MultiHop Register Parameters Guide (End Users)

rev. - 6/1/2012

155289

Contents

Input and Output Registers

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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
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40015	15	40515	15
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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.

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.

For more information about registers, refer to the MultiHop Product Manual, Banner part number 151317.

40000s Standard Physical Inputs

Registers 40001 through 40016 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

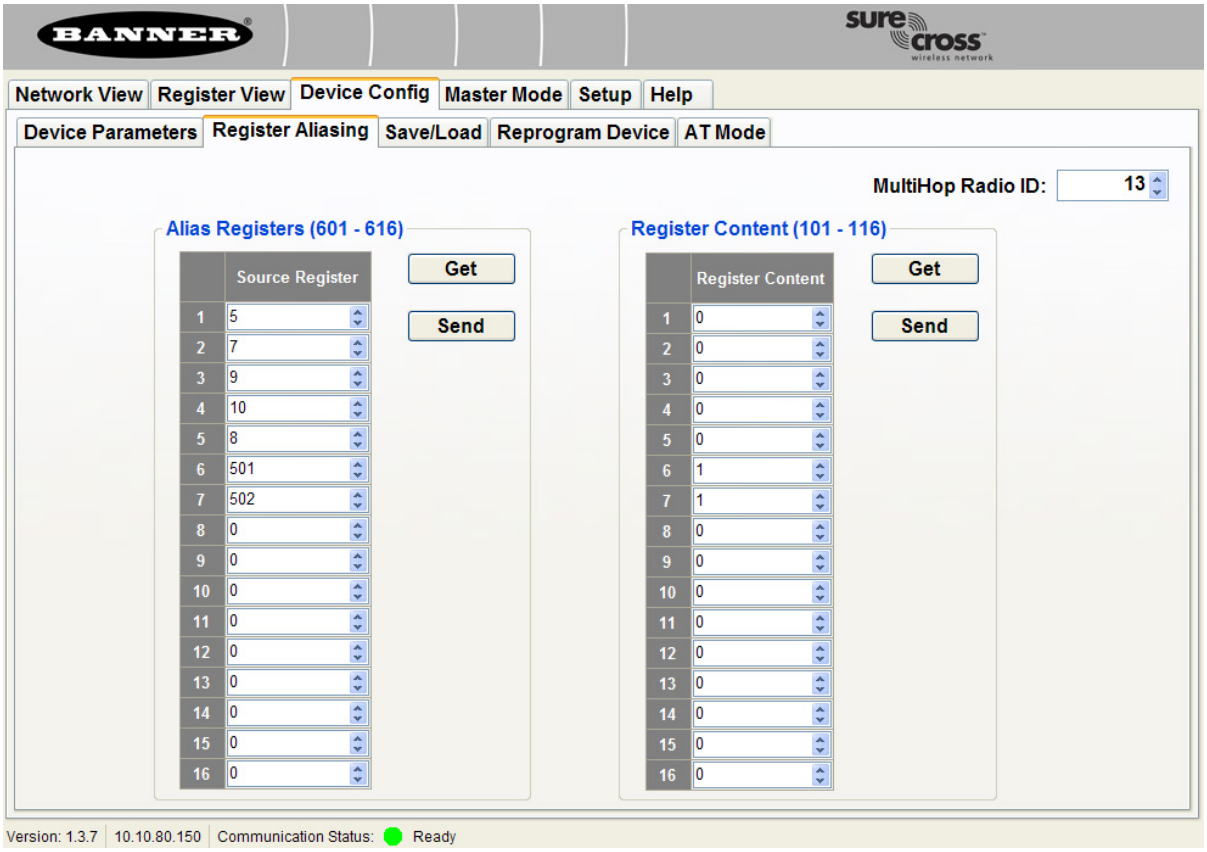
Use these remap registers to map any I/O registers to a contiguous location to allow for easier access from a host system.

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 Aliasing

Use the Register Aliasing screen to map registers to contiguous register locations to optimize Modbus read/write functions.



Before making any changes to the screen, select the desired MultiHop Radio ID.

