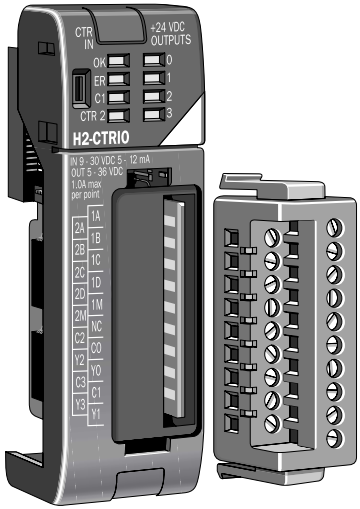
CTRIO
High-Speed Counter Module

Manual Number: H24-CTRIO-M



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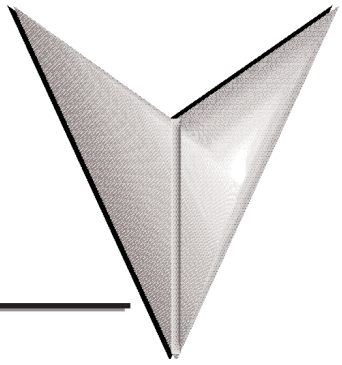
MANUAL REVISIONS



Please include the Manual Number and the Edition, both shown below, when communicating with us regarding this publication.

Title: CTRIO High-Speed Counter Module Installation and Operation
Manual Number: H24-CTRIO-M

Issue	Date	Description of Changes
1st Edition	***9/01***	Original issue
lst Ed., Rev. A	***l0/01***	Correct minor errors
lst Ed., Rev. B	***8/02***	Correct minor errors

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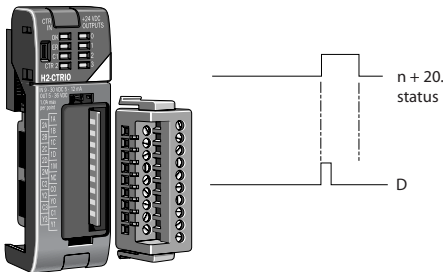
Introduction to the CTRIO Module

In This Chapter...

General Information about the CTRIO Module

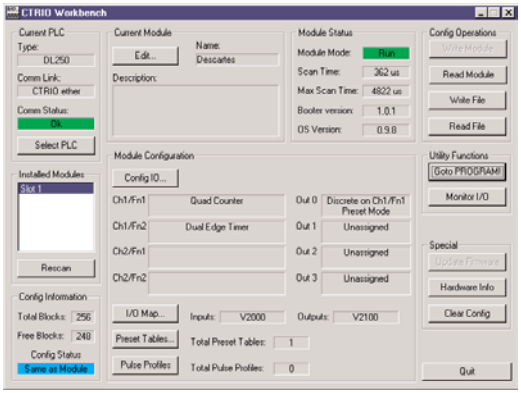
The Counter I/O (CTRIO) module is designed to accept high-speed pulse-type input signals and provide discrete or pulse outputs for monitoring, alarm, or control functions. The CTRIO module offers great flexibility for applications which call for precise counting or timing, based on input events.

The CTRIO module has its own microprocessor and operates asynchronously with respect to the CPU. The response time of on-board outputs is based on the module's scan time, not the CPU's scan time.



CTRIO Workbench

All scaling and configuration is done via a software utility, eliminating the need for ladder programming to set up the module. The software utility is called CTRIO Workbench. The use of CTRIO Workbench is explained in Chapter 3.



Supported CPUs

You can use the CTRIO module with conventional CPUs (D2-240 or D2-250), our Windows-based WinPLC CPU module, or PC-based control strategies using the H2-EBC interface module.

The CTRIO module plugs into any I/O slot of any DirectLogic 205 base except slot 0 (slot 0 is available for the CTRIO module when using the WinPLC CPU). Slot 0 is the I/O slot adjacent to the CPU. Multiple CTRIO modules can reside in the same base provided that the power supply is adequate. CTRIO modules may be placed in secondary local bases connected via ERM-to-EBC.

The CTRIO module is designed to work with incremental encoders or other field devices that generate pulses or edges.

Typical Counter Applications:

- cut to length
- piece counting
- positioning (e.g. flying punch)
- PLS - programmable limit switch replacement (e.g. gluing application)
- stepper motor drive control
- valve control
- rate monitoring for speed and/or flow

Specifications

General	
Module Type	Intelligent
Modules Per Base	Limited only by power consumption
I/O Points Used	None, I/O map directly in PLC V-memory or PC control access
Field Wiring Connector	Standard removable terminal block
Internal Power Consumption	400mA Max at +5V from 205 Base Power Supply Maximum of 6 Watts (All I/O in ON State at Max Voltage/Current)
Operating Environment	32°F to 140°F (0°C to 60°C), Humidity (non-condensing) 5% to 95%
Manufacturer	Host Automation Products, LLC
Isolation	2500V I/O to Logic, 1000V among Input Channels and All Outputs

Inputs	
Primary Inputs	4 pts sink/source 100K Hz Max
Secondary Inputs	4 pts, high speed, for Reset, Inhibit, or Capture
Minimum Pulse Width	5 µsec
Input Voltage Range	9-30VDC
Maximum Voltage	30VDC
Input Voltage Protection	Zener Clamped at 33VDC
Rated Input Current	8mA typical 12mA maximum
Minimum ON Voltage	9.0VDC
Maximum OFF Voltage	2.0VDC
Minimum ON Current	5.0mA (9VDC required to guarantee ON state)
Maximum OFF Current	2.0mA
OFF to ON Response	Less than 3 µsec
ON to OFF Response	Less than 3 µsec

Specifications (cont'd)

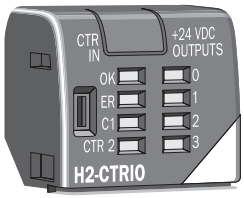
CTRIO Output Specifications	
Outputs	4 pts, independently isolated, current sourcing or sinking (open collector)
Pulse output control	2 channels, 20Hz - 25kHz (per channel), pulse and direction or cw/ccw pulses
Voltage range	5VDC - 36VDC
Maximum voltage	36VDC
Output clamp voltage	60VDC
Maximum load current	1.0A
Maximum load voltage	36VDC
Maximum leakage current	100µA
Inrush current	5A for 20ms
OFF to ON response	less than 3µsec
ON to OFF response	less than 3µsec
ON state V drop	≤ 0.3V
External power supply	for loop power only, not required for internal module function*
Overcurrent protection	15A max
Thermal shutdown	Tjunction = 150°C
Overtemperature reset	Tjunction = 130°C
Target position range	- 2.1 billion to + 2.1 billion (31 bits + sign bit)
Duty cycle range	1% to 99% in 1% increments (default = 50%)
Configurable Presets ***a) single*** ***b)mulitple***	a) each output can be assigned one preset, or b) each output can be assigned one table of presets, one table can contain max. 128 presets, max. predefined tables = 255

*** User supplied power source required for stepper drive configurations**

Specifications (cont'd)

Resources	
Counter/Timer	Four (2 per 4 input channel group)
Resource Options	1X, 2X, or 4X Quadrature, Up or Down Counter, Edge Timer, Dual Edge Timer, Input Pulse Catch
Timer Resolution	1 µsec
Counter Range	±2.1 billion (32 bit + sign bit)

LED Descriptions			
OK	Module OK	**0**	Out 0
ER	User Program Error	**1**	Out 1
1A (C1 on older modules)	Ch 1 A Status / Pulses	**2**	Out 2
2A (CTR2 on older modules)	Ch 2 A Status / Pulses	**3**	Out 3



LED Definitions		
OK	**ER**	**Description**
ON	OFF	All is well - RUN Mode
ON	ON	205 Base Power Fault
Blinking	Blinking	Boot Mode - Used for Field OS Upgrades
Blinking	OFF	Program Mode
OFF	Blinking	Module Self-diagnostic Failure
OFF	ON	Module Error Due to Watchdog Timeout
OFF	OFF	No Power to Module
1 A or 2A (C1 or CTR2 on older modules)		**Based on Configuration of Input A**
Blinking 7 times per second		A is Configured as Counter and is Changing
Following State of Input		A is not Configured as Counter
Output LEDs 0 - 3 Follow Actual Output State		

Installation and Field Wiring

In This Chapter...

How to Install the CTRIO Module

The CTRIO module installs into any DL205 base, and it is compatible with several DL205 CPU-slot devices. Consideration must be given to the firmware versions of the CPU-slot devices to assure their compatibility (see chart below).

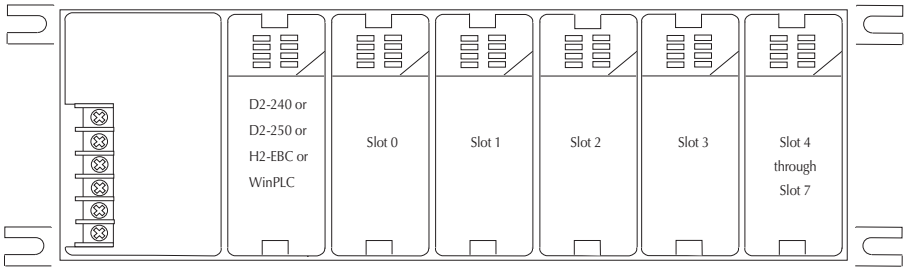
DirectSOFT32 version 3.0C, Build 71 (or later) is required for use with the CTRIO module if the D2-240 or D2-250 CPUs are to be used.

The first time you power-up the CTRIO module, you should see the OK LED blinking. The blinking LED indicates that the module is in program mode.

CPU and CTRIO Compatibility Chart

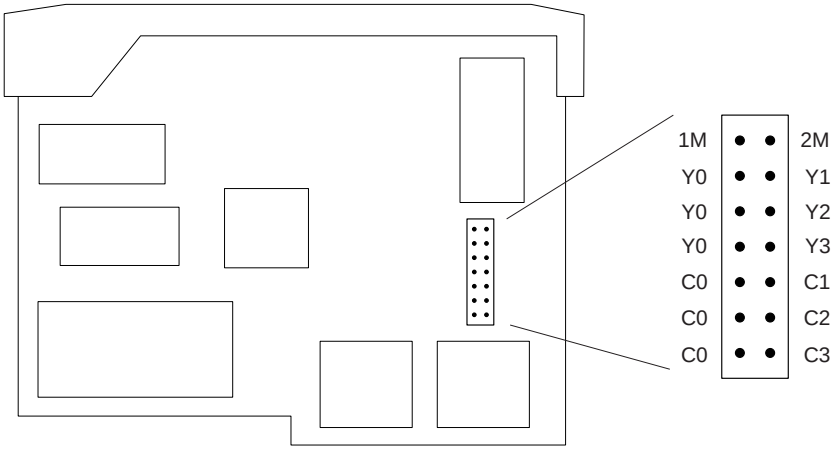
CPU-slot Device	*Firmware*	*Slot Restrictions*	*Max. per Base*
D2-240	v. 3.22 or later	any I/O slot except 0	6 CTRIO modules in 9-slot bases, 3 modules in smaller bases*
D2-250	v. 1.56 or later	any I/O slot except 0	6 CTRIO modules in 9-slot bases, 3 modules in smaller bases
H2-WinPLC	-	any I/O slot	6 CTRIO modules in 9-slot bases, 3 modules in smaller bases
H2-EBC	v. 2.1.357 or later	any I/O slot except 0	6 CTRIO modules in 9-slot bases, 3 modules in smaller bases

*** for applications requiring multiple CTRIO modules, DirectLOGIC CPUs, and dynamic access (in ladder logic) to CTRIO data, we recommend using the D2-250 CPU.**



Jumpers

Jumpers are provided to connect input commons or outputs/output commons. Use of these jumpers is not necessary to set up the CTRIO module. The jumpers are provided solely for convenience in wiring.

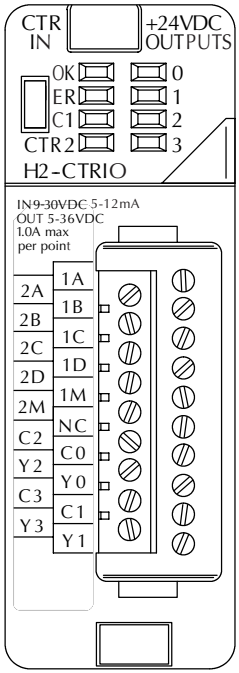


Jumper Settings	
1M to 2M	Share supply voltage between Ch 1 & Ch2
Y0 to Y1, Y2, Y3	Share commons between high or low side of outputs when isolation is not required
C0 to C1, C2, C3	

Wiring the CTRIO Module

The CTRIO module is a two channel device. Each channel accepts four optically isolated input signals which share the same common. Input circuits can be wired with either polarity without changing the module configuration. Channel 1 inputs can have the opposite polarity from channel 2 inputs.

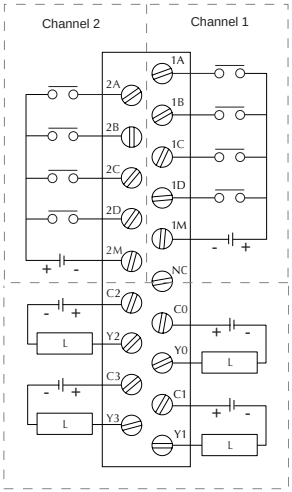
The module is configured, using CTRIO Workbench, to accommodate the user's application. The function of each input is defined in the configuration of the module (counting, timing, reset, etc.). Refer to Chapter 3, to determine what input configurations are possible.



Field device wiring must be compatible with the module configuration.

Each output circuit is optically isolated from the other outputs. Output commons are independent but can be tied together using internal jumpers. All four discrete outputs are available to be energized in response to any of the inputs.

