 43621 through 43623. Each following switch power is offset from the previous one by 20 registers.

		4xxxx Registers	Parameters
Switch Power Output Parameters	SP1	3601–3603	36x1 Continuous Voltage Setting
	SP2	3621–3623	36x2 Default Output Voltage
	SP3	3641–3643	36x3 Hold Last Voltage Enable
	SP4	3661–3663	

36x1 Continuous Voltage Setting. Use this voltage parameter to set the output voltage when supplying continuous power through the SP# terminals (not associated with inputs). The Continuous Voltage parameter cannot be used if any input uses switch power. To set a continuous voltage on the SP output, also turn on the default output condition "default on power up." This will turn on this continuous voltage output when the radio powers up.

Output Voltage	Parameter Value	Output Voltage	Parameter Value
0V	255	15V	32
5V	204	20V	12
7V	125	24V	03
10V	69		

36x2 Default Output State. The Default Output State parameter represents the default condition of the switch power output. When communication is lost to the host or the wireless link is lost for the I/O data radio, the data radio can set the outputs and switch power outputs in this default state. When set to 0, the switch power is turned off. When set to 1, the switch power is set to the voltage established by the Continuous Voltage Setting.

36x3 Hold Last State Enable. Set Hold Last State Enable to 1 to set the switch power output to its last known value when communications are lost. Set this parameter to 0 to disable the Host Last State Enable and use the Default Output State settings.

43700s Discrete Output Parameters

The following characteristics are configurable for each of the discrete outputs. Parameters for Output 1 start at 43701 through 43703. Parameters for Output 2 start at 43721 through 43723. Each following input is offset from the previous one by 20 registers.

		4xxxx Registers	Parameters
Discrete Output Parameters	Output 1	3701–3703	3xx1 Default Output State
	Output 2	3721–3723	3xx2 Hold Last State Enable
	Output 3	3741–3743	3xx3 Enable Switch Power Logic
	Output 4	3761–3763	

3xx1 Default Output State. The Default Output State parameter represents the default condition of the discrete output. When an error condition exists, the outputs are set to this user-defined output state, either a 0 or a 1.

3xx2 Hold Last State Enable. Set the Hold Last State to 1 to set the output to its last known value before the error occurred. Set this parameter to 0 to disable the Hold Last State and use the Default Output State setting during an error condition.

3xx3 Enable Switch Power Logic.

44000s Analog Output Parameters

The following characteristics are configurable for each of the analog outputs. Parameters for Analog Output 1 start at 44001 through 44005. Parameters for Analog Output 2 start at 44021 through 44025. Each following input is offset from the previous one by 20 registers.

		4xxxx Registers	Parameters
Analog Output Parameters	Output 1	4001–4005	40x1 Maximum Analog Value
	Output 2	4021–4025	40x2 Minimum Analog Value
	Output 3	4041–4045	40x3 Enable Register Full Scale
	Output 4	4061–4065	40x4 Hold Last State Enable
			40x5 Default Output State

40x1 Maximum Analog Value. The Maximum Analog Value register stores the maximum allowed analog value. The specific units of measure apply to the register value. For example, the register may contain 20000, for 20 mA, or for a voltage output the register may contain 8000, for 8 volts.

40x2 Minimum Analog Value. The Minimum Analog Value register stores the minimum allowed analog value. The specific units of measure apply to register value. For example, the register may contain 4000, for 4 mA, or for a voltage output the register may contain 2000, for 2 volts.

40x3 Enable Register Full Scale. Set to 1 to enable a linear range from 0 to 65535 for specified input range. For a 4-20 mA output, a value of 0 represents 4 mA and 65535 represents 20 mA. Set this parameter to 0 to store readings in unit-specific data. For example, the register data representing a 15.53 mA reading is 15530. For units of current (0-20 mA outputs), values are stored as µA (micro Amps) and voltage values are stored as mV (millivolts).

40x4 Hold Last State Enable. Set the Hold Last State to 1 to set the output to its last known value before the error occurred. Set this parameter to 0 to disable the Hold Last State and use the Default Output State setting during an error condition.

40x5 Default Output State. The Default Output State parameter represents the default condition of the analog output. When an error condition exists, the outputs are set to this 16-bit user-defined output state.