Alias Registers

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

Register Contents

The aliased register contents 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 40501 through 40516 are the results registers for outputs 1 through 16.

For a list of the active results registers for your MultiHop 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.

Parameter Registers for Inputs									
1	2	3	4	5	6	7	8	9	Parameters
41001	41051	41101	41151	41201	41251	41301	41351	41401	Enable

Parameter Registers for Inputs									
1	2	3	4	5	6	7	8	9	Parameters
41002	41052	41102	41152	41202	41252	41302	41352	41402	Sample Interval (high word)
41003	41053	41103	41153	41203	41253	41303	41353	41403	Sample Interval (low word)
41008	41058	41108	41158	41208	41258	41308	41358	41408	Out-of-Sync Enable

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

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).

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.

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

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

Switch Power Input Parameters

The switch power input parameters 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. Switch power parameters for Input 1 are at 41004 through 41007. Switch power parameters for input 2 are at 41054 through 41057. Each following input is offset from the previous one by 50 registers.

Parameter Registers for Inputs									
1	2	3	4	5	6	7	8	9	Parameters
41004	41054	41104	41154	41204	41254	41304	41354	41404	Switch Power Enable
41005	41055	41105	41155	41205	41255	41305	41355	41405	Switch Power Warm-up
41006	41056	41106	41156	41206	41256	41306	41356	41406	Switch Power Voltage
41007	41057	41107	41157	41207	41257	41307	41357	41407	Extended Input Read

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.

Switch Power Enable. 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.

- 0x0 - No switch power enabled
- 0x1 - Enable SP1
- 0x2 - Enable SP2
- 0x3 - Enable SP1 and SP2
- 0x4 - Enable SP3
- 0x8 - Enable SP4
- 0xC - Enable SP3 and SP4

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

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.

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.

Parameter Registers for Outputs									
1	2	3	4	5	6	7	8	9	Parameters
42001	42051	42101	42151	42201	42251	42301	42351	42401	Enable
42002	42052	42102	42152	42202	42252	42302	42352	42402	Flash Output Enable
42003	42053	42103	42153	42203	42253	42303	42353	42403	Flash Index
42004	42054	42104	42154	42204	42254	42304	42354	42404	Out of Sync Enable

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

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.

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.

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.

42951 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.

42952 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.

42953 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.

42954 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.

Parameter Registers for Discrete Inputs				
IN 1	**IN 2**	**IN 3**	**IN 4**	**Parameters**
43001	43021	43041	43061	PNP/NPN
43002	43022	43042	43062	Sample High
43003	43023	43043	43063	Sample Low
43004	43024	43044	43064	Enable Latch on Change of State
43007	43027	43047	43067	Enable Discrete Input Time Active Counter
43008	43028	43048	43068	Discrete Input Time Active Count
43009	43029	43049	43069	Discrete Input Time Active Count

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.

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.

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.

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.

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.

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.

43300s Analog Input Parameters

The following characteristics are configurable for each of the analog inputs.

Analog input parameters for input 1 start at 43301. Analog input parameters for input 2 start at 43321. Each following input is offset from the previous one by 20 registers.

Registers for Analog Parameters				Parameters
IN 1 43301-43320	**IN 2 43321-43340**	**IN 3 43341-43360**	**IN 4 43361-43380**	
43301	43321	43341	43361	Maximum Analog Value
43302	43322	43342	43362	Minimum Analog Value
43303	43323	43343	43363	Enable Register Full Scale
43304	43324	43344	43364	Temperature Degrees C/F