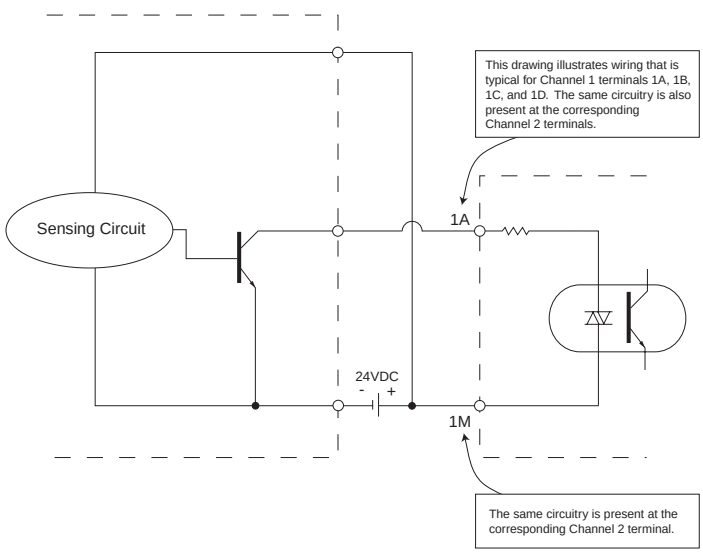
See the notes below for further details about power source considerations, circuit polarities, and field devices. Also, refer to the specifications on pages 1-2 and 1-3 for more information.



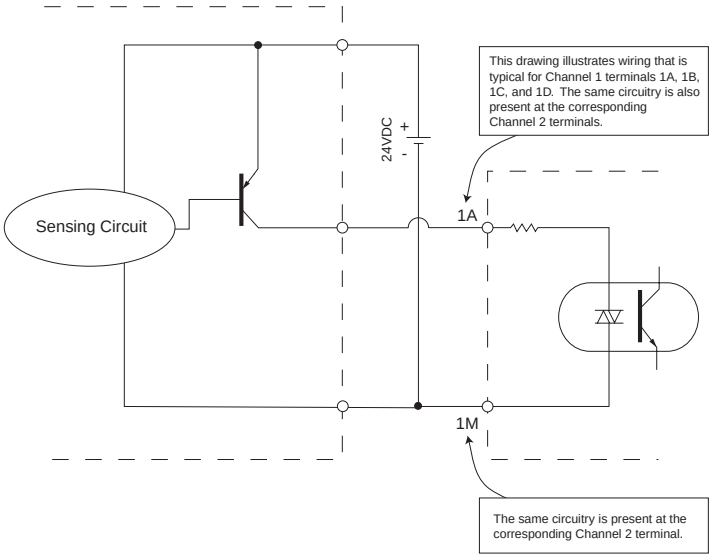
Notes:

1. **Inputs (1A, 1B, 1C, 1D and 2A, 2B, 2C, 2D) require user-provided 9-30VDC power sources. Terminals 1M and 2M are the commons for Channel 1 and Channel 2 inputs. Maximum current consumption is 12mA per input point.**
2. **Polarity of the input power sources (shown above) can be reversed. Consideration must be given, however, to the polarity of the field device. Many field devices are designed for only one polarity and can be damaged if power wiring is reversed.**
3. **Outputs have one polarity only (as shown above) and are powered by user-provided 5-36VDC power sources. The maximum allowable current per output circuit is 1A.**

NPN Field Device

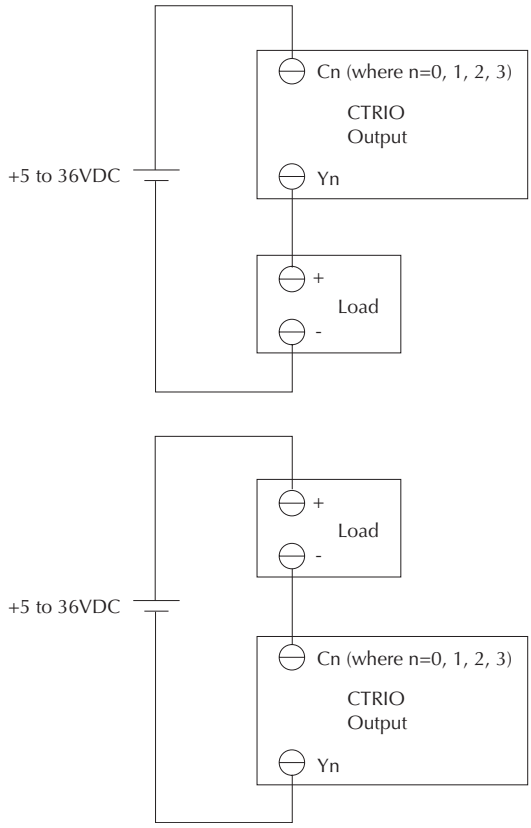


PNP Field Device

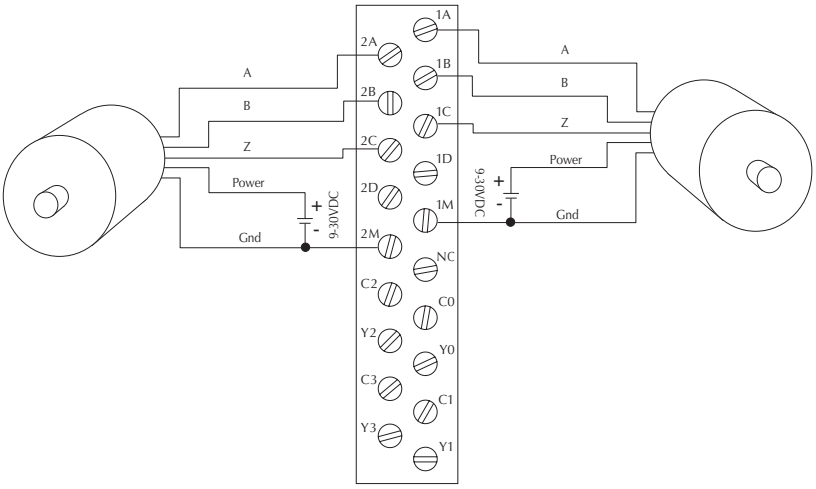


Output Schematic

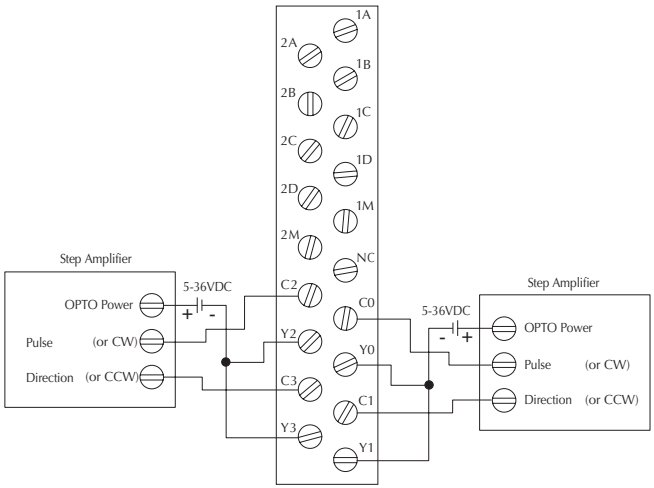
The CTRIO outputs are individually isolated DC switches that can be used to break the high or the low side of a DC load.



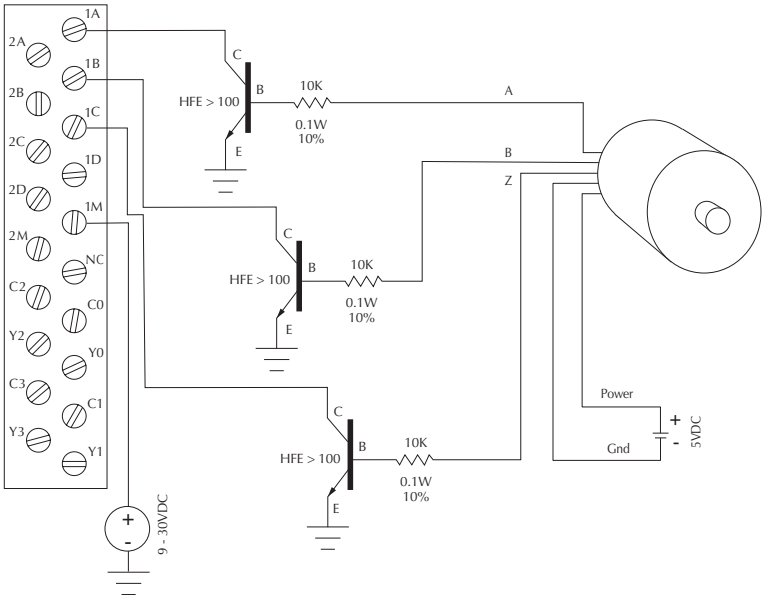
Quadrature Encoder Wiring Example



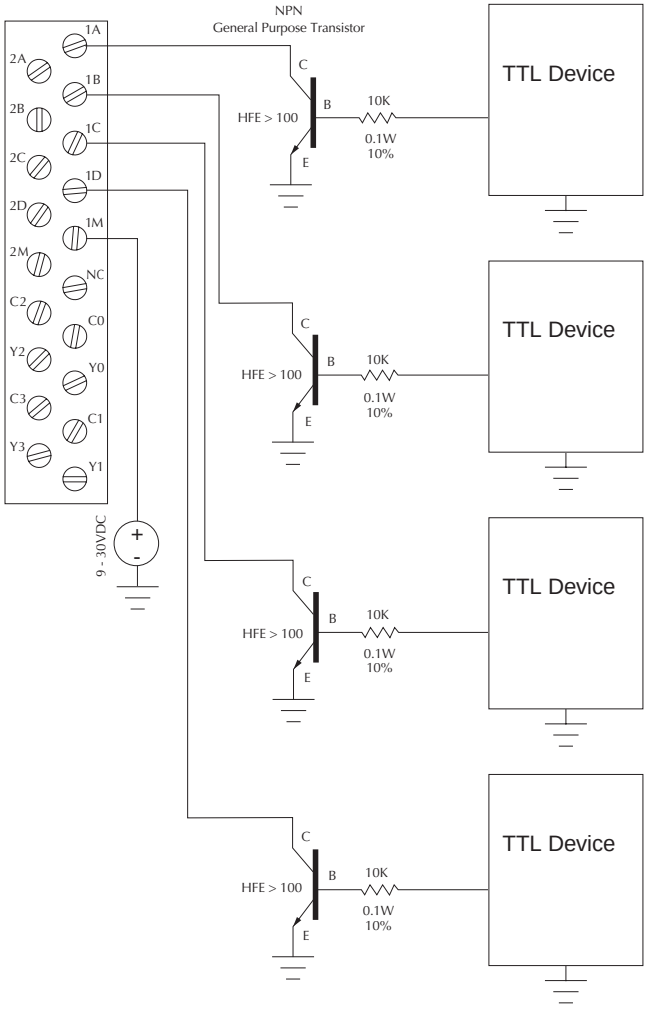
Stepper Drive Wiring Example



TTL Quadrature Encoder Field Wiring



TTL Input Wiring



CTRIO Workbench

In This Chapter...

What is CTRIO Workbench?

CTRIO Workbench is the software utility you will use to configure the CTRIO module and to scale signals to desired engineering units. Workbench also allows you to perform various other functions, such as switching between the CTRIO's Program mode and Run mode, monitoring I/O status and functions, and diagnostic control of module functions.

The CTRIO Workbench utility ships with the CTRIO User Manual. You can also download the latest version free at the Host Engineering Web site: ***www.hosteng.com****.*

Installing CTRIO Workbench

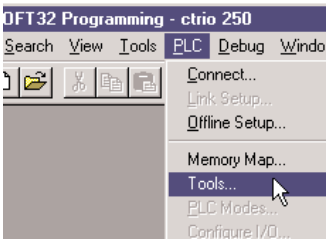
The CTRIO Workbench utility installs directly from its executable file. Double click on the Setup.exe icon. The install shield will step you through the installation process.

Two versions of CTRIO Workbench are loaded on your PC during the installation. One is for DirectSOFT32 users. It runs from within DirectSOFT32. CTRIO Workbench requires DirectSoft32, Rel. 3.0C, Build 71 (or later).

The other version is for H2-WPLC and H2-EBC users. This version is started directly from the "exe" file. For further information, see your WinPLC's software documentation.

Getting Started with CTRIO Workbench

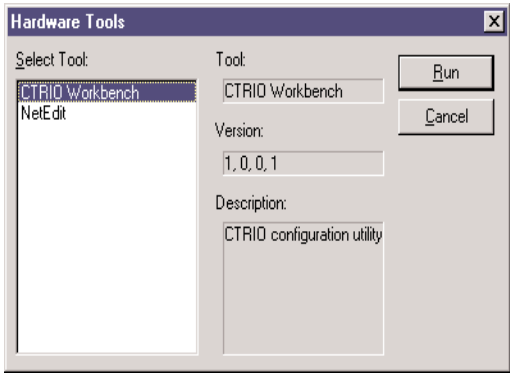
To run CTRIO Workbench, an H2-CTRIO module must be installed in the base, and the base must be powered up. You will need to connect to a port on the DirectLOGIC CPU, D2-DCM, H2-ECOM, H2-EBC, or H2-WPLC. Your PC communicates with the CTRIO module through the CPU-slot device port or through a port on a DCM or ECOM module.



Several paths are available to start CTRIO Workbench. DirectSOFT32 users will find CTRIO Workbench under PLC (menu)/Tools/CTRIO Workbench.

DirectSOFT32 users will also find access to CTRIO Workbench in the DirectSOFT32 Launch Window. Double click the Workbench icon as you would do to open a project.

