

TechNote TN041

Ctek SkyRouter

Automation Programming Syntax

TN041



Ctek – Things That Move Data

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Programs

Programs are named groups of functions that can be applied to a specific input or output as the result of a threshold event on an input or output. For instance, a program called **Power Indicator OFF** could be used to turn on an indicator whenever charging power is removed from a battery powered system. The same program could also set the application status to yellow or 1 for display on SkyCloud. Programs are assigned names that are made available in the program pull-down field of the input and output edits screens. To create, modify, or delete a program select the Program option on the main menu screen.

Functions are predefined building blocks used to build user defined programs. Parameters or arguments to the functions **must be separated by a single space.**

Function List

- Digital I/O – Set
- Numeric I/O – Set
- Hex I/O – Set
- Hex I/O - Set Bits
- Hex I/O Clear Bits
- Numeric I/O – Add
- Numeric I/O – Subtract
- Numeric I/O – Multiply
- Numeric I/O – Divide
- Remote I/O - Set
- Remote Numeric I/O - Set
- Remote Hex I/O - Set
- Timer/Counter – Start
- Timer/Watchdog – Start
- Timer/Clock – Start
- Timer/Counter/Ext/Clk – Start
- Timer/Alarm Override - Start
- Timer/Any – Stop
- Motor Group Control
- Application Status – Set
- Input Threshold – Set
- Execute New Configuration
- Geo-Fence - Set

Function Descriptions

In the following descriptions, P1, P2, P3, etc. are used to indicate positional parameters or arguments that must be specified during programming. Parameters are always separated by a space.



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Digital I/O – Set

Digital I/O – Set P1 P2 P3 P4

P1 and P2 define the destination that is being set while P3 and P4 define the source. Use user defined value 1 to set a pin and user defined 0 to reset a pin.

P1 = i for input or o for output (must be digital)
P2 = pin number (must be digital)
P3 = i for input, o for output or u for user defined value
P4 = pin number or user defined value

Example: Setting digital output pin 6 to On (1)
Action = Digital I/O – Set
Parameters = o 6 u 1

Numeric I/O – Set

Numeric I/O – Set P1 P2 P3 P4

P1 and P2 define the destination that is being set while P3 and P4 define the source

P1 = i for input or o for output (Must be numeric)
P2 = pin number (Must be numeric)
P3 = i for input, o for output or u for user defined value
P4 = pin number or user defined value

Example: Setting numeric input pin 12 to the value of numeric output pin 9
Action: Numeric I/O – Set
Parameters: i 12 o 9

Hex I/O – Set

Hex I/O – Set places the absolute value specified in the source definition on the destination pin.

Hex I/O - Set P1 P2 P3 P4

P1 = I/O hex (destination)
P2 = pin number (destination)
P3 = I/O/U (source)
P4 = pin number or user defined value (source)

Hex I/O - Set Bits

Hex I/O – Set Bits performs a Boolean Or of the absolute value specified in the source definition with the destination pin.

Hex I/O - Set Bits P1 P2 P3 P4



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P1 = I/O hex (destination)
P2 = pin number (destination)
P3 = I/O/U (source)
P4 = pin number or user defined value (source)

Hex I/O Clear Bits

Hex I/O – Clear Bits performs a Boolean And of the 1's compliment of the absolute value specified in the source definition with the destination pin.

Hex I/O Clear Bits P1 P2 P3 P4

P1 = I/O hex (destination)
P2 = pin number (destination)
P3 = I/O/U (source)
P4 = pin number or user defined value (source)

Math functions

Numeric I/O – Add P1 P2 P3 P4
Numeric I/O – Subtract P1 P2 P3 P4
Numeric I/O – Multiply P1 P2 P3 P4
Numeric I/O – Divide P1 P2 P3 P4

P1 and P2 define the destination that is being set while P3 and P4 define the source

P1 = i for input or o for output (numeric)
P2 = pin number (numeric)
P3 = i for input, o for output or u for user defined value
P4 = pin number or user defined value

Example: Add 1200.77 to input pin 17 and place the result on output pin 17
Action: Numeric I/O – Add
Parameter: o 17 u 1200.77

Example: Multiple input pin 14 by input pin 15 and place the result on input pin 14
Action: Numeric I/O – Multiply
Parameter: i 14 i 15

Note on Remote Commands

Remote operations are those decisions and resulting actions that are distributed between two or more SkyRouters in different physical locations connected over the cellular network. All remote operations are a single function providing the ability to remotely set the values of remote virtual input pins and all types of output pins, both physical and virtual. This approach allows decisions to be made at the site where the actually machinery will be turned on and off and therefore provides a high degree of reliability.