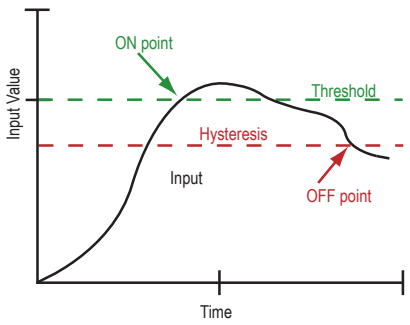
Registers for Analog Parameters				Parameters
IN 1 43301-43320	IN 2 43321-43340	IN 3 43341-43360	IN 4 43361-43380	
43305	43325	43345	43365	Temperature Scaling
43306	43326	43346	43366	Thermocouple Type
43307	43327	43347	43367	Temperature Resolution
43308	43328	43348	43368	Threshold
43309	43329	43349	43369	Hysteresis
43310	43330	43350	43370	Delta
43311	43331	43351	43371	
43312	43332	43352	43372	
43313	43333	43353	43373	
43314	43334	43354	43374	
43315	43335	43355	43375	
43316	43336	43356	43376	Sample High
43317	43337	43357	43377	Sample Low
43318	43338	43358	43379	Change of State Push Enable
43319	43339	43359	43379	Median Filter Enable
43320	43340	43360	43380	Tau Filter

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.

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

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).

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. Setting a threshold establishes an ON point. Hysteresis defines how far below the threshold the 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.

Maximum Analog Value. The Maximum 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.

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

Minimum Analog Value. The Minimum Value register stores the minimum allowed analog value. The specific units of measure apply to the 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.

Threshold. See **Hysteresis and Threshold**.

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 minus hysteresis before a signal is considered deactivated. The sample high and sample low parameters are used to avoid unwanted input transitions.

Tau Filter. Set to zero (0) to turn off the tau filter. Set to 1 (weakest filter) through 6 (strongest filter) to turn on the tau filter. (In the DX80 products, the Low Pass Filter is a combination of the median filter and the tau filter.)

Temperature Parameters

The following parameters are used to configure analog inputs involving temperature and are typically used to configure thermocouple or RTD inputs.

Registers for Analog Parameters				Parameters
IN 1 43301-43320	IN 2 43321-43340	IN 3 43341-43360	IN 4 43361-43380	
43304	43324	43344	43364	Temperature Degrees C/F
43305	43325	43345	43365	Temperature Scaling
43306	43326	43346	43366	Thermocouple Type
43307	43327	43347	43367	Temperature Resolution

Temperature Degrees C/F. Set to 1 to represent temperature units in degrees Fahrenheit, and set to 0 (default) to represent temperature units in degrees Celsius.

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.

Temperature Scaling. Set to 1 to store temperatures the same way as the DX80 devices (measured temp × 20) represent temperature. Set to 0 (default) 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.

Thermocouple Type. Write the listed value to this register to select a thermocouple type. The default configuration is set to a Type B thermocouple (0).

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

Value	Thermocouple Type	Value	Thermocouple Type	Value	Thermocouple Type
3	E	8	M	13	T
4	G	9	N	14	U

43500s Counter Input Parameters

The following parameters are 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.

Parameter Registers for Counter Inputs	
IN 1	**Parameters**
43501	Enable Frequency/Event Counter
43502	Enable Read Counter State
43503	Set Preset Value
43504	Counter Preset Value
43505	Counter Preset Value

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.

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.

Enable Read Counter State. Manufacturing/test register only

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.

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.

Parameter Registers for H-Bridge Outputs	
H-Bridge 1	**Parameters**
43604	Enable H-Bridge
43605	H-Bridge Warmup Cap Time
43606	H-Bridge Active Current Time
43607	H-Bridge Switches

Parameter Registers for H-Bridge Outputs	
H-Bridge 1	**Parameters**
43608	H-Bridge Switches
43609	H-Bridge Booster Enabled When Active

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

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

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
43607 Rising Switch (ON)	0	0	1	0	0	0	0	1
43608 Falling Switch (OFF)	0	0	0	1	0	0	1	0

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.

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

The Power Output Configuration parameters provide the basic operation for each power output. These parameters are not associated to specific inputs.

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 time denotes 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.

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.

Parameter Registers for Switch Power Outputs				
SP1	**SP2**	**SP3**	**SP4**	**Parameters**
43601	43621	43641	43661	Continuous Voltage Setting
43602	43622	43642	43662	Default Output Voltage
43603	43623	43643	43663	Hold Last Voltage Enable

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

Output Voltage	Parameter Value	Output Voltage	Parameter Value
7V	125	24V	03
10V	69		

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.

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.