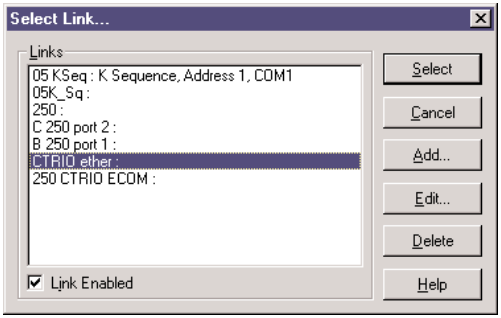
All users will find CTRIO Workbench at Start/Programs/AutomationDirect Tools/CTRIO Workbench.



Linking to CTRIO Module in

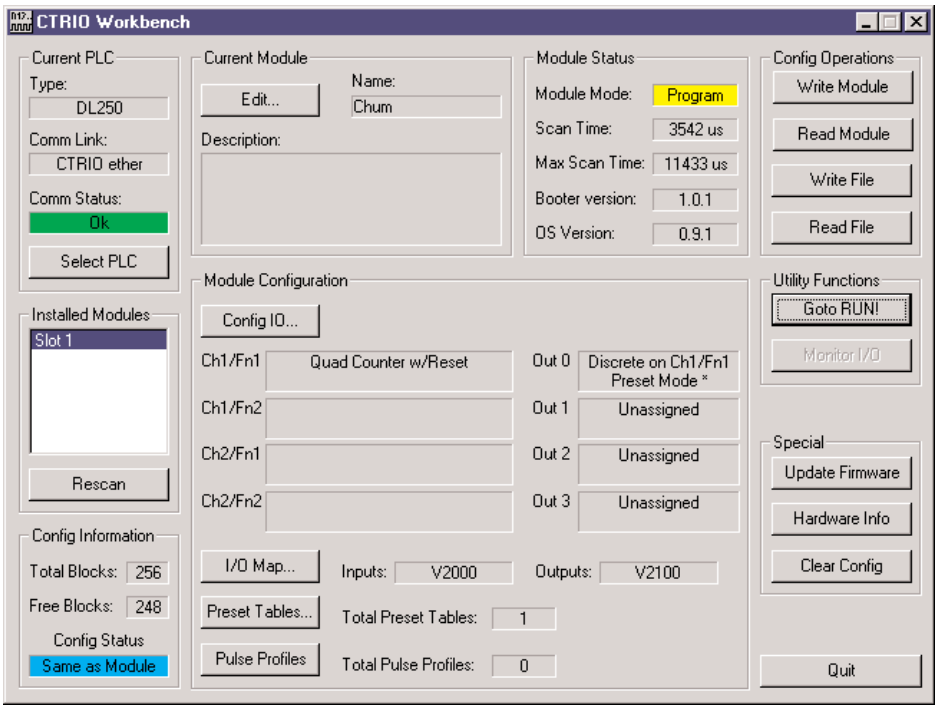
DirectSOFT32

If you are linked to your CPU through DirectSOFT32, CTRIO Workbench will start via the existing link. If you are "disconnected" from your PLC and start CTRIO Workbench, you will be prompted to establish a link to your CTRIO module.



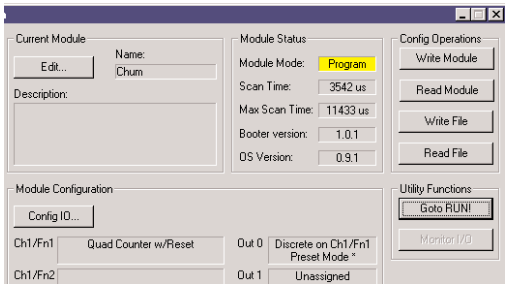
Successful Connection

Once you are connected to your PLC (or PLC network) and you select the desired CPU (Link), you will enter the main window of CTRIO Workbench. Here, you select the CTRIO module you wish to configure by clicking on its slot number in the "Installed Modules" box. If the steps mentioned above are all accomplished successfully, you will be able to enter Workbench's configuration and monitoring dialogs, and you will be able to toggle the CTRIO module between Program Mode and Run Mode.

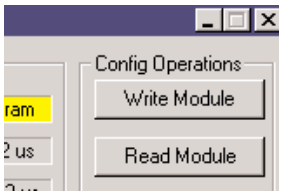


Choose "Program Mode" to Configure the CTRIO Module

On the CTRIO Workbench main window, a single button toggles between Run Mode and Program Mode. The Module Mode indicator will tell you which mode your module is in. You can configure the module "offline" in either Run Mode or Program Mode, but to save your configuration to the module, you must click "Write Module" which is only active in Program Mode.



Clicking on the Config I/O button, causes the Configure I/O window to appear. From the Configure I/O window, you can select the primary input functions your application requires and assign those functions to appropriate terminals.



You can also select subordinate functions on the Configure IO dialog. Primary and subordinate functions are explained in more detail under the heading "Supported Functions."

After the configuration is created in CTRIO Workbench, it must be "written" to the CTRIO module. This is accomplished by returning to the main CTRIO Workbench window and clicking on "Write Module."

Entering program mode takes the CTRIO module offline. Input pulses are not read or processed in Program mode, and all outputs are disabled. DirectLOGIC CPUs will hold last value in V-memory while the CTRIO is in Program Mode.

Choose "Run Mode" to Start Processing Pulses with the CTRIO

Selecting Run Mode causes the CTRIO module to begin processing pulses based on the configuration you created.

In Run mode the CTRIO Workbench utility also allows you to monitor and verify the proper operation of inputs and outputs. You can see the count change, reset, etc. The Monitor feature is particularly useful during debugging and commissioning of a new system. This feature allows you to verify that wiring and configuration were performed correctly.

If you are using a DirectLOGIC CPU, the CTRIO mode follows the CPU mode. If the CPU is placed in Run Mode, the CTRIO module will also enter Run Mode. If the CPU is placed in STOP or PROGRAM Mode, the CTRIO will enter Program Mode. The CTRIO also responds to mode changes made in Workbench and can be placed in Run Mode while the CPU is in Stop or Program Mode. The CTRIO module responds to the most recent change whether performed in Workbench or from the CPU.

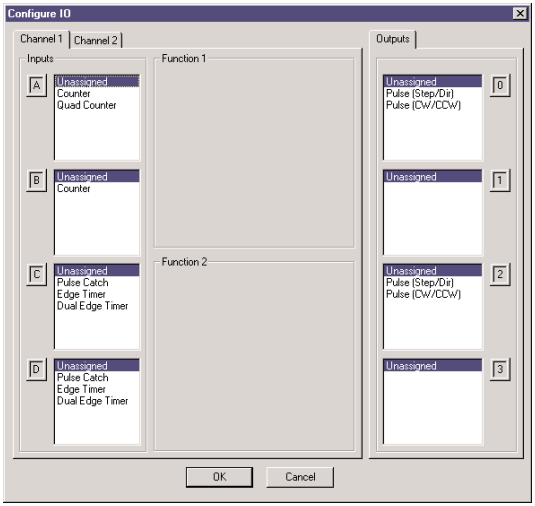
The CTRIO module will not enter Run Mode if it does not have a valid configuration stored.

Using the Configure IO Dialog

The Configure IO dialog is the location where input and output functions are assigned to the module. The choice of input and output functions determines which options are available.

The input function boxes prompt you with selections for supported functions. The Workbench software disallows any unsupported configurations.

From the main CTRIO Workbench window, click on the "Go to PROGRAM Mode" button. Then, click on the "Config I/O" button to arrive at the dialog below. Notice that the window has a tab for each Channel. Channel 1 and Channel 2 offer the same configuration options.



A maximum of one quadrature input or two single-ended encoder inputs is possible for each channel.

The input options are listed by function. Four boxes labeled A, B, C, and D correspond to the input terminals on the face of the module.

Select the desired input function by clicking on the input type and then clicking OK.

For example, you might click on "Counter" in the "A" box, then OK to return to the main Workbench window. Once you arrive back at the main window, you must click "Write Module" to save your selection to the module. The module will need to be in Program Mode to perform the Write Module operation. If you do not perform the Write Module operation (or a Write File operation) your configuration will be lost upon quitting Workbench. This applies to all changes to the module configuration.

In the lower left corner of the main Workbench dialog, is the Config Status indicator. If the current configuration is different from the CTRIO and different from any saved files, the indicator will display the word "Changed." If the current configuration has been written to the module or a file, the message will read "Same as Module," "Same as File," or "Same as Both."

Field devices and field wiring must be consistent with the configuration chosen.

The Output functions are listed as 0, 1, 2, and 3. These numbers correspond to the markings beside the module's output terminals. Again, only supported functions are accessible. It is not possible to create an "illegal" configuration.

Supported Functions

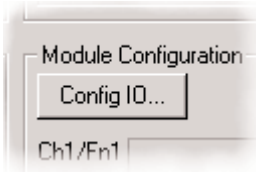
Reset, Inhibit, and Capture. If desired, two subordinate functions can be selected for the first Counter on each channel, Reset and Inhibit or Reset and Capture.

Capture and Inhibit use the same terminal, so you cannot use both of those subordinate functions. You can also access the Scaling Wizard, for counting and timing applications and other configuration features.

The CTRIO module supports five primary input functions: Counter, Quad Counter, Pulse Catch, Edge Timer, and Dual Edge Timer. Each of the primary functions uses one or two terminals for making connections to field devices (plus a common).

Three secondary input functions are also supported. These functions, Reset, Capture, and Inhibit, each modify the primary input functions in some way. More information is available about each of the primary and secondary functions later in this chapter.

Input Function Selections

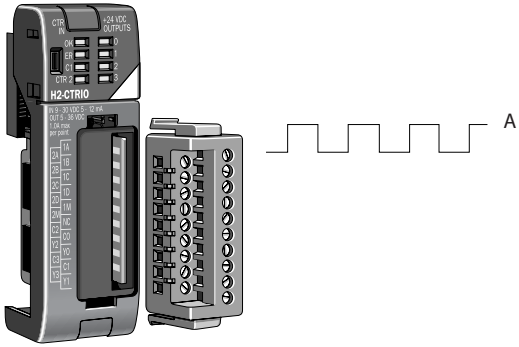


To make function selections (counter, timer, etc.), navigate to the Configuration IO dialog. From the main Workbench window, click the "Config IO" button to open the Config IO dialog.

Counter Function

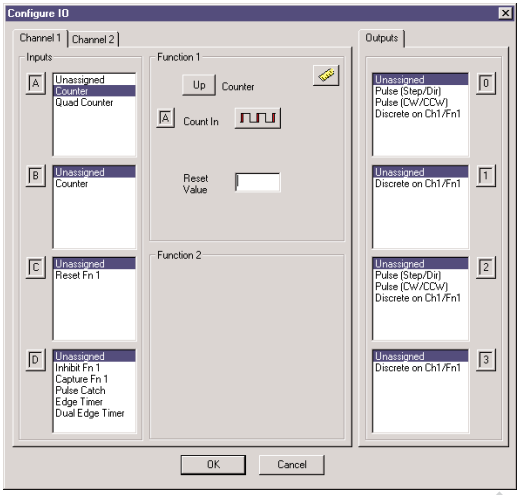
The CTRIO module supports up or down counting using single-ended encoders (or other single-ended pulse sources) as inputs. Encoders, proximity sensors, etc., can be connected to input A and/or input B on either channel or both channels. The C and D inputs are available to modify the A and B inputs. The C and D inputs can be used for Reset, Inhibit, or Capture. These functions are more fully explained later in this chapter.

To insure proper operation, the field device wiring and the configuration must be compatible. For wiring information see Chapter 2.



To select the Counter function, first open CTRIO Workbench. On the main dialog, click the button labeled "Config IO." This causes the Input Settings dialog to open.

The module's four input terminals are represented by the A, B, C, and D boxes on the left side of this dialog. If you are wiring your counter input to terminal 1A, you will want to select the Channel 1 tab near the top of this window and click "Counter" in box A.



At this point, you have four decisions to make regarding your input at 1A.

1. Select count up or count down. A button, in the Function 1 box, toggles between Up and Down counting. Click the button labeled "Up" (or "Down") to see the change to the opposite count direction.

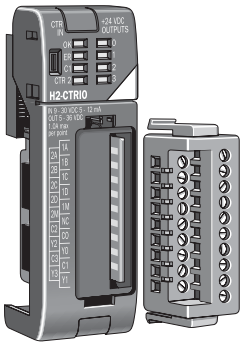
2. Each input pulse is counted, but you are free to designate whether you want the count to register on the rising edge of the pulse, the falling edge, or both. The button with the graphical representation of a pulse toggles between these choices.

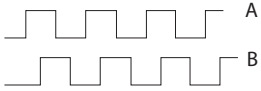
3. The Reset value is assigned by clicking and typing a value in the data input field. This value is for hardwired resets. When the hardwired reset is activated, the count value returns to the reset value.

4. The last remaining decision to be made is about scaling. Clicking the button with the ruler symbol starts the Scaling Wizard. We discuss the scaling wizard later in this chapter. The Scaling Wizard is intelligent in that it offers scaling options that are appropriate for your input selections.

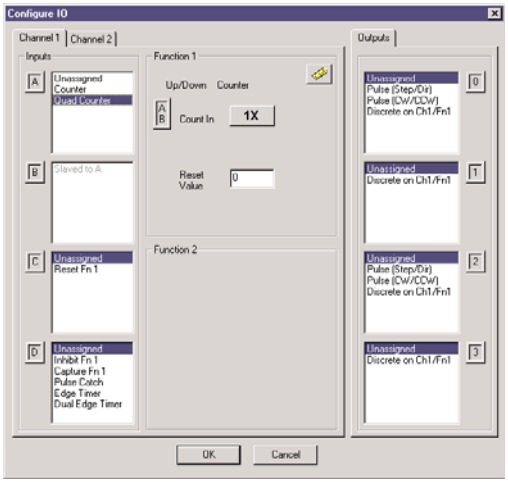
Quad Counter

The CTRIO module supports quadrature counting using quadrature encoders as inputs. Connect your encoder to input A and input B on either channel. A second quadrature endcoder can be connected to the other channel. The C and D inputs are available to control the quadrature input counting. The C and D inputs can be used for Reset, Inhibit, or Capture. These functions are more fully explained later in this chapter.