44150s Initialization Controls

x4151 Reset Device. Write a 1 to this register to trigger a device reset of the parameters selected by the next three registers.

x4152 Default I/O Configuration. Returns all I/O configuration parameters to their factory default settings.

x4153 Default System Parameters. Returns all system-level parameters to their factory default settings.

x4154 Initialize Variables from the Serial Number. Returns all variables that are normally calculated (or seeded) from the serial number to values seeded from the serial number.

44400s Output Flash Pattern Parameters

Setting the flash pattern establishes an on and off pattern that can be used for a discrete output or switch power. Flash patterns are established by selecting specific timeslots to turn the output on or off. While originally the flash pattern was designed to turn on and off an indicator light, the flash pattern can be set for any discrete output or switch power.

Each slot represents one frame size, which may vary from radio to radio. The default frame is 40 milliseconds. Users may configure up to four different flash patterns.

4401-4408 Flash Pattern Index 1.

4401-4408 Flash Pattern Index 2.

4401-4408 Flash Pattern Index 3.

4401-4408 Flash Pattern Index 4.

44500s M-GAGE Parameters

The following characteristics are configurable for the M-GAGE devices.

x4501 Set Baseline. Write a 1 to this register to set the baseline. The baseline function of the M-GAGE Node stores the ambient magnetic field values of the X, Y, and Z axes as a baseline value. Once this baseline is established, any deviation in the magnetic field represents the presence of a ferrous object and will be reflected in the M-GAGE register. The more disruption in the magnetic field, the larger the M-GAGE register value.

x4502 Disable Axes. A bit-wise register (0000). Write a one to disable the selected axis where bit 0 is the x axis, bit 1 is the y axis, and bit 2 is the z axis.

x4503 Disable Compensation Median Filter. Write a 1 to this register to disable the compensation median filter.

x4504 Disable Sensing Median Filter. Write a 1 to this register to disable the sensing median filter.

x4505 Low Pass Filter. The filters T0 through T6 are parameter settings that define the degree of input digital signal filtering for analog inputs. T0 is the least amount of filtering. T6 is the highest filter setting and has the least amount of fluctuation between readings. Write the following values to select a low pass (tau) filter.

Low Pass (Tau) Filter	Register Value		Low Pass (Tau) Filter	Register Value
T0	0		T4	4
T1	1		T5	5
T2	2		T6	6
T3	3			

x4506 Sample High. The sample high counter parameter defines the number of consecutive samples the input signal must be above the threshold before a signal is considered active. The default value is 0, which disables this feature. The value range is 1 through 255. The Sample High parameter refers to the number of samples (1 through 255) a discrete input must be detected high (1) before it is considered to be a change of state.

x4507 Sample Low. The default value of 0 disables this feature. The value range is 1 through 255. The Sample Low parameter refers to the number of samples (1 through 255) a discrete input must be detected low (0) before it is considered to be a change of state.

x4508 Compensation Time. Temperature compensation parameter.

x4509 Delta. Rate of change filter.

x4510 Threshold and **x4511 Hysteresis**. Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for the M-GAGE™ input. The hysteresis value establishes how much below the active threshold (ON point) an analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range.

The M-GAGE Node's threshold and hysteresis ranges are 0 to 65,535.

The factory default threshold setting is 100 and default hysteresis is 30 (the sensor detects an OFF condition at threshold minus hysteresis, or 100 - 30 = 70). With the default settings, once the magnetic field reading is above 100, an ON or "1" is stored in the lowest significant bit (LSB) in the Modbus register. When the M-GAGE reading drops below the OFF point (threshold minus hysteresis), the LSB of the Modbus register is set to "0."

To determine your threshold, take M-GAGE readings of the test objects at the distance they are likely to be from the sensor. For example, if a car reads 100, a bicycle 15, and a truck reads 200, setting the threshold to 150 will detect only trucks of a specific size. Magnetic field fluctuations vary based on the amount of ferrous metal present and the distance from the sensor.

x4512 Baseline (Drift) Filter Time. Baseline filter time. When the Baseline Filter is on and the magnetic field readings are below the baseline filter threshold setting, an algorithm is used to slowly match the device's baseline to the current ambient magnetic field. This helps to account for the natural fluctuations in the magnetic field.

x4513 Baseline (Drift) Filter Threshold. Baseline filter threshold is used with the baseline filter time to account for the natural fluctuations on the magnetic field.

x4514 Baseline (Drift) Filter Tau. Baseline filter's low pass filter.