Parameter Registers for Discrete Outputs				
OUT 1	**OUT 2**	**OUT 3**	**OUT 4**	**Parameters**
3701	3721	3741	3761	Default Output State
3702	3722	3742	3762	Hold Last State Enable
3703	3723	3743	3763	Enable Switch Power Logic

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.

Enable Switch Power Logic.

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.

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.

Parameter Registers for Analog Outputs				
OUT 1	**OUT 2**	**OUT 3**	**OUT 4**	**Parameters**
44001	44021	44041	44061	Maximum Analog Value
44002	44022	44042	44062	Minimum Analog Value
44003	44023	44043	44063	Enable Register Full Scale
44004	44024	44044	44064	Hold Last State Enable
44005	44025	44045	44065	Default Output State

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.

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).

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.

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.

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.

44150s Initialization Controls

44151 Reset Device. Write a 1 to this register to trigger a device reset of the parameters selected by the next three registers.

44152 Default I/O Configuration. Returns all I/O configuration parameters to their factory default settings.

44153 Default System Parameters. Returns all system-level parameters to their factory default settings.

44154 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.

44401-44408 Flash Pattern Index 1.

44401-44408 Flash Pattern Index 2.

44401-44408 Flash Pattern Index 3.

44401-44408 Flash Pattern Index 4.

44500s M-GAGE Parameters

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

44501 Set Baseline. Write a 1 to this register to set the baseline. The baseline function of the M-GAGE 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.

44502 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.

44503 Disable Compensation Median Filter. Write a 1 to this register to disable the compensation median filter.

44504 Disable Sensing Median Filter. Write a 1 to this register to disable the sensing median filter.

44505 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

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

44506 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.

44507 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.

44509 Delta. Rate of change filter.

44510 Threshold and **44511 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's threshold and hysteresis ranges are 0 to 65,535.

The factory default threshold setting is 150 and default hysteresis is 30 (the sensor detects an OFF condition at threshold minus hysteresis, or 150 - 30 = 120). With the default settings, once the magnetic field reading is above 150, 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 150, a bicycle 15, and a truck reads 250, setting the threshold to 200 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.

44512 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.

44513 Baseline (Drift) Filter Threshold. Baseline filter threshold is used with the baseline filter time to account for the natural fluctuations on the magnetic field.

44514 Baseline (Drift) Filter Tau. Baseline filter's low pass filter.

44521 Baseline Difference Signal Value Total. A combination of the x-, y-, and z-axis baseline different signal values.

44522 Baseline Difference Signal Value [x-axis]. The difference between the ambient magnetic field and the current magnetic field reading for the x axis.

44523 Baseline Difference Signal Value [y-axis]. The difference between the ambient magnetic field and the current magnetic field reading for the y axis.

44524 Baseline Difference Signal Value [z-axis]. The difference between the ambient magnetic field and the current magnetic field reading for the z axis.

44525 Baseline Value [x-axis]. Ambient magnetic field reading for the x axis.

44526 Baseline Value [y-axis]. Ambient magnetic field reading for the y axis.

44527 Baseline Value [z-axis]. Ambient magnetic field reading for the z axis.

44528 Raw Signal Value [x-axis]. The actual magnetic field reading for the x axis.

44529 Raw Signal Value [y-axis]. The actual magnetic field reading for the y axis.

44530 Raw Signal Value [z-axis]. The actual magnetic field reading for the z axis.

44800s Ultrasonic Input Parameters

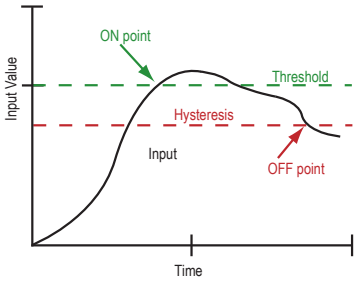
The following characteristics are configurable for the Ultrasonic input devices.

44810 Max Scale Value. The Maximum 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.

44811 Min Scale Value. The Minimum Value register stores the minimum allowed analog value. The specific units of measure apply to the 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.

44812 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).

44813 Threshold and **44814 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 a sensor input. Setting a threshold establishes an ON point. Hysteresis defines how far below the threshold the 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.