To insure proper operation, the field device wiring and the configuration must be compatible. For wiring information see Chapter 2.



To select the Quad Counter function, first open CTRIO Workbench. On the main dialog, click the button labeled "Config I/O." This causes the Configure IO dialog to open.

Notice that the module's four input terminals are represented by the A, B, C, and D boxes on the left side of this dialog. If you are wiring your quadrature counter inputs to terminal 1A and 1B, you will need to select the Channel 1 tab near the top of this window and click "Quad Counter" in box A. Notice that input B is now slaved to input A.

At this point, you have three decisions to make regarding your quadrature input.

1. A multiplier can be applied to the quadrature input to increase its resolution. Select "1x", "2x", or "4x." (1X = pulses processed on leading edge of input A, 2X = pulses are processed on both edges of input A, 4X = pulses processed on both edges of input A and both edges of input B.)

2. The "Reset Value" is assigned by clicking in the data input field and typing in a value. When the count is reset, using any of the reset methods, the count value returns to the Reset Value. The reset options are described in more detail later in this chapter.

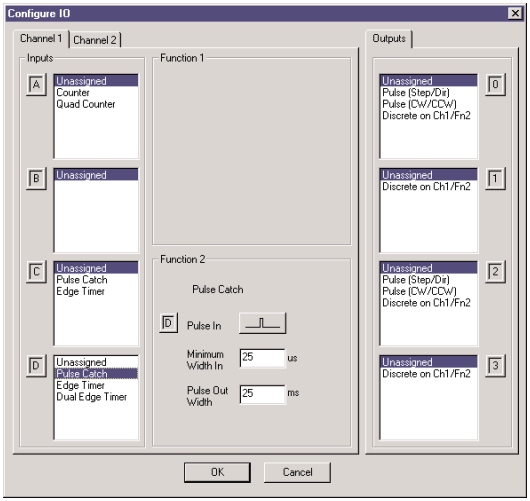
3. The last remaining decision to be made is about scaling. Clicking the button with the ruler symbol starts the Scaling Wizard. The Scaling Wizard is intelligent in that it offers only those scaling options that are appropriate for your input selections. We discuss the scaling wizard in greater detail later in this chapter.

Pulse Catch

The CTRIO "Pulse Catch" function allows a very short duration pulse to be qualified and lengthened to a time period long enough to guarantee that it is seen by the CPU. CPU scans necessarily vary with the length and complexity of the user's program. A scan frequency of several milliseconds, or more, is common. A pulse that lasts less than one millisecond, is typically hard to catch during the CPU scan.

The CTRIO module's Pulse Catch function sees the fast incoming signal and holds its status in a status bit until the CPU can see it. A discrete output can also be tied to the Pulse Out.

To insure proper operation, the field device wiring and the configuration must be compatible. For wiring information see Chapter 2.

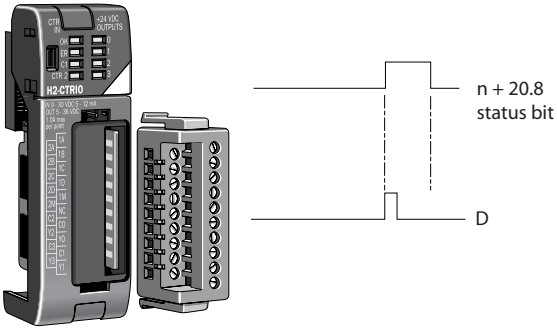


To select the Pulse Catch function, first open CTRIO Workbench. On the main dialog, click the button labeled "Config I/O." This causes the Input Settings dialog to open.

Notice that the module's four input terminals are represented by the A, B, C, and D boxes on the left side of this dialog. If you are wiring your input to terminal 1C, you will need to select the Channel 1 tab near the top of this window and click Pulse Catch in box C.

Three selections must be made in conjunction with the Pulse Catch option.

1. First, a decision must be made whether to look for the rising edge of the pulse or the falling edge of the pulse. This is a critical decision. Careful attention should be paid to the type of output the field device generates. If the signal voltage is normally low, but a short duration pulse sends the signal to the ON state, you will want to trigger off the rising edge, and vice versa.

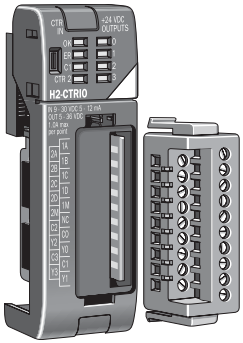


2. The second decision you will need to make is the minimum pulse width you want to capture. Transients below this width will not be recorded. Set this value by typing the desired value in the "Minimum Width In" field.

3. The final decision to be made is the length of pulse the CTRIO module should send in response to the input pulse. Make this setting by typing in the desired value in the "Pulse Out Width" field.

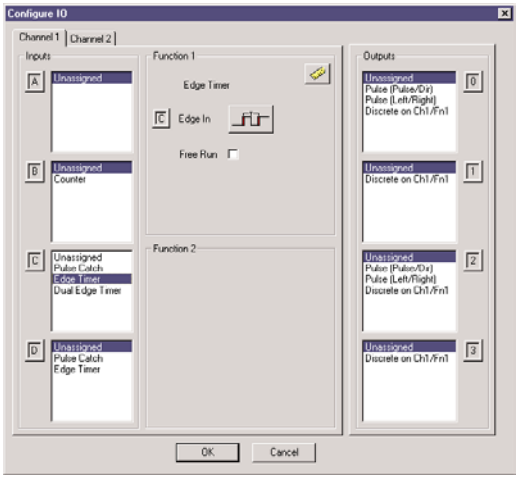
Edge Timer

The Edge Timer measures the time from the rising edge of one pulse to the rising edge of the next pulse, or the falling edge of one pulse to the falling edge of the same pulse, or the falling edge of one pulse to the falling edge of the next pulse. Encoders, proximity sensors, etc., can be connected to input C and/or input D on either channel or both channels.



To insure proper operation, the field device wiring and the configuration must be compatible. For wiring information see Chapter 2.

To select the Edge Timer function, first open CTRIO Workbench. On the main dialog, click the button labeled "Config I/O." This causes the Input Settings dialog to open.



Notice that the module's four input terminals are represented by the A, B, C, and D boxes on the left side of this dialog. If you are wiring your input to terminal 1C, you will need to select the Channel 1 tab near the top of this window and click Counter in box C.

At this point, you have three decisions to make regarding your input at 1A.

1. First, designate the pulse edges you want to measure between. There are four choices. You can measure the time from the leading edge of the upward pulse to the leading edge of the next upward pulse, or from the trailing edge of an upward pulse to the trailing edge of the next upward pulse, or from the leading edge of an upward pulse to the trailing edge of the same pulse, or, finally, from the leading edge of a downward pulse to the trailing edge of the same downward pulse.

   The last option could be restated as timing from the trailing edge of an upward pulse to the rising edge of the next upward pulse.

2. The "Free Run" option is assigned by clicking in the appropriate box. If your application calls for velocity measurements to be taken at the commencement of some event, do not use Free Run. If your application calls for velocity measurement on a continuous (moving average) basis, you should use Free Run.

3. The last remaining decision to be made is about scaling. Clicking the button with the tape measure symbol starts the Scaling Wizard. We discuss the scaling wizard later in this chapter. The Scaling Wizard is intelligent in that it offers scaling options that are appropriate for your input selections.

Dual Edge Timer

The Dual Edge Timer is designed to measure from a pulse edge on one incoming signal to a pulse edge on another incoming signal. The user selects whether to measure between rising edges, falling edges, etc. The choices are summarized in the tables below.

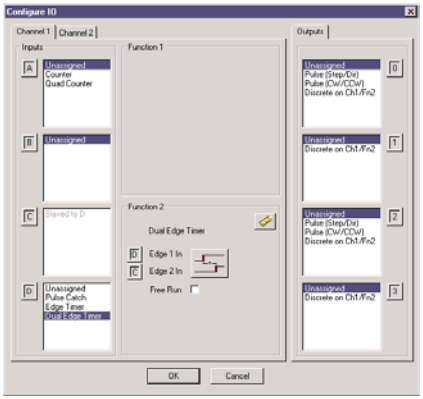
Dual Edge Timer at Function 1
Rising edge of C to rising edge of D
Rising edge of C to falling edge of D
Falling edge of C to rising edge of D
Falling edge of C to falling edge of D

Dual Edge Timer at Function 2
Rising edge of D to rising edge of C
Rising edge of D to falling edge of C
Falling edge of D to rising edge of C
Falling edge of D to falling edge of C

To insure proper operation, the field device wiring and the configuration must be compatible. For wiring information see Chapter 2.

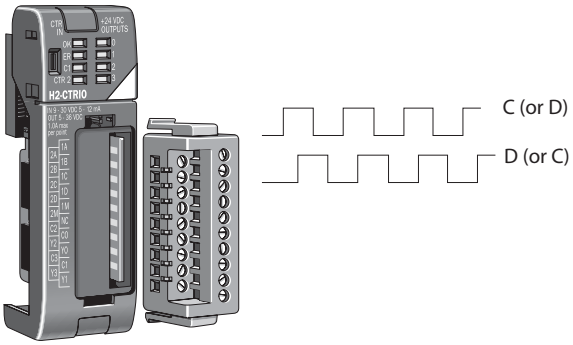
To select the Dual Edge Timer function, first open CTRIO Workbench. On the main dialog, click the button labeled "Config I/O." This causes the Input Settings dialog to open.

Notice that the module's four input terminals are represented by the A, B, C, and D boxes on the left side of this dialog. If you are wiring your inputs to terminals 1C and 1D, you will need to select the Channel 1 tab near the top of this window and click Dual Edge Timer in box C or D.



Dual Edge Timer (cont'd)

At this point, you have three decisions to make regarding your input at 1C or 1D.



1. First, designate the pulse edges you want to measure between.

2. The "Free Run" option is assigned by clicking in the appropriate box. If your application calls for velocity measurements to be taken at the commencement of some event, do not use Free Run. If your application calls for velocity measurement on a continuous basis, you should use Free Run.

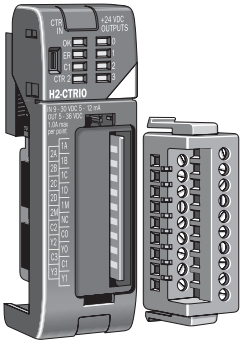
3. The last remaining decision to be made is about scaling. Clicking the button with the tape measure symbol starts the Scaling Wizard. We discuss the scaling wizard later in this chapter. The Scaling Wizard is intelligent in that it offers scaling options that are appropriate for your input selections.

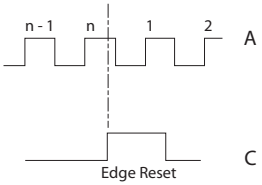
Reset 1 and Reset 2

"Reset 1" is available only if you have selected a Counter or Quad Counter as the primary function. For example, if you have chosen either counter function (single-ended or quadrature) on terminal 1A, you will have an option of using terminal 1C for a hard reset signal. Other options are available on terminal 1D. Those options are Capture and Inhibit (see below).

Reset 2 is available if you have selected to use terminal 1B for a counter input. Reset 2 will reset the counter connected to terminal 1B.

Two distinct types of hard resets are available. One is an edge reset. The other is a level reset. The Edge Reset sets the current count to zero on the specified edge (rising or falling) of the reset pulse (see upper exampel). The Level Reset resets the count to zero (as long as the reset pulse is held high (or low depending on configuration). When the reset pulse disappears, the count resumes (see lower example).

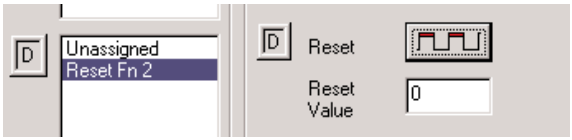




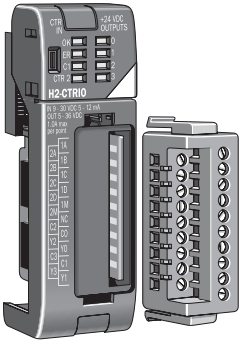
If the Reset options are not available in the Configure IO dialog, then you have selected input functions that do not use the reset modifier.

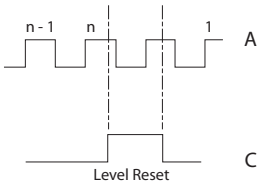
A Word About Soft Resets

Soft resets are also available from the Monitor dialog within Workbench or by turning on a control bit in your control program. Soft resets are always level resets, meaning they hold the count at zero until the reset bit is turned off.



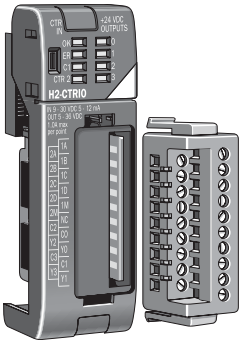
Reset 1 and Reset 2 represent hard-wired inputs to terminal C or D. An appropriate field device must be connected to the designated terminal to perform the reset function.

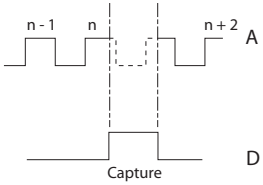




Capture 1

"Capture 1" is available only if you have selected a Counter or Quad Counter as the primary function. For example, if you have chosen either counter function on terminal 1A, you will have an option of using terminal 1D for a capture signal.





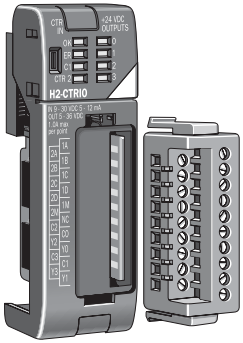
Capture 1 "snapshots" the current count into the 2nd DWord register (Parameter 2). The Capture feature is available with a single-ended Counter on input A or a Quad Counter on inputs A and B.