x4521 Baseline Difference Signal Value Total. A combination of the x-, y-, and z-axis baseline different signal values.

x4522 Baseline Difference Signal Value [x-axis]. The difference between the ambient magnetic field and the current magnetic field reading for the x axis.

x4523 Baseline Difference Signal Value [y-axis]. The difference between the ambient magnetic field and the current magnetic field reading for the y axis.

x4524 Baseline Difference Signal Value [z-axis]. The difference between the ambient magnetic field and the current magnetic field reading for the z axis.

x4525 Baseline Value [x-axis]. Ambient magnetic field reading for the x axis.

x4526 Baseline Value [y-axis]. Ambient magnetic field reading for the y axis.

x4527 Baseline Value [z-axis]. Ambient magnetic field reading for the z axis.

x4528 Raw Signal Value [x-axis]. The actual magnetic field reading for the x axis.

x4529 Raw Signal Value [y-axis]. The actual magnetic field reading for the y axis.

x4530 Raw Signal Value [z-axis]. The actual magnetic field reading for the z axis.

x4531 Sensing Numerator [x-axis].

x4532 Sensing Numerator [y-axis].

x4533 Sensing Numerator [z-axis].

x4534 Compensation Denominator [x-axis].

x4535 Compensation Denominator [y-axis].

x4536 Compensation Denominator [z-axis].

x4537 Compensation Numerator [x-axis].

x4538 Compensation Numerator [y-axis].

x4539 Compensation Numerator [z-axis].

51000s SDI-12 Parameter Descriptions

The following characteristics are configurable for the SDI-12 devices. Device A refers to the first SDI-12 device and device B refers to the second SDI-12 device. We are using A and B instead of numbers to avoid confusion with the actual assigned device IDs of the SDI-12 devices.

11001 SDI-12 Device Address for Device A. Assign the SDI-12 device address for the first SDI-12 device to register 11001.

11201 SDI-12 Device Address for Device B. Assign the SDI-12 device address for the second SDI-12 device to register 11201.

An SDI-12 Device Address may be an alphanumeric value of 0 through 9, 'a' through 'z,' or 'A' through 'Z.' For this reason, store its ASCII value in the Device Address register. For example, an SDI-12 address of 0 is stored as its ASCII value of 0x30.

Configuration Registers for SDI-12 Devices

There are nine registers for each SDI-12 device. The parameters are used to configure the properties of the information coming back from the SDI-12 device.

Parameter numbering for the first SDI-12 device (device A) begins at 11011, with each Modbus register number offset from the previous one by 20 Modbus registers. For example, the first parameter for the first SDI-12 register begins at Modbus register 11011. The first parameter for the second SDI-12 register begins at Modbus register 11021.

Parameter numbering for the second SDI-12 device (device B) begins at 11211. The registers for the second SDI-12 device are offset from the first device by 200.

	Configuration Registers for SDI-12 Device A				
	Register Enable	Decimal Point Move	Move Right or Left	Signed or Un-signed	16 or 32 bit
Register 1	11011	11012	11013	11014	11015
Register 2	11021	11022	11023	11024	11025
Register 3	11031	11032	11033	11034	11035
Register 4	11041	11042	11043	11044	11045
Register 5	11051	11052	11053	11054	11055
Register 6	11061	11062	11063	11064	11065
Register 7	11071	11072	11073	11074	11075
Register 8	11081	11082	11083	11084	11085
Register 9	11091	11092	11093	11094	11095

11xx1 Register Enable. Use this register or enable (1) or disable (0) each register.

11xx2 Decimal Point Move. Enter a value from 0 to 7 to indicate the number of places to move the decimal point to convert from the SDI-12 value to an integer.

11xx3 Move Right or Left. Write a 0 to move the decimal point to the right; write a 1 to move the decimal point to the left.

11xx4 Signed or Unsigned. Write a 1 for a signed value; write a 0 for an unsigned value.

11xx5 16-bit or 32-bit Registers. Write a 0 for a 16-bit value; write a 1 for a 32-bit value.

Configuration Examples

Configuring an Analog IN to use SP3

Example 1: Enable the first analog input to power an external sensor using switched power 3 and change the parameters based on the requirements of the external sensor.

This data radio model has analog 1 associated to input 5.