44815 Delta. The delta parameter defines the change required between sample points of an analog input before the analog input reports a new value. To turn off this option, set the Delta value to 0.

44816 Sample High and 44817 Sample Low. For discrete inputs, the sample high parameter defines the number of consecutive samples the input signal must be high before a signal is considered active. Sample low defines the number of consecutive samples the input signal must be low before a signal is considered low. The sample high and sample low parameters are used to create a filter to avoid unwanted input transitions. The default value is 0, which disables this feature. The value range is 1 through 255.

44818 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.

44819 Median Filter Enable. Set to zero (0) to turn off the median filter. Set to one (1) to turn on the median filter.

44820 Low Pass (Tau) Filter. Set to zero (0) to turn off the tau filter. Set to 1 (weakest filter) through 6 (strongest filter) to turn on the tau filter. (In the DX80 products, the Low Pass Filter is a combination of the median filter and the tau filter.) 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			

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.

51001 SDI-12 Device Address for Device A. Assign the SDI-12 device address for the first SDI-12 device to register 51001.

51201 SDI-12 Device Address for Device B. Assign the SDI-12 device address for the second SDI-12 device to register 51201.

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.

51002 SDI-12 Mode Select for Device A. By default, the code supports the M! command. Enter a one (1) to support the C! command.

51202 SDI-12 Mode Select for Device B. By default, the code supports the M! command. Enter a one (1) to support the C! command.

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 51011, 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 51011. The first parameter for the second SDI-12 register begins at Modbus register 51021.

Parameter numbering for the second SDI-12 device (device B) begins at 51211. 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	51011	51012	51013	51014	51015
Register 2	51021	51022	51023	51024	51025
Register 3	51031	51032	51033	51034	51035
Register 4	51041	51042	51043	51044	51045
Register 5	51051	51052	51053	51054	51055
Register 6	51061	51062	51063	51064	51065
Register 7	51071	51072	51073	51074	51075
Register 8	51081	51082	51083	51084	51085
Register 9	51091	51092	51093	51094	51095

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

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.

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.

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

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

Acclima Register No.		Results Registers (high:low)	Integer Conversion Multiplier	Sample Reading	Actual Value
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

46001 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.

46004 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.

46051 Enable Battery Read. Set to zero to disable the battery read function. Set to 1 to enable the battery read function.

46052 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).

46053 Battery Voltage Threshold. Use this parameter to define the incoming voltage threshold at which register 44061 will be set to a zero or one. Set this value in number of 100 mA increments. The default value is 38 (or 3.8V).

46054 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.

46061 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).

46062 Battery Voltage Reading. Actual incoming voltage reading in units of 100 mV.

46360s Network System Binding

46362- 46363 Binding Mode Extended Pattern: Master to Children. Seeded from serial number. 32-bit value.

46364-46365 Binding Mode Extended Pattern: Child from Master. Seeded from serial number. 32-bit value.

46400s Messages

46401 Device Address (Read only). The Device Address is seeded from serial number.

46402 Parent Address (Read only). Device address of the parent radio. Normally this is automatically filled in when the child chooses a parent radio.

46403 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

46404 Destination Address (Current). The Destination Address is where messages are routed to. This value is automatically filled in by the system.

46405 System Master Device Address. Stores the Device Address of the network's master radio.

46451 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.

46452 Green Count. After the Site Survey is finished, the "green" signal strength count is written to this register on the child radio.

46453 Yellow Count. After the Site Survey is finished, the "yellow" signal strength count is written to this register on the child radio.

46454 Red Count. After the Site Survey is finished, the "red" signal strength count is written to this register on the child radio.

46455 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

46502 Modbus Offset (Start). The Modbus Slave ID to start at for numbering devices. By default, begin numbering at 11.

46503 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.

46504 Modbus Slave Destination Address Index 1, **46505 Modbus Slave Destination Address Index 2,** through **46553 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.

46801 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 0

46804 Modbus Address Override. Overrides the Modbus address specified on the rotary dials.

46805 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: 0

46808 Current Modbus Address. The Slave ID as selected by the rotary dials. This register is populated automatically by the rotary dials.