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Remote I/O - Set (digital)

Remote I/O - Set P1 P2 P3 P4 P5 P6

P1, P2 and P3 define the remote destination that is being set while P4 and P5 define the local source

P1 = iP address of destination

P2 = i for input or o for output

P3 = pin number

P4 = i for input, o for output or u for user defined value

P5 = pin number or user defined value

P6 = net wait.

- a) If P6 = 1 causes the remote operation to wait for a certain period of time for the SkyRouter to get an IP address from the network.
- b) If P6 = 0, do not wait for network. Instead simply assume that the network is available and initiate the remote operation which will succeed if an address is available or fail if it is not.

Example: Set a input pin 24 of IP address 166.155.12.12 to 1 after waiting for the network to respond

Action: Remote I/O - Set

Parameters: 166.155.12.12 i 24 u 1 1

Example: Set output pin 18 at IP address 173.101.15.44 to the value of local input pin 4 without waiting for the network

Action: Remote I/O - Set

Parameters: 173.101.15.44 o 18 i 4 0

Remote Numeric I/O – Set

P1 = iP address of destination

P2 = i for input or o for output

P3 = pin number

P4 = i for input, o for output or u for user defined value

P5 = pin number or user defined value

P6 = net wait.

- a) If P6 = 1 causes the remote operation to wait for a certain period of time for the SkyRouter to get an IP address from the network.
- b) If P6 = 0, do not wait for network. Instead simply assume that the network is available and initiate the remote operation which will succeed if an address is available or fail if it is not.



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Remote Hex I/O – Set

P1 = iP address of destination

P2 = i for input or o for output

P3 = pin number

P4 = i for input, o for output or u for user defined value

P5 = pin number or user defined value

P6 = net wait.

- a) If P6 = 1 causes the remote operation to wait for a certain period of time for the SkyRouter to get an IP address from the network.
- b) If P6 = 0, do not wait for network. Instead simply assume that the network is available and initiate the remote operation which will succeed if an address is available or fail if it is not.

Note On Timer/Counter

Timer/Counter is a value incrementing or decrementing at one second intervals. It is housed on a numeric input or numeric output. If it is in an output it is non-volatile and if it is in an input it is volatile. If it is in an output, the output can still be connected to an input. In either case the thresholds of an input can then be used to make decisions based on the counter value or the value can just be used to accumulate things like engine hours.

Timer/Counter – Start

Timer/Counter – Start P1 P2 P3 P4 P5 P6 P7 P8 P9

P1 = i for input or o for output (numeric)

P2 = pin number. This is where the timer value lives (numeric)

P3 = counter type. 0 = count up from current value, 1 = count up from user/pin defined value, 2 = count down from current value, 3 = count down from user/pin defined value

P4 = i for input, o for output or u for user defined value

P5 = pin number or user defined starting value

P6 = limit type. 0 = no limit, 1 = stop at user defined limit, 2 = roll over to start value at user defined limit and continue counting

P7 = limit value for P5 mode 1 and 2 (numeric)

P8 = update value (float). How much to add or subtract at the end of each second.

P9 = write rate in 1 second increments. How often to write timer value to selected input or output pin (numeric)

Example – Create a counter on output pin 14 that counts up from 0 to infinity in seconds and updates the display every 15 seconds

Action: Timer/Counter – Start

Parameters: o 14 0 u 0 0 0 1 15



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Timer/Watchdog – Start

A watchdog timer is a value decrementing at a one second rate. The value is NOT directly housed in an input or output pin. When the value decrements to zero the defined digital output or input pin will turn on. If you keep setting the watchdog timer, it will never get to zero.

Timer/Watchdog – Start P1 P2 P3 P4 P5

P1 = i for input or o for output (digital)

P2 = pin number. This is the pin that will go high when the watchdog expires (digital)

P3 = i for input, o for output or u for user defined value

P4 = pin number or user defined starting value

P5 = update value (float). How much will be subtracted from the timer each second.

Example – Set output pin 4 when a 60 second timer reaches 0.

Action: Timer/Watchdog – Start

Parameters: o 4 u 60 1

Timer/Clock – Start

A clock is a square wave signal generated on an input or output. It can be continuous or of a pre-defined pulse length. The clock frequency is generated by a decrementing counter. Each time the counter decrements to zero, the defined digital input or output will toggle state.

Timer/Clock – Start P1 P2 P3 P4 P5 P6 P7

P1 = i for input or o for output (digital)

P2 = pin number. This is where the clock is generated (digital)

P3 = i for input, o for output or u for user defined value

P4 = pin number or user defined clock rate value

P5 = update rate (int) in 0.1 second increments. How often start value will be decremented.

P6 = update value (float). How much will be decremented from P4 for each update period.

P7 = stop value. Stop clock after this many pulses. If P6 is zero, clock is continuous.