The parameters to adjust and their Modbus registers are:

- Sample interval (reg 1202 hi word, 1203 low word): Change from factory default of 1 second to 15 minute sample interval
- Switch Power Enable (reg 1204): Turn on switch power 3 for this input, using the bit mask
- Switch Power Warm-up (reg 1205): Based on the sensor requirements, turn on the switched power for a certain time before it is sampled.
- Switch Power Voltage (reg 1206): Set the voltage for the sensor operation.

The values to set in the registers are:

- Sample Interval: 15 min, (900 seconds)
- Switch Power Enable: 0x4
- Switched Power Warm-up: 1 second
- Switched Power Voltage: 15 Volts

Set the following registers to the values shown.

Modbus Register	Value	Description
1202	0	
1203	22,500	This register contains the number of 40 ms time units. 900 seconds ÷ 0.040 seconds = 22,500
1204	4	Enable switch power 3 for this input, see parameter description for bit mask.
1205	25	Set warm-up time to 1 second, the register contains the number of 40 ms time units. 1 seconds ÷ 0.040 seconds = 25
1206	32	Set switch power voltage to 15V. Value from table next to parameter description.

Configuring for Acclima SDI-12 Sensors

Use the following configuration for Acclima SDI-12 devices.

Use the following parameters for Acclima SDI-12 sensors.

SDI-12 Device Register (Acclima)		Register Enable (1)	Decimal Point Move (0-7)	Move Right (0) or Left (1)	Signed (1) or Unsigned (0)	16 bit (0) or 32 bit (1)
1	Volumetric water content	ON	2	Left	Unsigned	32 bit
2	Temperature	ON	1	Left	Signed	32 bit
3	Soil Permittivity	ON	2	Left	Unsigned	32 bit
4	Soil Conductivity	ON	2	Left	Unsigned	32 bit

Results Registers

Acclima Register No.		Results Registers (high:low)	Integer Conversion Multiplier	Sample Reading	Actual Value
1	Volumetric water content	11101:11102	×100	0:124	1.24%
2	Temperature	11103:11104	×10	0:238	23.8°C
3	Soil Permittivity	11105:11106	×100	0:402	4.02
4	Soil Conductivity	11107:11108	×100	0:123	1.23 dS/m

Configuring for Decagon 5T3 SDI-12 Sensors

Use the following configuration for Decagon 5T3 SDI-12 devices.

Use the following parameters for Decagon 5T3 SDI-12 sensors.

SDI-12 Device Register (Decagon 5T3)		Register Enable (1)	Decimal Point Move (0-7)	Move Right (0) or Left (1)	Signed (1) or Unsigned (0)	16 bit (0) or 32 bit (1)
1	Volumetric water content	ON	2	Left	Unsigned	32 bit
2	Soil Conductivity	ON	2	Left	Unsigned	32 bit
3	Temperature	ON	1	Left	Signed	32 bit

Results Registers

Decagon Register No.		Results Registers (high:low)	Integer Conversion Multiplier	Sample Reading	Actual Value
1	Volumetric water content	11101:11102	×100	0:124	1.24%
2	Soil Conductivity	11103:11104	×100	0:123	1.23 dS/m
3	Temperature	11105:11106	×10	0:238	23.8°C

Manufacturer Parameter Registers

The following are the device-specific and manufacturer parameters for the MultiHop radio devices. These registers are all within the 4xxxx range.

44100s Manufacturing Information

Address	Name	Format
4101–4104	Serial number, digits 1–8	ASCII, read only
4111–4113	Model number, digits 1–6	ASCII, read only
4121–4123	Production date, digits 1–6	ASCII, read only

44200s Device Name

Address	Name	Format
4201–4209	Name characters 1-18	ASCII

44300s Software Information

Address	Name	Format
4301–4303	RF firmware p/n	ASCII, read only
4304–4305	RF firmware version	ASCII, read only
4306–4308	RF EEPROM part number, digits 1–6	ASCII, read only
4309–4310	RF EEPROM version number, characters 1–3	ASCII, read only
4311–4313	LCD firmware p/n	ASCII, read only
4314–4315	LCD firmware version	ASCII, read only
4316–4318	LCD EEPROM part number, digits 1–6	ASCII, read only
4319–4320	LCD EEPROM version number, characters 1–3	ASCII, read only

46400s Message Parameters

Address	Name	Format
6401	Device address	Hex
6402	Parent address	Hex, read only

Strings stored in ASCII format are read as two characters per Modbus register. The lower numbered Modbus register contains the right-most characters in the string. Within a given Modbus register, the upper byte contains the ASCII character that goes to the right of the character in the lower byte.