46831 Input Push Register Index 1, 46832 Input Push Register Index 2, etc. A total of 20 push register indices are available (up through 46850). 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.

46871-46872 Push Register Report Interval. Establishes how often, in frames/slots, to push data to the master. Select values between 1 and 4.2 × 102 (1 to FFFFFFFF). 46871 is the high word, 46872 is the low word. This is typically a slave or repeater parameter.

46873-46874 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. 46873 is the high word, 46874 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.

46875 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.

47001 Number of Devices in the Formation table. How many devices are in the network.

47002 Device Address Index 1. Device address for the first device that joins the network.

47003 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.

47302 Device MacTo Index 1. Device address for the first radio in the routing path to get to the device defined in index 1.

47303 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 46807. When enabling push registers, the host system redirects the register reads to this register area (47909, 47910). The host still requests a specific slave ID but with registers 47909 and 47910. The master data radio intercepts the read request and returns the cached data it collects from the push data.

47901 Device Address. Device address

47902 MacTo. Device address in the first step along the routing path to communicate with the device listed in register 47901.

47904 Status. -

47909 Push Register 0, 47910 Push Register 1, through **47924 Push Register 16**. Contents of the push registers of the slave listed in register 47901.

Technical Notes

Network Information Registers

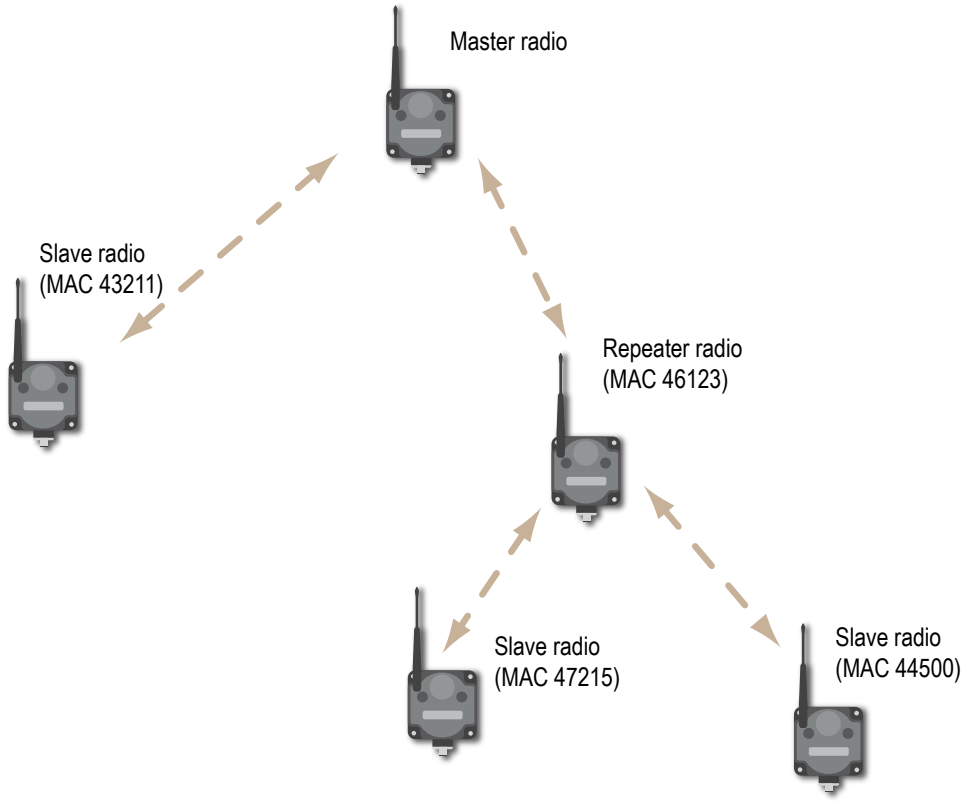
The Master device network table maintains three pieces of data for every device in the system: Device or MAC Address, Route MAC Address, and Route MACWhen. Repeater data radios contain this same network information about all child radios connected through it to the master device.

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

Index