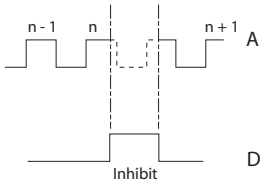
Capture 1 represents a hard-wired input to terminal D. An appropriate field device must be connected to the designated terminal to perform the capture function.

The Capture feature must be enabled in your control program or on the Monitor dialog in CTRIO Workbench.

Inhibit 1

"Inhibit 1" is available only if you have selected a Counter or Quad Counter as the primary function. For example, if you have chosen either counter function on terminal 1A, you will have an option of using terminal 1D for an inhibit signal.



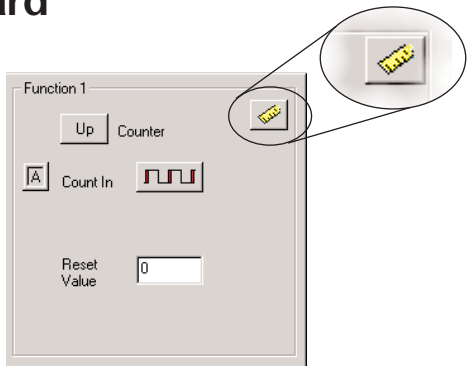


The "Inhibit 1" signal prevents the receipt of pulses into the Counter or Quad Counter input terminals. The Inhibit feature is available with the "A" Counter or Quad Counter on each channel.

Inhibit 1 represents a hard-wired input to terminal D. An appropriate field device must be connected to the designated terminal to perform the inhibit function.

Introduction to the Scaling Wizard

Scaling raw signals to engineering units is accomplished using the Scaling Wizard. Start the Scaling Wizard by clicking the ruler button on the Configure IO dialog. This button appears only after you select one of the Counter or Timer functions.

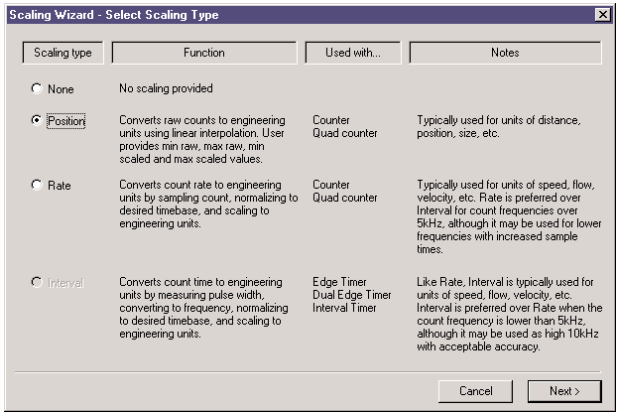


The Scaling Wizard options are different for the Counter functions as compared with the Timer functions. “Position” and “Rate” scaling are available when you select a Counter function. “Interval” scaling is available when you select a Timing function.

We will step through the dialogs used for each scaling type. Substitute appropriate values to set up scaling for your application.

Scaling Wizard Examples for Counter Functions

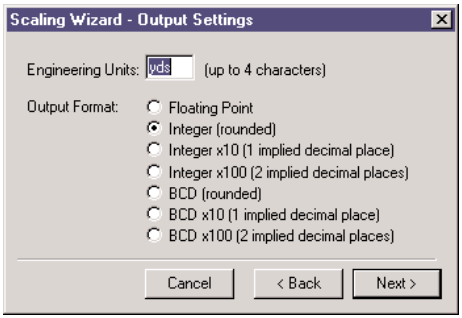
On the counter Scaling Wizard, you can select None, Position, or Rate. No scaling is accomplished if the None button is selected. Position scaling is appropriate for measuring distance, position, or size. Rate scaling is appropriate for velocity, RPM, flow, or similar rate based measurements. You may want to read the Notes and other information before leaving this window.



Position Scaling (Counter)

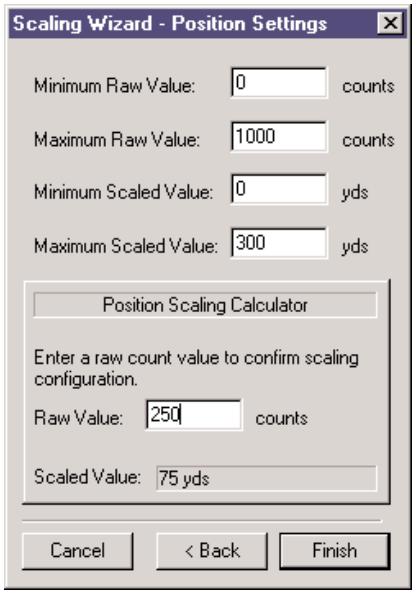
To select Position Scaling, click the radio button beside the word Position. Now, click Next to move to the Output Settings dialog.

On the Output Settings dialog, you will notice the field for engineering units. Enter an appropriate value for Position Scaling, for example yards, feet, meters, cubic inches, etc. Seven data types are available including BCD (to make values more easily used by DirectLOGIC PLCs).



Click Next, to open the Position Settings dialog. It is here that you enter the span of raw counts that equates to a span of engineering units.

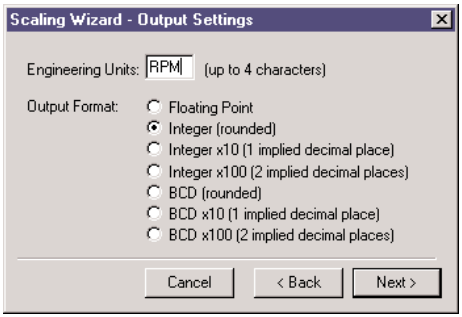
This window contains a calculator to double check the meaning of your Position Settings. Enter a value into the Raw Value field to see the equivalent value in engineering units.



Rate Scaling (Counter)

To select Rate Scaling, click the radio button beside the word Rate. Now, click Next to move to the Output Settings dialog.

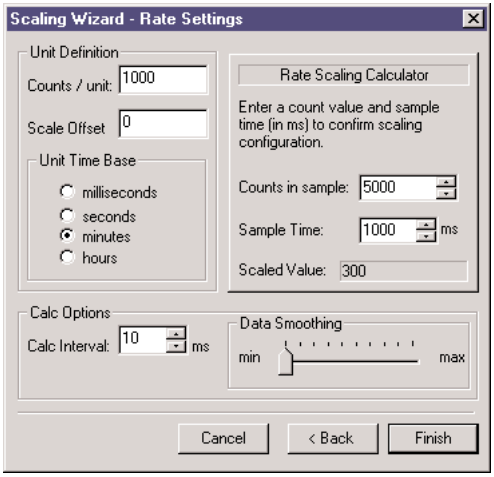
On the Output Settings dialog, you will notice the field for engineering units. Enter an appropriate value for Rate Scaling, for example RPM, fps, flow, etc. Seven data types are available including BCD (to make values more easily used by DirectLOGIC PLCs).



Click Next, to open the Rate Settings dialog. It is here that you enter the counts per unit of time and the time base. A scale offset is also provided to adjust the result by a constant amount.

This window contains a calculator to double check your Rate Settings. Enter a value into the Raw Value field to see the equivalent value in engineering units.

As an example, let's say you have a 1,000 pulse/revolution encoder, and you want to use it to measure RPM (of the encoder shaft). You would enter "1,000" for the Counts/unit and "minutes" as the Time Base. A check using the calculator (over a sample time of 1,000 ms = 1 second) reveals that 5,000 counts equals 300RPM.

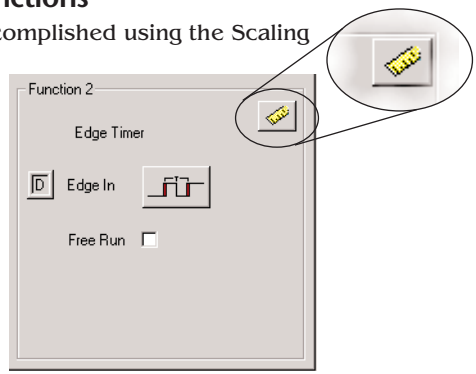


5000 counts/1000 counts per rev = 5 revolutions;

5 revolutions/1 sec x 60 sec/1 minute= 300 RPM

Using the Scaling Wizard with Timer Functions

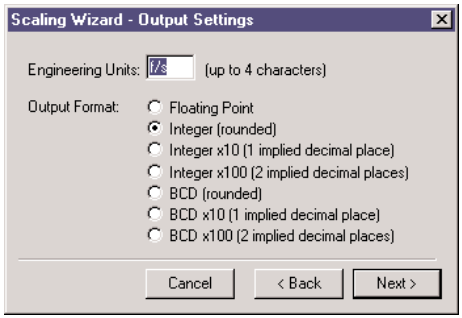
Scaling raw signals to engineering units is accomplished using the Scaling Wizard. Start the Scaling Wizard by clicking the ruler button on the Configure IO dialog. This button appears only after you select one of the Counter or Timer functions.



Interval Scaling (Timer)

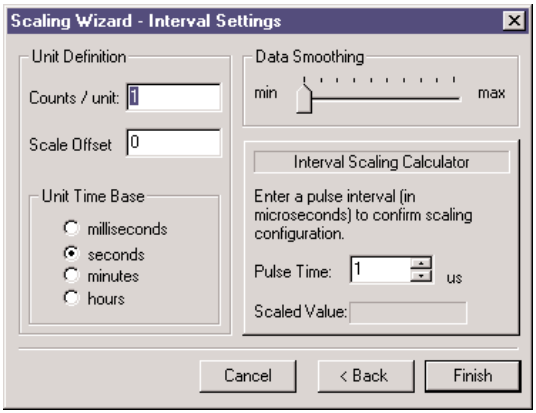
To select Interval Scaling, click the radio button beside the word Interval. Now, click Next to move to the Output Settings dialog.

On the Output Settings dialog, you will notice the field for engineering units. Enter an appropriate value for Interval Scaling, for example RPM, fps, flow, etc. Seven data types are available including BCD (to make values more easily used by DirectLOGIC PLCs).



Click Next, to open the Interval Settings dialog. It is here that you enter the counts per unit of time and the time base. A scale offset is also provided to adjust the result by a constant amount.

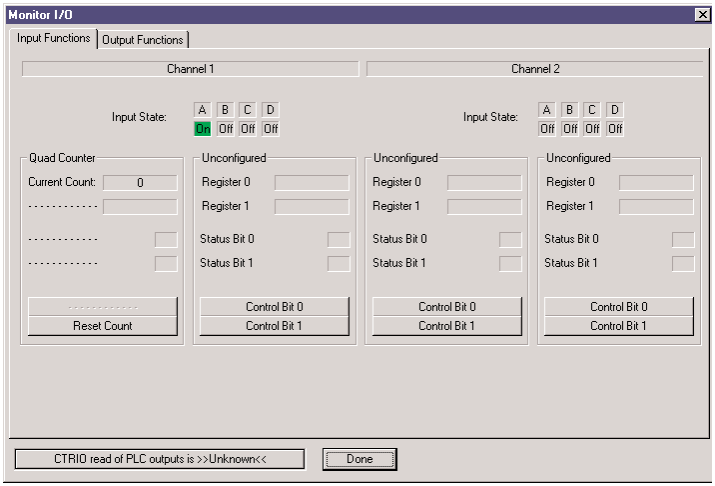
This window contains a calculator to double check the meaning of your Rate Settings. Enter a value into the Raw Value field to see the equivalent value in engineering units.



Using the Monitor I/O Dialog

The Monitor I/O dialog is accessible from the main Workbench dialog when the module is in Run Mode. On the main Workbench dialog, click the button labeled Monitor I/O. The dialog below will appear.

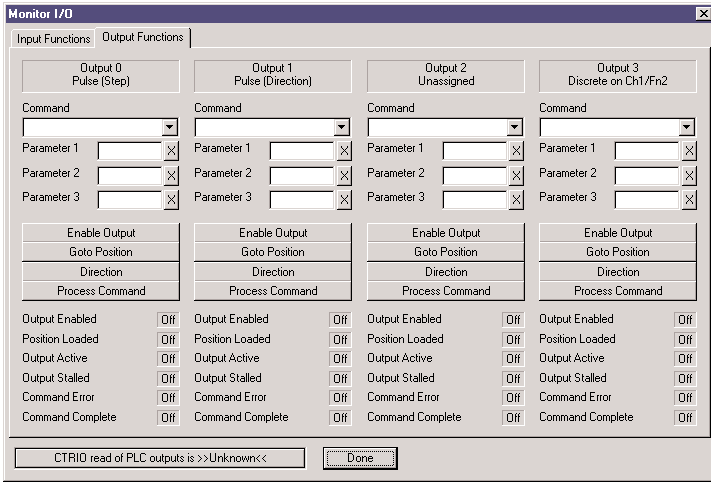
The Monitor I/O dialog is divided into two functional areas: Input Functions and Output Functions. Just below the Windows title bar, you will see tabs to switch between Input Functions and Output Functions.



Input Functions include all DWord, Word, and status bit data passed from the CTRIO module to the CPU. Output Functions include all DWord, Word, and control bit data passed from the CPU module to the CTRIO.

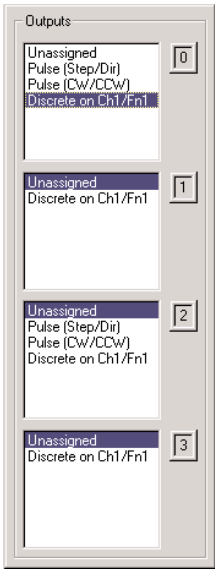
The data displayed under the Input Functions tab includes the current status of each configured input and output function.