Storing a Model Number

For example, the model number 148691 is stored as shown below.

Address (4xxxx)	Name	Modbus Register Value (in hex)	Character Representation
4111	Model number digits 6-5	0x3139	1 9
4112	Model number digits 4-3	0x3638	6 8
4113	Model number digits 2-1	0x3431	4 1

Parameters Stored as Numbers

Parameters stored as number values (not ASCII) read out directly as 16-bit values. Examples of parameters of this type include the Parent Address or Device Address.

Address (4xxxx)	Name	Value (in hex)	Value (decimal)
6401	Device address	0x002A	42
6402	Parent address	0x0023	35

Device and System Parameters

46000s Device Parameters

x6001 Is Master (Read Only). Typically configured from the DIP switches, writing a 1 to this register sets the radio to be the MultiHop master radio.

x6004 Is Repeater (Read Only). Typically configured from the DIP switches, writing a 1 to this register sets the radio to be the MultiHop repeater radio.

46050s Battery Monitoring Parameters

Use the battery monitor parameters to monitor and set a threshold based on the incoming device voltage (on some models). The incoming voltage is approximately 3.6V dc from a battery input or 4.2V dc from the 10 to 30V dc input. These parameters allow users to determine which power source is powering the MultiHop device.

6051 Enable Battery Read. Set to zero to disable the battery read function. Set to 1 to enable the battery read function.

6052 Battery Read Sample Interval. Use this parameter to set the time interval at which the incoming voltage is read. Sample Interval (in seconds) = 0.040 seconds × 2^RegValue. Default register value: 9 (20 seconds).

6053 Battery Voltage Threshold. Use this parameter to define the incoming voltage threshold at which register 4061 will be set to a zero or one. Set this value in number of 100mA increments. The default value is 38 (or 3.8V).

6054 Hardware Reference Select. Use this parameter to allow for the correct calibration reference for different hardware platforms. Set to zero for 3.0V PCB Vcc. Set to one for 3.3V PCB Vcc. Default value is zero.

6061 Battery Threshold Reading. When zero (0), the incoming voltage is below the threshold defined by parameter 6053 (powered by battery). When one (1), the incoming voltage reading is above the defined threshold (powered by a solar panel or 10 to 30V dc).

6062 Battery Voltage Reading. Actual incoming voltage reading in units of 100mV.

46360s Network System Binding

x6362- x6363 Binding Mode Extended Pattern: Master to Children. Seeded from serial number. 32-bit value.

x6364-x6365 Binding Mode Extended Pattern: Child from Master. Seeded from serial number. 32-bit value.

46400s Messages

x6401 Device Address (Read only). The Device Address is seeded from serial number.

x6402 Parent Address (Read only). Device address of the parent radio. Normally this is automatically filled in when the child chooses a parent radio.

x6403 Destination Address (Default). Broadcast. Typically, the Destination Address is set to force a routing when the radios are operating in transparent mode. This default value (FFFF) broadcasts the message if the recipient is not in the routing table. Enter a specific destination address to force a routing. Default: 0xFFFF

x6404 Destination Address (Current). The Destination Address is where messages are routed to. This value is automatically filled in by the system.

x6405 System Master Device Address. Stores the Device Address of the network's master radio.

x6451 External Site Survey Control. To begin a Site Survey from a host system, write a one (1) to the child radio's 46451 register. After 100 data packets have been send between the parent and child radios, the system automatically writes a zero (0) to this register to end the Site Survey.

x6452 Green Count. After the Site Survey is finished, the "green" signal strength count is written to this register on the child radio.

x6453 Yellow Count. After the Site Survey is finished, the "yellow" signal strength count is written to this register on the child radio.

x6454 Red Count. After the Site Survey is finished, the "red" signal strength count is written to this register on the child radio.

x6455 Miss Count. After the Site Survey is finished, the number of "missed" data packets is written to this register on the child radio.