Example – Clock output pin 1 at a rate of once every 1 second (1 seconds On followed by 1 seconds Off) for 400 iterations

Action: Timer/Clock – Start

Parameters: o 1 u 5 10 1 400



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Timer/Counter/Ext/Clk – Start

Note: The input value being counted in this function is coming from the Discrete or Relay input of the SkyRouter.

Timer/Counter/Ext/Clk is a value incrementing or decrementing at the rate of the Discrete Input (DI) pin on the SkyRouter, also known as the relay input. The Timer/Counter is assigned to a numeric input or numeric output. If it is in an output it is non-volatile and if it is in an input it is volatile. If it is in an output, the output can still be connected to an input. In either case the thresholds of an input can then be used to make decisions based on the counter value or the value can just be used to accumulate things like engine hours.

Timer/Counter/Ext/Clk - Start P1 P2 P3 P4 P5 P6 P7 P8 P9 P10

P1 = i for input or o for output (numeric)

P2 = pin number. This is where the timer value lives (numeric)

P3 = counter type. 0 = count up from current value, 1 = count up from user defined value, 2 = count down from current value, 3 = count down from user defined value

P4 = i for input, o for output or u for user defined value (counter types 1 & 3)

P5 = pin number or user defined starting value

P6 = limit type. 0 = no limit, 1 = stop at user defined limit, 2 = roll over to start value at user defined limit and continue counting

P7 = limit value for P5 mode 1 and 2 (float)

P8 = update value (float). How much to add or subtract at each input transition.

P9 = write rate in 1 second increments. How often to write timer value to selected input or output pin (int)

P10 = sample type. 0 = count negative going transitions. 1 = count positive going transitions.

Example – Count negative going transitions of the Discrete Input and place the count on output pin 17. The counter should count up from zero and has no limits. For each transition of the Discrete Input add 15 to the value of pin 17. Pin 17 will be updated every 30 seconds.

Action: Timer/Counter/Ext/Clk - Start

Parameters: o 17 1 u 0 0 0 15 30 0



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Timer/Alarm Override – Start

P1 P2 P3 P4

Timer/Alarm Override – Start provides a mechanism to override (disable) all alarms for a specified (in minutes) period of time. P1 and P2 define the pin that will represent the state of override, and P3 and P4 define the period of time for which alarms will be disabled.

As with all timers Timer/Alarm Override is stopped with Timer/Any - Stop

P1 = i for input or o for output (numeric)

P2 = pin number. This is where override condition is represented – Use this pin in Stop command

P3 = i for input, o for output or u for user defined value of override duration in minutes

P4 = pin number or user defined override duration value

Example: Disable alarms for the number of minutes specified by input pin 11 and show override status on output pin 18.

Action: Timer/Alarm Override – Start

Parameters: o 18 i 11

Timer/Any – Stop

This will stop any class of Timer shown above.

Timer/Any – Stop P1 P2

P1 = i for input or o for output

P2 = pin number

Example – Stop a time previously started on output pin 5

Action: Timer/Any – Stop

Parameters: o 5

Important Notes on Motor Group Control

- Parameters P3 (Outputs), P4 (Inputs), and P5 (Outputs) require sequential assignment starting at the pin specified for the number of elements in the sequence. For example, a controller having 3 pumps might assign output pin 12 to be the starting pin for the first motor. This would automatically require that output pins 13 and 14 be the starting pins for motors 2 and 3 respectively.
- All motor control outputs (defined by P3) must be configured so that their initial state is set to zero during automation control start up.
- All override pins (defined by P4) must be configured to execute `override_state_change` function when override pin turns on or off. This means that `override_state_change` must be defined as both the “Off Program” and “On Program” on all override pins.
- All hour timers (defined by P5) must be housed in outputs. The value of P5 will be interpreted as an output.



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Motor Group Control

Allows up to four motors to be controlled in a group where primary responsibility will alternate to ensure wear leveling. Hours of operation will be tracked in hours and tenths of hours.

Motor Group Control – P1 P2 P3 P4 P5

P1 = function:

start_primary 1
start_secondary 2
start_tertiary 3
start_quaternary 4
start_all 5
stop_primary 6
stop_secondary 7
stop_tertiary 8
stop_quaternary 9
stop_all 10
override_state_change 11

P2 = motor_count: how many motors in this group (1 - 4)

P3 = motor_start: Starting output pin for motors. Others will be assigned sequentially

P4 = override_start: Starting input pin for override control of motor. Others will be assigned sequentially.

P5 = hours_start: Starting output pin for hour meters. Others will be assigned sequentially.

Note: Override (P4) refers to a switch or signal to place the motor in service or take it out of service. When the motor is in service it operates automatically under the control of the Control_Motor_Group function. When it is out of service it is not available as a part of the group being controlled. A motor that is out of service can still be switched on and off manually but its state will be unknown to the Control_Motor_Group function.