The fields displayed under the Output Functions tab includes all configuration information that can be altered during runtime and the bits that indicate successful transfers or errors.



Discrete Outputs

The CTRIO module offers four discrete outputs numbered 0, 1, 2, and 3. The outputs respond to presets assigned by the user in the Configure IO dialog.

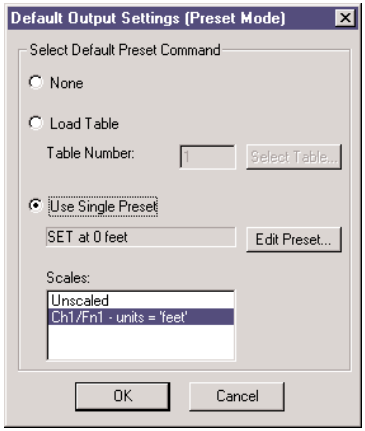


The presets are assigned based on the scaled value of an input, or the raw value if it has no scaled value. The four outputs can all be assigned to one function, or they can be grouped within functions and within channels in any manner selected by the user.

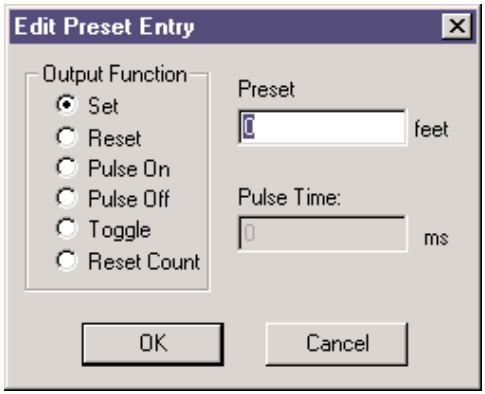
To assign output presets, begin by selecting the ouput on the Configure IO dialog. The outputs are identified based on terminal number. In the example to the right, output terminal "0" is designated for a discrete output.

Once the output selection is made, a new button appears on the Configure IO dialog. The button is labeled as shown to the right. The leading numeral represents the number of the output terminal. Clicking on the Preset button causes the Default Output Settings dialog to pop up. Default settings are loaded on power-up.

On the Output Settings dialog, select "Use Single Preset." We will discuss Preset Tables later in this chapter. Now, click OK to arrive at the Edit Preset Entry dialog.



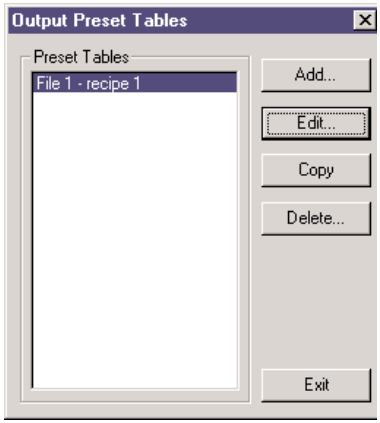
Six output functions are available (as shown in the figure below). Set the preset value in engineering units if the signal has been scaled. Set the preset value in raw count if the signal has not been scaled. We discuss scaling elsewhere in this chapter. Pulse ON and Pulse OFF require a Pulse Time setting. The Pulse Time is set in msec (1,000 sec = 1 msec)



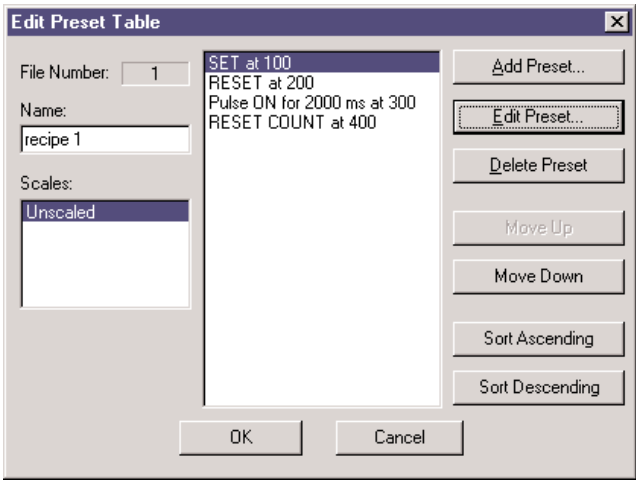
Output Function Definitions	
Set	Writes output ON (maintained)
Reset	Writes output above OFF
Pulse On	Writes output ON for specified time
Pulse Off	Writes output OFF for specified time
Toggle	Changes state of output
Reset Count	Resets the count to Preset Value

Creating and Using the Output Preset Tables

To create tables of presets, click the Preset Tables button on the main Workbench dialog. This will open the Output Preset Tables dialog. To create a new table, click Add (or Edit). This will open the Edit Preset Table dialog.

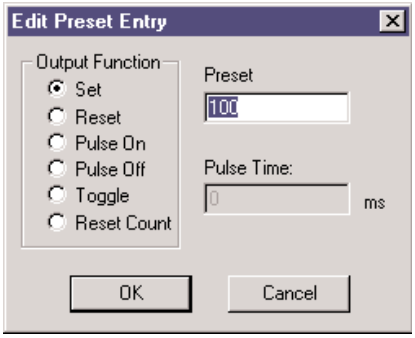


Build a Preset Table by adding preset entries one at a time. Click Add Preset (or Edit Preset) to open the Edit Preset Entry dialog.



On the Edit Preset Entry dialog, select one of the six Output Functions. Set the preset value in engineering units if the signal has been scaled. Set the preset value in raw count if the signal has not been scaled. We discuss scaling elsewhere in this chapter. Pulse ON and Pulse OFF require a Pulse Time setting. The Pulse Time is set in msec (1,000 sec = 1 msec). For a description of the Output Functions see page 3-21.

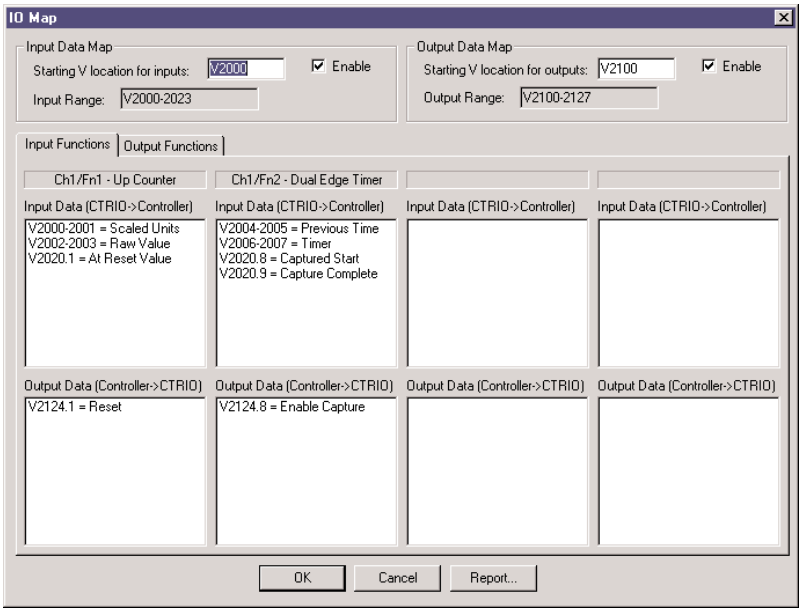
To set a particular table as the default table, use the Default Output Settings dialog described on page 3-21.



I/O Map Dialog

On the main dialog, click the I/O Map button to open the I/O Map dialog. The I/O Map dialog performs three important functions for users of DirectLOGIC PLCs.

First, it gives you the opportunity to assign CPU memory locations for data transfers from the CTRIO module to the CPU and data transfers from the CPU to the CTRIO module. The example shown below indicates the V-memory locations of a DirectLOGIC PLC.



The I/O Map also allows you to enable these data transfers. You will need to enable the data transfers in order to use the CTRIO data within your control program or to make dynamic changes to the stored CTRIO data or configuration values.

The third important function of the I/O Map is to identify, in a table form, the memory locations where raw or scaled input values are located and where status and control bits appear.

Program Control

In This Chapter...

Memory Map for Inputs from CTRIO to CPU

The following table shows which memory locations are used for memory transfers from the CTRIO module to the CPU. The starting memory location is defined by the user in the I/O Map within CTRIO Workbench. If you are using the D2-240 or D2-250 CPU, you will use the memory address offsets in the second column. If you are using an H2-WinPLC in the CPU slot, you will use the non-PLC offsets in column one.

Data Type and Offset WinPLC & EBC	*Address for Inputs (DirectLOGIC)*	*Definition*	*Format*	*Bytes*
dwX0	n+0	Ch 1/Fn 1 Parameter 1	DWord	4
dwX1	n+2	Ch 1/Fn 1 Parameter 2	DWord	4
dwX2	n+4	Ch 1/Fn 2 Parameter 1	DWord	4
dwX3	n+6	Ch 1/Fn 2 Parameter 2	DWord	4
dwX4	n+10	Ch 2/Fn 1 Parameter 1	DWord	4
dwX5	n+12	Ch 2/Fn 1 Parameter 2	DWord	4
dwX6	n+14	Ch 2/Fn 2 Parameter 1	DWord	4
dwX7	n+16	Ch 2/Fn 2 Parameter 2	DWord	4
bX0...7 bX8...15	n+20	Ch 1/Fn 1 Status (Low Byte) Ch 1/Fn 2 Status (High Byte)	Word	2
bX16...23 bX24...31	n+21	Ch 2/Fn 1 Status (Low Byte) Ch 2/Fn 2 Status (High Byte)	Word	2
bX32...39 bX40...47	n+22	Output 0 Status (Low Byte) Output 1 Status (High Byte)	Word	2
bX48...55 bX56...63	n+23	Output 2 Status (Low Byte) Output 3 Status (High Byte)	Word	2

For DirectSOFT32 users: the I/O Map dialog displays the exact memory locations in use by the CTRIO module. Within the I/O Map dialog you can print out a report of memory loctions in use.

Memory Map for Outputs from CPU to CTRIO

The following table shows which memory locations are used for memory transfers from the CPU module to the CTRIO. The starting memory location is defined by the user in the I/O Map within CTRIO Workbench. If you are using the D2-240 or D2-250 CPU, you will use the memory address offsets in the second column. If you are using an H2-WinPLC in the CPU slot, you will use the non-PLC offsets in column one.

Data Type and Offset WinPLC & EBC	*Addr. for Inputs (DirectLOGIC)*	*Definition*	*Format*	*Bytes*
dwY0	n+0	Output 0 Parameter 3	DWord	4
dwY1	n+2	Output 1 Parameter 3	DWord	4
dwY2	n+4	Output 2 Parameter 3	DWord	4
dwY3	n+6	Output 3 Parameter 3	DWord	4
wY0	n+10	Output 0 Command	Word	2
wY1	n+11	Output 0 Parameter 1	Word	2
wY2	n+12	Output 0 Parameter 2	Word	2
wY3	n+13	Output 1 Command	Word	2
wY4	n+14	Output 1 Parameter 1	Word	2
wY5	n+15	Output 1 Parameter 2	Word	2
wY6	n+16	Output 2 Command	Word	2
wY7	n+17	Output 2 Parameter 1	Word	2
wY8	n+20	Output 2 Parameter 2	Word	2
wY9	n+21	Output 3 Command	Word	2
wY10	n+22	Output 3 Parameter 1	Word	2
wY11	n+23	Output 3 Parameter 2	Word	2
bY0...7 bY8...15	n+24	Ch 1/Fn 1 Status (Low Byte) Ch 1/Fn 2 Status (High Byte)	Word	2
bY16...23 bY24...31	n+25	Ch 2/Fn 1 Status (Low Byte) Ch 2/Fn 2 Status (High Byte)	Word	2
bY32...39 bY40...47	n+26	Output 0 Status (Low Byte) Output 1 Status (High Byte)	Word	2
bY48...55 bY56...63	n+27	Output 2 Status (Low Byte) Output 3 Status (High Byte)	Word	2

For DirectSOFT32 users: the I/O Map dialog displays the exact memory locations in use by the CTRIO module. Within the I/O Map dialog you can print out a report of memory loctions in use.

CTRIO Input Parameter Definitions

The following table defines the meaning of Parameter 1 and Parameter 2 under different configuration settings. The functions listed in column one are defined by the user in CTRIO Workbench.

Configured Function from CTRIO Workbench	***Parameter 1 Contents*** ***DWORD***	***Parameter 2 Contents*** ***DWORD***
Non-scaled Counter	Raw Input Value	Not Used
Scaled Counter	Scaled Value (pos. or rate)	Raw Value
Non-scaled Counter with Capture	Raw Value	Captured Value
Scaled Counter with Capture	Scaled Value (pos. or rate)	Captured Value
Non-scaled Timer	Previous Time (us)	In Progress Time (us)
Scaled Timer	Scaled Interval (rate)	In Progress Time (us)
Pulse Catch	Not Used	Not Used

Function Status and Control Bit Definitions

The table below defines the bit locations for control and status of user configured functions. The functions are configured in CTRIO Workbench and can be controlled or monitored from your control program. EBC users see note on page 3-20.

Control Bit (transfers from CPU to CTRIO)	***Bit Offsets WinPLC & EBC***	***V-memory Offsets DirectLOGIC PLCs***
Enable Count Capture	0, 8, 16, 24	24.0, 24.8, 25.0, 25.8
Scaled Counter	0, 8, 16, 24	24.0, 24.8, 25.0, 25.8
Enable Pulse Catch	0, 8, 16, 24	24.0, 24.8, 25.0, 25.8
Reset	1, 9, 17, 25	24.1, 24.9, 25.1, 25.9
Status Bit (transfers from CTRIO to CPU)	***Bit Offsets WinPLC & EBC***	***V-memory Offsets DirectLOGIC PLCs***
Count Capture Complete Bit	0, 8, 16, 24	20.0, 20.8, 21.0, 21.8
Timer Capture Start	0, 8, 16, 24	20.0, 20.8, 21.0, 21.8
Timer Capture Complete (Timing) OR At Reset Value (Counting)	1, 9, 17, 25	20.1, 20.9, 21.1, 21.9
Pulse Catch Output Pulse State	0, 8, 16, 24	20.0, 20.8, 21.0, 21.8
Pulse Catch Start	1, 9, 17, 25	20.1, 20.9, 21.1, 21.9

Runtime Changes to the Preset Tables

Presets and preset tables can be set up entirely within CTRIO Workbench. You can also make runtime edits to presets from your control program. To make a runtime change, a series of commands must be executed which will pass new values to a preset table (or call a different preconfigured table).