46500s Application Modes

x6502 Modbus Offset (Start). The Modbus Slave ID to start at for numbering devices. By default, begin numbering at 11. Default: 0x0B

x6503 Modbus Number of Slaves. The maximum number of Modbus slaves. By default, the maximum number is 50, allowing slave IDs of 11 through 61 for network formation. Default: 0x32

x6504 Modbus Slave Destination Address Index 1, **x6505 Modbus Slave Destination Address Index 2,** through **x6553 Modbus Slave Destination Address Index 50**. These registers act as the translation table between the Modbus Slave ID (set by the rotary dials) and the Device Address (5-digit address derived from the serial number) of all Modbus slaves within the data radio network. This information is filled in by the system. For example, Address Index 1 will contain the device address of the first slave in the network. This is Slave ID 11 when using the default Modbus Offset.

x6801 Modbus Rotary Switch BCD Disable. Defaults to decimal coding on the rotary switches, which means only rotary dial positions 0 through 9 are recognized. Default 0x00

x6804 Modbus Address Override. Overrides the Modbus address specified on the rotary dials.

x6805 Enable Modbus Nack. Controlled by the master radio. The master radio can determine if a device is in the radio network. If a device has dropped out of the network, the master will NACK the packet of data destined for that device to avoid having the host system spend time waiting for an acknowledgement. Default: 0x00

x6808 Current Modbus Address. The Slave ID as selected by the rotary dials. This register is populated automatically by the rotary dials.

x6831 Input Push Register Index 1, x6832 Input Push Register Index 2, etc. A total of 20 push register indices are available (up through x6850). For a slave or repeater, these define which registers to push to the master device. This allows a slave/repeater to send local input data back to the master without having to wait to be asked for the data.

x6871-x6872 Push Register Report Interval. Establishes how often, in frames/slots, to push data to the master. Select values between 1 and 4.2×10^2 (1 to FFFFFFFF). x6871 is the high word, x6872 is the low word. This is typically a slave or repeater parameter.

x6873-x6874 Health Heartbeat Time. Sets how often, in frames, slaves/repeaters send a health message back to the master radio. For example, a value of 128 means to send health data back to the master once every 128 frames. x6873 is the high word, x6874 is the low word. The device status can be read beginning at register 52700, or the device status is read in a bit-packed format at register 52981.

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x6875 Report Interval Random Modulus. The interval, in frames, that the report interval is offset by. This randomizes the reporting interval time so that devices set to the same report interval do not continuously collide when reporting push data.

47000s Network Formation

Used by the Master radio only, the Network Formation parameter values are populated as slaves and repeaters join the radio network.

x7001 Number of Devices in the Formation table. How many devices are in the network.

x7002 Device Address Index 1. Device address for the first device that joins the network.

x7003 Device Address Index 2. Device address for the second device that joins the network. A total of 50 devices may be a part of the radio network.

x7302 Device MacTo Index 1. Device address for the first radio in the routing path to get to the device defined in index 1.

x7303 Device MacTo Index 2. Device address for the first radio in the routing path to get to the device defined in index 2. A total of 50 devices may be a part of the radio network.

47900s Master as a Slave Network Registers

The data stored in these registers act as a "window" into the push/poll registers. These registers "cache" the register values associated with register x6807. When enabling push registers, the host system redirects the register reads to this register area (7909, 7910). The host still requests a specific slave ID but with registers 7909 and 7910. The master data radio intercepts the read request and returns the cached data it collects from the push data.

x7901 Device Address. Device address

x7902 MacTo. Device address in the first step along the routing path to communicate with the device listed in register x7901.

x7904 Status. -

x7909 Push Register 0, x7910 Push Register 1, through **x7924 Push Register 16**. Contents of the push registers of the slave listed in register x7901.

3 Technical Notes

Network Information Registers

The Master device network table maintains three pieces of data for every device in the system: Device or MAC Address, Route MAC Address, and Route MACWhen. Repeater data radios contain this same network information about all child radios connected through it to the master device.

MAC Address. Unique identifier for a data radio. The MAC Address is the lower 16-bits of the serial number (also referred to as the Device Address).

Route MAC Address. Connection information; lists the MAC Address of the first hop for a routed message from the parent. When the Route MAC Address and the MAC Address are the same, that device is directly linked to the parent device for whom the formation table is formed. (See examples below).

Route MACWhen. Defines how often this parent can communicate to the child specified by the Route MAC Address entry.