Example – Starting the primary pump at a pump station with two pumps starting on output pin 2 that are managed by override switches starting at input 4 and whose hours are tracked on outputs starting at output 6.

Action: Motor Group Control

Parameters: 1 2 2 4 6

Example – Stopping all pumps at a pump station with two pumps starting on output pin 2 that are managed by override switches starting at input 4 and whose hours are tracked on outputs starting at output 6.

Action: Motor Group Control

Parameters: 10 2 2 4 6



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Application Status – Set

Application Status – Set provides a queuing and prioritization mechanism for Automation Control events/thresholds/states (Alarm States) that wish to change the application status color of the pin indicating the units position on the SkyCloud display. Between 1 and 10 different pins, each capable of changing the display to red, yellow, or green can be managed.

The prioritization mechanism insures that any red condition has the highest priority, followed by any yellow condition. The application status can only be green if no red or yellow inputs are being processed.

Important – The Application Status – Set mechanism requires that the number of events capable of producing an alarm state be defined. It also requires that each alarm event report its status once before the first application status change will be issued to SkyCloud. In terms of implementation, this means that each alarm event must have a corresponding alarm-clear event. The alarm-clear event should update *Application Status – Set* with a green status. Specifically, for a digital pin there needs to be a function with a program assigned to both the On and Off states of the pin, and for an analog/numeric pin there needs to be both an alarming threshold and a corresponding alarm clear threshold. In short, both an Alarm and an Alarm-Clear needs to be assigned to each pin that can generate an alarm.

Application Status – Set P1 P2 P3 P4

P1 = Alarm Point ID – A unique number between 1 and 10 that identifies an alarm point (pin) in an Automation Application. As an example a switch might be 1 and a temperature sensor might be 2.

P2 = Status – The value that this specific alarm point is setting. Valid values are:

- 0 – Green
- 1 – Yellow
- 2 – Red
- 3 – Force status updates. This function causes the values of all pins displayed on the SkyCloud icon to be updated.

P3 = Total number of alarm points - Defines the number (between 1 and 10) of all pins having programs assigned that are capable of issuing Alarm and Alarm-Clear updates.

P4 = ID – A single alpha-numeric character that is used by all alarm points in a single application. This parameter can have any value but must be the same for all alarm points.

Example: Set the application status of the SkyCloud pin representing your end point to red where there are 6 possible alarm points and you have assigned an ID of 3 to the specific alarm point that you are setting.

*Action: Application Status – Set
Parameters: 3 2 6 A*

Another Example: For the same application described in the previous example set alarm point ID 5 to Green.



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Action: Application Status – Set
Parameters: 5 0 6 A

NOTE – Force status update (P2 = 3) is a special case. It does not require a corresponding Alarm – Clear program and can use the P1, P3, and P4 values of any the application. For the two examples above a force status update could be issued using any of the examples below to achieve the same results.

Action: Application Status – Set
Parameters: 5 3 6 A

Or

Action: Application Status – Set
Parameters: 1 3 6 A

Or

Action: Application Status – Set
Parameters: 6 3 6 A

Input Threshold – Set

Input threshold set enables the user to change a defined threshold on an analog, pulse, or numeric pin under program control. An Execute New Configuration command **MUST** be issued after the threshold has been changed. Threshold changes are persistent, meaning that the changed value will be in effect until it is changed again.

Input Threshold – Set – P1 P2 P3 P4 P5

P1 – Input pin where threshold will be changed (must be analog, pulse, or numeric)

P2 – Threshold number (1 – 15) to be changed on the pin identified in P1

P3 - i for input, o for output or u for user defined value (of new threshold setting)

P4 – Pin number or user defined value of new threshold to be set

P5 – Threshold reset (hysteresis) band multiplier. The percentage of the new threshold that will be assigned to the offset between when the threshold triggers and when it resets so that it can trigger again. A value of 0.95 in this parameter would assign reset values of either 9.50 or 10.50 depending on the direction of the triggering event.

Example – Change a pressure threshold (threshold 4) on pin 12 to greater than 70 PSI with a 10% reset offset.

Action: Input Threshold – Set
Parameters – 12 4 u 70 0.90.

Execute New Configuration

Produces, under program control the exact same effect as the Execute New Configuration button on the GUI screen. Required after an Input Threshold – Set. This function does not require any parameters.



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Geo-Fence - Set

The Geo-Fence Set function enables or disables a pre-configured geo-fence on the unit. Geo-fences are configured on the SkyRouter's Location Source screen and may be either assigned to automation control for use with this function, or operated from the web interface.

Geo-Fence - Set P1 P2

P1 = fence select (1, 2)

P2 = disable, enable (0,1)