Command Codes are passed to the CTRIO module to effect the required edit. Each Command Code has its own syntax, and all Command Codes must be presented in a particular sequence:

The command code and associated parameters must be loaded into the appropriate memory locations.

A Process Command instruction must be passed to the CTRIO module.

A Command Complete signal must be received and the Command Error bit must stay at zero.

Finally, the Enable Output instruction must be passed to the CTRIO module.

Some changes require a combination of Command Codes so those changes must follow the steps above for each Command Code processed.

Control Bit	***Bit Y Offsets WinPLC & EBC***	***V-memory Offsets DirectLOGIC PLCs***
Enable Output	32, 40, 48, 56	26.0, 26.8, 27.0, 27.8
Process Command	39, 47, 55, 63	26.7, 26.15, 27.7, 27.15
Status Bit	***Bit X Offsets WinPLC & EBC***	***V-memory Offsets DirectLOGIC PLCs***
Count Capture Complete Bit	38, 46, 54, 62	22.6, 22.14, 23.6, 23.14
Timer Capture Start	39, 47, 55, 63	22.7, 22.15, 23.7, 23.15

Runtime Changes Cont'd

Command DirectLOGIC n+10	*Code Hex/BCD*	*Parameter 1 (Word) DirectLOGIC n+11*	*Parameter 2 (Word) DirectLOGIC n+12 (decimal)*	*Parameter 3 (DWord) DirectLOGIC n+0/n+1 (decimal)*
Load Table from RAM	10	File Number (decimal)	-	-
Clear RAM Table	11	-	-	-
Initialize RAM Table	12	Entry Type (decimal)	Pulse Time[1]	Preset Count/Time[4]
Add Table Entry	13	Entry Type (decimal)	Pulse Time[1]	Preset Count/Time[4]
Edit Table Entry	File &[2] 14	Entry Num. &[2] Entry Type[3] (Hex/BCD)	Pulse Time[1]	Preset Count/Time[4]
Write RAM to ROM	99[5]	-	-	-
Edit and Reload	File &[2] 15	Entry Num. &[2] Entry Type[3] (Hex/BCD)	Pulse Time[1]	Preset Count/Time[4]
Edit Level Response	30	Level Behavior (decimal)	Deadband	Level Rate Setting

[1] If appropriate for Entry Type (in ms).

[2] Field entries separated by an "&" are to be loaded in the high byte and low byte of that word (See example on page 4-9).

[3] Entry types are defined below.

[4] Follows format of Input DWord Parameter 1.

[5] Flash ROM is rated for 100,000 writes.

Entry Number and Entry Type for Edit Table Entry Command

The Entry Number refers to the position of the preset in the table sequence. The first preset is Entry Number "0," the second preset is "1," and so forth.

The Entry Type is defined according to the table below.

Entry Type	*Code*	*Notes*
Write Output ON (Set)	0	-
Write Output OFF (Reset)	1	-
Pulse Output ON	2	-
Pulse Output OFF	5	-
Toggle Output	4	-
Reset Function	5	Edits preset that resets count

Edit Level Response Command

If a Counter or Timer function is scaled to produce a rate, alarm level settings can be used to trigger discrete outputs at values predetermined by the user. The alarm levels can be set within CTRIO Workbench or from the user's control program.

Additionally, a deadband percentage (in tenths of a percent) can be set to prevent the output from changing too frequently near the Rate Level threshold. Consider a Discrete Output set to turn ON when a level gets to 100 with a 10% deadband. The output will turn ON when the level gets to 100. If the level drops, the output will stay on until the level drops below 90, where it will turn OFF.

Edit the behavior of a Discrete Output triggered by a Rate Level by using the "Edit Level Response Command" (Command Code 30Hex).

The Level Behavior setting for Parameter 1 is given in the table below:

Level Behavior for Discrete Output	***Parameter 1 Contents***	***Notes***
ON when greater than Level Rate setting	0000 Hex	-
ON when less than Level Rate setting	0001 Hex	-
OFF when greater than Level Rate setting	0080 Hex	-
OFF when less than Level Rate setting	0081 Hex	-

The Deadband is written to Parameter 2 as a x10 integer (one implied decimal position). To achieve a 10.0% deadband, the control program needs to write 100 decimal (64 Hex) to Parameter 2.

The Level Rate setting is written to Parameter 3 in the same format as Input Parameter 1 of the CTRIO Function to which this Discrete Output has been assigned.

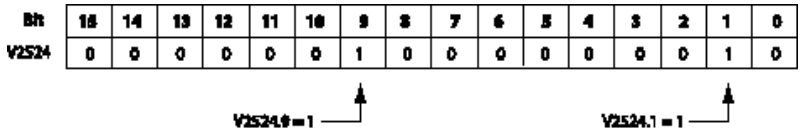
Addressing Conventions (with V-memory Examples for DirectLOGIC PLCs)

Example for Bit-accessed Data in PLC CPUs

In this example, the V-memory location V2524 contains a value equal to 514 in decimal.

514 decimal = 0202 Hex = 0000 0010 0000 0010 binary

The bit V2524.1 refers to the 2nd to the least significant bit (set to 1 in this example). Likewise, V2524.9 refers to bit number 9, the 10th from the least significant bit (also set to 1 in this example).



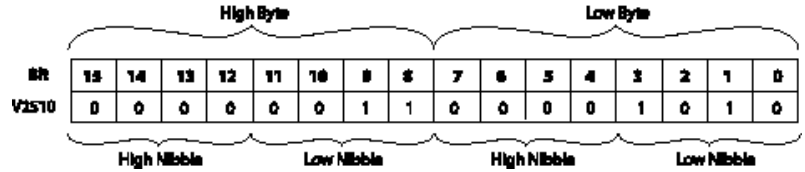
Addressing High and Low Byte of Word Parameters

In the following example, the V-memory location V2510 contains a value equal to 3 (decimal) in the high byte and 10 (decimal) in the low byte.

3 decimal = 03 Hex = 0000 0011 binary in the high byte, and

10 decimal = 0A Hex = 0000 1010 binary in the low byte.

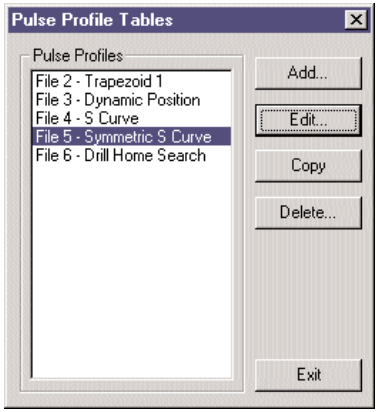
This example could represent the Command Code "Edit Table Entry." The value 03 (Hex) would represent the File number in the high byte, and the 0A (Hex) would represent the remainder of the Command Code in the low byte.



Addressing High and Low Word of DWord Parameters

Double Word parameters are addressed in a similar fashion to the high and low bytes of a Word Parameter. For example, a DWord that begins in V2300 consumes both V2300 and V2301. The Low Word is V2300, and the High Word is V2301.

Pulse Output Commands



The CTRIO module can generate Pulse Outputs based on predefined user profiles. Using program control techniques, the Pulse Profiles can also be changed dynamically during runtime.

CTRIO Workbench can create a maximum of 255 predefined Pulse Profiles. The total number of Pulse Profiles available is 255 minus the number of predefined Preset Tables. Pulse Profiles and Preset Tables are saved as File 1 through File 255.

Based on the Workbench configuration, either of the two Pulse Output channels can output Pulses and Direction, or Up Pulses and Down Pulses.

Control Bit CPU to CTRIO	*Bit Offsets*	*V memory Offsets from Output Start (octal)*	*Read as:*
Enable Output	32, 48	26.0, 27.0	Level
Go to Position	33, 49	26.1, 27.1	Rising Edge
Direction	36, 52	26.4, 27.4	Level
Process Command	39, 55	26.7, 27.7	Rising Edge

Status Bit CTRIO to CPU	*Bit Offsets*	*V memory Offsets from Input Start (octal)*
Output Enabled	32, 48	22.0, 23.0
Position Loaded	33, 49	22.1, 23.1
Output Active	34, 50	22.4, 23.4
Output Stalled	35, 51	22.5, 23.5
Command Error	38, 54	22.6, 23.6
Command Complete	39, 55	22.7, 23.7

Word Control CPU to CTRIO	*Word Offsets*	*V-memory Offsets from Output Start (octal)*
Command Code	0, 6	10, 16
Word Parameter 1	1, 7	11, 17
Word Parameter 2	2, 8	12, 20
DWord Control CPU to CTRIO	*Word Offsets*	*V-memory Offsets from Output Start (octal)*
DWord Parameter 1	0, 2	0, 4

Cont'd

Command	*Code (Hex/BCD)*	*Word Parameter 1 (decimal)*	*Word Parameter 2*	*DWord Parameter 3 (decimal)*
Load Profile from ROM	10	Trapezoid or S-curve File Number	-	-
Load Profile from ROM	10	Dynamic Positioning File Number	-	New Position
Pulse Output at Velocity	20	Run Frequency (20Hz - 25KHz)	Duty Cycle (0 to 99)* (decimal)	Number of Pulses
Pulse Output to Limit	21	Run Frequency (20Hz - 25KHz)	Edge & Duty Cycle (0 to 99)* (Hex/BCD)	-
Pulse Output to Position	22	Run Frequency (20Hz - 25KHz)	Compare Function & Duty Cycle (0 to 99)* (Hex/BCD)	Desired Input Function Value

* A value of 0 will generate a duty cycle of 50%

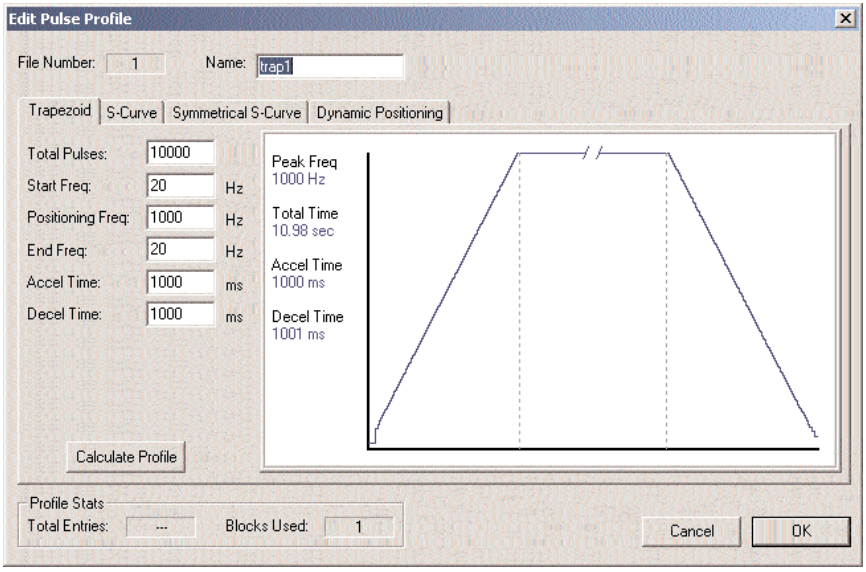
Fields above separated by an "&" indicate a code with different definitions for each byte (high byte and low byte). For example, to enter the Pulse Output to Limit command, set the high byte of the Word Parameter 2 to the edge you wish to terminate the output pulses (see definition following), and set the low byte to the desired duty cycle.

In order to process a command, first the program must load the Command Code and required DWord, Word, and bit parameters. Then the program should drive the Process Command bit to a 1 and look for the CTRIO to acknowledge the command with the Command Complete bit. Finally, the program should remove the Process Command bit and set the Enable Output bit when appropriate. If the Command Error bit is received, the CTRIO was unable to process the command due to n illegal value in either the Command Code or parameter files.

DWord and Word values for pulse outputs are considered unsigned integers.

Pulse Output Profiles

Loading a profile is the easiest method for pulse output motion control (Command Code = 0010 Hex/BCD). All the characteristics of acceleration, run frequency, and total pulse count are entered in the CTRIO Workbench Pulse Profile entry window. The profile can be a Trapezoid, Velocity S-Curve, or program controlled Dynamic Positioning.



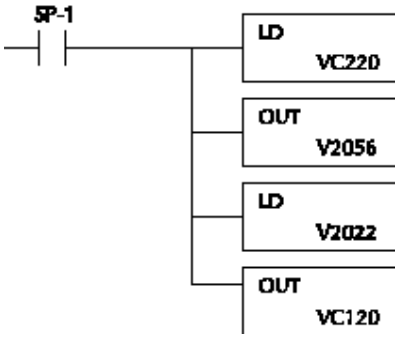
Status Registers, using V2000 as base input address (status bit received from CTRIO)

Name	*PLC Example 1: Bit-of-Word (see note 2) D2-250 CPU only*	*PLC Example 2: Control Relay (see note 1) D2-240/250 PUs*	*Value*
Output Enabled	V2022.0	C120	ON when Enable Output is ON
Position Loaded	V2022.1	C121	Used for Dynamic Positioning
Output Active	V2022.4	C124	ON when Output is Pulsing
Output Stalled	V2022.5	C125	CTRIO Output Fault (should never be ON)
Command Error	V2022.6	C126	ON if Command or Parameters are invalid
Command Complete	V2022.7	C127	ON if Module Receives Process Command

Control Registers, using V2030 as base output address (control DWords, Words, and bits sent from CPU to CTRIO)

Name	*PLC Example 1: Bit-of-Word (see note 2) D2-250 CPU only*	*PLC Example 2: Control Relay (see note 1) D2-240/250 CPUs*	*# Format*
Command Code	V2040	V2040	Hex/BCD
Parameter 1	V2041	V2041	Decimal
Parameter 2	V2042	V2042	Decimal
Parameter 3	V2031 - V2030	V2031 - V2030	Signed Decimal
Enable Output	V2056.0	C220	Bit
Go to Position	V2056.1	C221	Bit
Direction	V2056.4	C224	Bit
Process Command	V2056.7	C227	Bit

Note 1:
The D2-240 CPU does not support bit-of-word addressing. The status and control bits must be mapped to control relay words. An example of mapping code is shown below.