- Route MACWhen = 128. Every timing slot is available to talk to a device (there are a total of 128 communication slots).
- Route MACWhen = 4. The device is available for 4 of 128 timing slots. This setting is typically used for battery-powered devices.
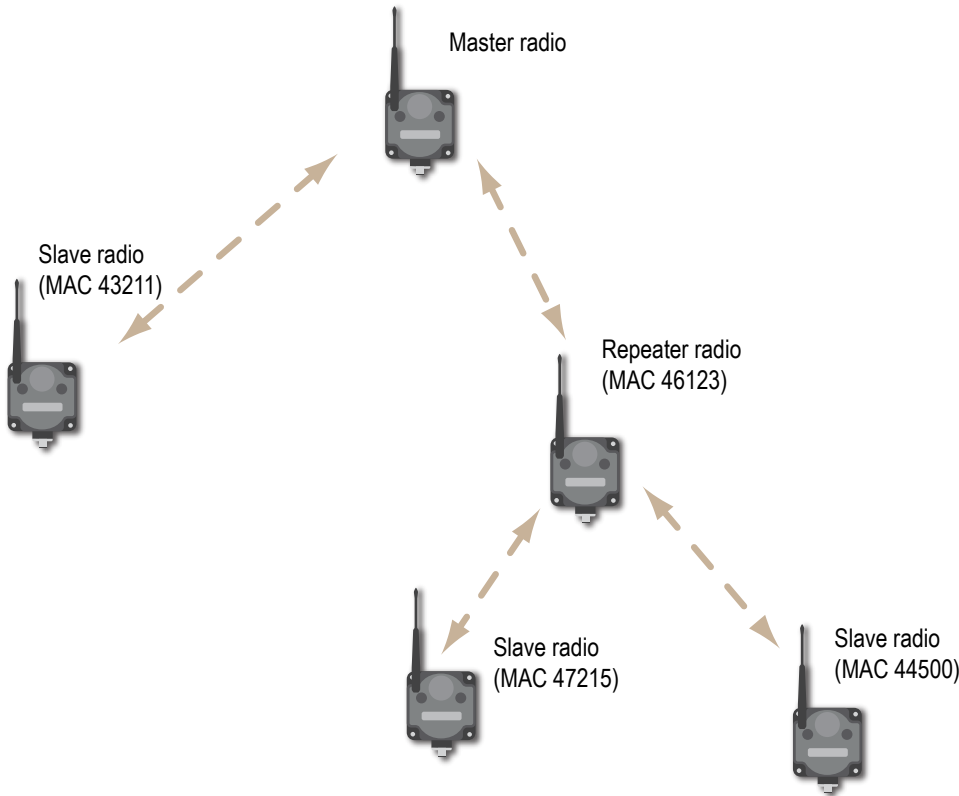
Network Formation Table for the Master

Index	MAC Address (7002-7051)	Route MAC Address (7302-7351)	Route MACWhen (7602-7651)
1	43211	43211	128
2	44500	46123	32

Index	MAC Address (7002-7051)	Route MAC Address (7302-7351)	Route MACWhen (7602-7651)
3	47215	46123	32
4	46123	46123	32

Network Formation Table for the Repeater (Address 46123)

Index	MAC Address (7002-7051)	Route MAC Address (7302-7351)	Route MACWhen (7602-7651)
1	47215	47215	4
2	44500	44500	4

Register 7001. Number of devices in the network formation table (MAC Address section)

Registers 7002–7051. Index 1 through index 50 for the MAC Address

Register 7301. Number of devices in the network formation table (Route MAC Address section)

Registers 7302–7351. Index 1 through index 50 for the device Route MAC Address

Register 7601. Number of devices in the network formation table (Route MACWhen section)

Registers 7602–7651. Index 1 through index 50 for the Route MACWhen

Register 6502. Modbus Offset. The starting Modbus Slave ID for the wireless system is defined in the master device at register 6502. Factory default is set to 11.

Registers 6504–6553. Modbus Slave ID to Device Address List. Register 6504 contains the MAC Address of the first wireless Modbus Slave ID. The first wireless Slave ID, factory default is 11, is defined by register 6502. If register 6504 contains the MAC Address of Modbus Slave 11, register 6505 contains the MAC Address of Modbus Slave 12, et cetera.

The example table below is shown with a starting Modbus Slave ID of 11.

Register	Slave ID	Device Address
6504	11	43987
6505	12	56109
6506	13	12354

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