Note 2:
DirectSoft32 uses B2022.2 in the ladder code to indicate that you are addressing the third bit of V-memory register 2022. The "B" prefix indicates bit-of-word addressing.

Trapezoid or S-Curve

For predefined Trapezoid or S-Curve profiles, the program needs to prepare the Load Table command by selecting Command Code = 0010 Hex/BCD and setting Word Parameter 1 to the File number of the profile (example: File 1 Trapezoid 1). Then the program can set the Process Command bit and watch for the Command Complete bit. Then the program should clear the Process Command bit and set the Direction bit and finally the Enable Output bit to start the output pulses. Clearing the Enable Output bit will always suspend pulsing and reset any profile in progress to it's beginning . Once complete, the profile remains loaded and can be restarted buy clearing the Enable Output, changing the direction bit (if desired), and again setting the Enable Output.

Easy step examples are given for PLCs with CTRIO I/O date mapped in the word and CR bit areas of CPU menmory.

Running a Trapezoid or S-Curve Profile on CTRIO Y0 & Y1

Steps	*Name*	*PLC Control Outputs Base Addr = V2030 (Bit-of-Word)*	*PLC Status Inputs Base Addr = V2000 (Bit-of-Word)*	*PLC Control Outputs Base Addr = V2030 (Control Relay)*	*PLC Status Inputs Base Addr = V2000 (Control Relay)*	*Action*
1	Command Code	V2040		V2040		Set to 10 (Load Stored Profile)
2	Parameter 1	V2041		V2041		File # of stored profile, determined by user
3	Process Command	V2056.7		C227		Turn ON until Command Complete status bit is returned (see step 4)
4	Command Status		V2022.7		C127	When ON, Profile is now loaded, clear Process Command bit (step 3)
5	Set Direction	V2056.4	V2022.7	C224		Set ON or OFF for Direction of Rotation
6	Enable Output	V2056.0		C220		Turn ON to start pulses
7	Enable Status		V2022.0		C120	When ON, module is confirming Enable Output
8	Output Status		V2022.4		C124	When ON, module is pulsing, OFF with Enable Status ON = profile has completed
9	Disable Output	V2056.0		C220		Turn OFF when pulse status is OFF and Enable Status is ON

To re-launch a loaded profile, repeat steps 5-9

Dynamic Positioning

For Dynamic Positioning, only the motion limits of Min Frequency, Max Frequency, and Max Acceleration come from the CTRIO Workbench Profile. After loading a Dynamic Position Profile per the above paragraph, setting the Enable Output causes the CTRIO module to assume a position of 0 pulses. The program should write the next target position in DWord Parameter 3, and set the Load/Seek Position bit. This will cause the CTRIO to set both the Pulses Active and the New Position Loaded bit and begin output pulses (with the proper direction setting) to achieve the new position.

The program can monitor the state of the Pulses Active bit and the New Position Loaded bit to determine when the new position has been attained. The New Position Loaded status bit will always follow the s tate of the Load/Seek New Position control bit. This status bit should be used to signal the program that the CTRIO has received the new state of the control bit.

Position Loaded Status Bit V40622.1 or C441	*Pulses Active Status Bit V40622.0 or c440*	*CTRIO Dynamic Position Pulse Output State*
0	0	Idle
1	1	Go To Position Acknowledged, Pulsing
0	1	Still Pulsing, Go To Position Control Bit is OFF
1	0	Go To Position Acknowledged, Position Attained

After the GoTo Position is acknowledged, the program can load the next position into the DWord Parameter 3. When Pulses Active Status goes to 0, then setting the GoTo Position control bit will again start the output toward the new position. The CTRIO moves to the new position relative to its previous position as long as the Enable Output control bit remains set. Clearing the Enable Output bit will disable output pulsing and reset the current position to 0.

Dynamic Positioning using the CTRIO Y0 and Y1

Steps	*Name*	*PLC Control Outputs Base Addr = V2030 (Bit-of-Word)*	*PLC Status Inputs Base Addr = V2000 (Bit-of-Word)*	*PLC Control Outputs Base Addr = V2030 (Control Relay)*	*PLC Status Inputs Base Addr = V2000 (Control Relay)*	*Action*
1	Command Code	V2040		V2040		Set to 10 (Load Stored Profile)
2	Parameter 1	V2041		V2041		File # containing Vmin, Vmax, and Accel
3	Process Command	V2056.7		C227		Turn ON until Command Complete status bit is returned (see step 4)
4	Command Status		V2022.7		C127	When ON, Profile is now loaded, clear Process Command bit (step 3)
5	Enable Output	V2056.0		C220		Turn ON to assume 0 position, Turn OFF to disable pulses and zero position
6	Enable Status		V2022.7		C127	When ON, pulses are now enabled and last position is retained
7	Parameter 3	V2031 / V2030		V2031 / V2030		Target position: User defined (DWord)
8	Go To Position	V2056.1		C221		Starts pulses with direction to obtain the new position relative to previous position.
9	Position Loaded Status		V2022.1		C121	When ON, Go To position is acknowledged
10	Output Active Status		V2022.4		C124	When ON, module is pulsing, OFF with Position Loaded status ON = new position move has completed
11	Go To Position	V2056.1		C221		Turn OFF to be ready to load a new position

To seek the next position, repeat steps 7-10.

Pulse Output at Velocity

For motion control directly from the CPU/controller program, use the Pulse Output at Velocity command (Command = 0020 Hex/BCD). The Number of Pulses can be set to "FFFFFFFF" in Hex for unlimited pulse counts. Leaving the Duty Cycle set to 0 achieves the default (50%), otherwise it can be set in 1% increments by writing this value from 1 to 99 decimal. After this command is processed, the Run Frequency and Duty Cycle fields can be adjusted by direct access. In order to change directions from Pulse Output in "Velocity" mode, the Enable Output bit must first be cleared (which stops the Pulse Outputs). Then after the new direction bit is written, the Enable Output bit can be set to resume pulsing.

Steps: PLC Address V40650and module channel 1 is used for the CTRIO base output address for all examples in this Doc.

Run Velocity control on CTRIO Y0 & Y1

Steps	*Name*	*PLC Control Outputs Base Addr = V2030 (Bit-of-Word)*	*PLC Status Inputs Base Addr = V2000 (Bit-of-Word)*	*PLC Control Outputs Base Addr = V2030 (Control Relay)*	*PLC Status Inputs Base Addr = V2000 (Control Relay)*	*Action*
1	Command Code	V2040		V2040		Set to 20 (Pulse at Velocity)
2	Parameter 1	V2041		V2041		Set initial run frequency (20Hz-25000Hz)
3	Parameter 2	V2042		V2042		Duty cycle (1-99) (can leave 0 for 50%)
4	Parameter 3	V2031 / V2030		V2031 / V2030		Number of pulses (DWord) set to FFFF FFFF for no limit
5	Set Direction	V2056.4		C224		Set ON or OFF for Direction of Rotation
6	Process Command	V2056.7		C227		Turn ON Command Complete status bit is returned (see step 4)
7	Command Status		V2022.7		C127	When ON, command has been accepted, clear Process Command bit (step 3)
8	Enable Output	V2056.0		C220		Turn ON to start pulses
9	Disable Output	V2056.0		C220		Turn OFF to start pulses

While Velocity Control is running, Run Frequency (step 2) and Duty Cycle (step 3) may be actively adjusted simply by writing the variable.

Pulse Output to Input Limit

The Pulse Output to Limit (Command = 0021Hex/BCD) can be used for Home Search routines where a relatively low frequency is used to seek a CTRIO discrete input. The CTRIO input must be assigned for Limit by the CTRIO Workbench utility.

As with Pulse Output at Velocity, set Word Parameter 1 to the desired frequency, Word Parameter 2 Low Byte to the Duty Cycle, and the High Byte to the Edge to Seek.

The Edge to Seek field reads Word Parameter 2 bits 13 and 12 to determine the edge(s) on which to terminate Output Pulses, and bits 9 and 8 to determine which CTRIO Input terminal to use.

Edge(s)	*Bits 15..12*	*CTRIO Input*	*Bits 11..8*
Rising	0000, 0Hex	Ch 1 C	0000, 0Hex
Falling	0001, 1Hex	Ch 1 D	0001, 1Hex
Both	0010, 2Hex	Ch 2 C	0010, 2Hex
		Ch 2 D	0011, 3Hex

Run Velocity on CTRIO Y0 & Y1 until Discrete Input Limit

Steps	*Name*	*PLC Control Outputs Base Addr = V2030 (Bit-of-Word)*	*PLC Status Inputs Base Addr = V2000 (Bit-of-Word)*	*PLC Control Outputs Base Addr = V2030 (Control Relay)*	*PLC Status Inputs Base Addr = V2000 (Control Relay)*	*Action*
1	Command Code	V2040		V2040		Set to 21 (Pulse at velocity until discret input limit))
2	Parameter 1	V2041		V2041		Set initial run frequency (20Hz-25000Hz)
3	Parameter 2	V2042		V2042		Select discrete input edge in high byte, low byte = duty cycle (1-99) Example: rising input 1D at Duty = 45%, set this parameter to 212D Hex
4	Set Direction	V2056.4		C221		Set ON or OFF for Direction of Rotation
5	Process Command	V2056.7		C227		Turn ON until Command Complete status bit is returned (see step 4)
6	Command Status		V2022.7		C127	When ON, command has been accepted, clear Process Command bit (step 3)
7	Enable Output	V2056.0		C220		Turn ON to start pulses
8	Output Active Status		V2022.4		C124	ON while pulsing, OFF when limit has stopped pulsing

Pulse Output to Input Limit Examples

Example 1: To run to a Rising Edge Limit on Channel 1's C Input at 50% Duty Cycle, use Word Parameter 2 = 0000 Hex. (Duty Cycle = 00 also creates 50% duty)

Example 2: To run to a Falling Edge Limit on Channel 2's C Input at 20% Duty Cycle, use Word Parameter 2 = 1214 Hex.

Pulse Output to Position

The Pulse Output to Position command (Command = 0022Hex/BCD) allows Pulse Outputs that terminate when a specific Input Function Value is obtained. Set Word Parameter 1 to the desired Frequency (As with Velocity and Run to Limit). Set Word Parameter 2 Low Byte to the Duty Cycle and the High Byte to the Compare Function as defined below.

The Compare Function field defines either greater or less than any of the four CTRIO Input Function Values. The compare will take place against Input DWord Parameter 1 of the selected Function. The CTRIO reads command code bit 12 to determine if the compare is "greater than or equal" or "less than". It reads bits 9 and 8 to determine the Input Function to use for comparison.

Comparison	***Bits 15..12***
Greater Than or Equal	0000, 0Hex
Less Than	0001, 1Hex

Input Function	***Bits 11..8***
Ch 1 Fn 1	0000, 0Hex
Ch 1 Fn 2	0001, 1Hex
Ch 2 Fn 1	0010, 2Hex
Ch 2 Fn 2	0011, 3Hex

Run Velocity on CTRIO until Function Input Value

Steps	***Name***	***PLC Control Outputs Base Addr = V2030 (Bit-of-Word)***	***PLC Status Inputs Base Addr = V2000 (Bit-of-Word)***	***PLC Control Outputs Base Addr = V2030 (Control Relay)***	***PLC Status Inputs Base Addr = V2000 (Control Relay)***	***Action***
1	Command Code	V2040		V2040		Set to 22 (Pulse at velocity until Function Input Limit)
2	Parameter 1	V2041		V2041		Set initial run frequency (20Hz-25000Hz)
3	Parameter 2	V2042		V2042		Select discrete input edge in high byte, low byte = duty cycle (1-99) Example: rising input 1D at Duty = 45%, set this parameter to 212D Hex
4	Parameter 3	V2031 / V2030		V2031 / V2030		Function DWord value for comparison
5	Set Direction	V2056.4		C224		Set ON or OFF for Direction of Rotation
6	Process Command	V2056.7		C227		Turn ON until Command Complete status bit is returned (see step 4)
7	Command Status		V2022.7		C127	When ON, command has been accepted, clear Process Command bit (step 3)
8	Enable Output	V2056.0		C220		Turn ON to start pulses
9	Output Active Status		V2022.4		C124	ON while pulsing, OFF when limit has stopped pulsing

Run Velocity until Function Value Example

While Run Velocity to Function Input Value is running, Run Frequency (Step 2) and Duty Cycle(Step 3) may be actively adjusted simply by writing the variable.

Example: To run a Pulse Output at 30% duty until Ch2 Fn 1 is at 100,000, write 100,000 to DWord Parameter 3, set the desired Frequency in Word Parameter 1, set Word Parameter 2 to 1E Hex (Hex 1E = 30% Decimal), set the proper direction bit, then load and execute Command Code = 22, and finally set the Enable Output bit. The Output will Pulse until Ch2 Fn1's Input DWord Parameter 1 gets to 100,000.