Overview

This document will detail the interface for the I/O definitions assigned by the CTRIO Workbench utility. The CTRIO Workbench is the only method for configuring the CTRIO wiring terminals as well as its internal counting and timing functions.

The control variables described herein are **Output** from the CPU/controller slot and used to control behaviors on the CTRIO. Associated data, status and error feedback are **Input** from the CTRIO module are described as well. The programmer's interface will allow the following actions on a previously configured CTRIO module:

Counter/Timer/Input Functions

- Enable Capture of Function Value upon Input Edge
- Enable Capture for an Edge-Timing Function
- Enable Capture for a Qualified Pulse Input
- Reset of a Function Value

Discrete Outputs Pre-Assigned to Counter/Timer Functions

- Enable or Disable the Discrete Output
- Edit Steps of pre-existing Preset Tables
- Load a pre-existing Preset Table to the Runtime Table
- Write RAM Configuration (Edited Table Steps) to Flash ROM
- Create a Single Runtime Preset Condition
- Create a new Runtime Preset Table (Runtime Table Edits are not savable to ROM)
- Add Preset Step Entries to the Runtime Table

Pulse Outputs

- Enable or Disable the Pulse Output
- Activate or Deactivate a Pre-existing Pulse Profile Table
- Index to a Dynamic Pulse Position
- Output Pulses at Velocity
- Output Pulses at Velocity until CTRIO Discrete Input Limit
- Output Pulses at Velocity until Input Function Value

Allocated I/O Memory

The CTRIO allocates the following I/O memory for each of the 4 Counter/Timer Input Functions:

- 2 Function DWords for reporting Counts or Time (Inputs to CPU/controller)
- 8 Function Control Bits (Outputs from CPU/controller)
- 8 Function Status Bits (Inputs to CPU/controller)

The CTRIO allocates the following I/O memory for each of the 4 **physical** outputs on the module:

- 1 Output DWord for Pulse Counts or Preset Step Entry (Output fromCPU/controller)
- 3 Output Words for Pulse Control (Output fromCPU/controller)
- 8 Output Control Bits (Outputs fromCPU/controller)
- 8 Output Status Bits (Inputs toCPU/controller)

So the total shared RAM I/O interface per CTRIO module is:

Inputs to CPU/Controller: 4 Functions x (2DW + 8Bits) + 4 Output Status x (8Bits) = 40 bytes

Outputs from CPU/Controller: 4 Functions x (8Bits) + 4 Outputs x (1DW + 3W + 8Bits) = 48 bytes

Accessing CTRIO Data

Memory Map for Inputs From CTRIO (Assume V2000 selected for PLC Input Start Address)

Data Type and Offset Non-PLC Access	Address for PLC Inputs (V2000) (PLC Octal)	DEFINITION	FORMAT (PLC)	BYTES
dwX0	V2000	Ch1/Fn1 Parameter 1	DWord	4
dwX1	V2002	Ch1/Fn1 Parameter 2	DWord	4
dwX2	V2004	Ch1/Fn 2 Parameter 1	DWord	4
dwX3	V2006	Ch1/Fn 2 Parameter 2	DWord	4
dwX4	V2010	Ch2/Fn1 Parameter 1	DWord	4
dwX5	V2012	Ch2/Fn1 Parameter 2	DWord	4
dwX6	V2014	Ch2/Fn 2 Parameter 1	DWord	4
dwX7	V2016	Ch2/Fn 2 Parameter 2	DWord	4
bX0..7 bX8..15	V2020	Ch1/Fn1 Status (Low Byte) Ch1/Fn2 Status (High Byte)	Word	2
bX16..23 bX24..31	V2021	Ch2/Fn1 Status (Low Byte) Ch2/Fn2 Status (High Byte)	Word	2
bX32..39 bX40..47	V2022	Output 0 Status (Low Byte) Output 1 Status (High Byte)	Word	2
bX48..55 bX56..63	V2023	Output 2 Status (Low Byte) Output 3 Status (High Byte)	Word	2

Memory Map for Outputs To CTRIO (Assume V3000 selected for PLC Output Start Address)

Data Type and Offset Non-PLC Access	Address for PLC Outputs (V3000) (PLC Octal)	DEFINITION	FORMAT (PLC)	BYTES
dwY0	V3000	Output 0 DWord Parameter 3	DWord	4
dwY1	V3002	Output 1 DWord Parameter 3	DWord	4
dwY2	V3004	Output 2 DWord Parameter 3	DWord	4
dwY3	V3006	Output 3 DWord Parameter 3	DWord	4
wY0	V3010	Output 0 Command	Word	2
wY1	V3011	Output 0 Word Parameter 1	Word	2
wY2	V3012	Output 0 Word Parameter 2	Word	2
wY3	V3013	Output 1 Command	Word	2
wY4	V3014	Output 1 Word Parameter 1	Word	2
wY5	V3015	Output 1 Word Parameter 2	Word	2
wY6	V3016	Output 2 Command	Word	2
wY7	V3017	Output 2 Word Parameter 1	Word	2
wY8	V3020	Output 2 Word Parameter 2	Word	2
wY9	V3021	Output 3 Command	Word	2
wY10	V3022	Output 3 Word Parameter 1	Word	2
wY11	V3023	Output 3 Word Parameter 2	Word	2
bY0..7 bY8..15	V3024	Ch1/Fn1 Control (Low Byte) Ch1/Fn2 Control (High Byte)	Word	2
bY16..23 bY24..31	V3025	Ch2/Fn1 Control (Low Byte) Ch2/Fn2 Control (High Byte)	Word	2
bY32..39 bY40..47	V3026	Output 0 Control (Low Byte) Output 1 Control (High Byte)	Word	2
bY48..55 bY56..63	V3027	Output 2 Control (Low Byte) Output 3 Control (High Byte)	Word	2

Accessing CTRIO Input Data

Two DWords are given for each of the 4 Input Functions. Based on the CTRIO Workbench configuration, these fields can be any of the data given below:

(Input Function Offsets are always listed in the order of Ch1/Fn1, Ch1/Fn2, Ch2/Fn1, Ch2/Fn2)

DWORD ACCESS (Controller INPUTS)	DWORD OFFSETs	VMemory Offsets from Input Start (PLC in Octal)
DWORD PARAMETER 1	0, 2, 4, 6	0, 4, 10, 14
DWORD PARAMETER 2	1, 3, 5, 7	2, 6, 12, 16

Configured Function From CTRIO WORKBENCH	Input DWORD Parameter 1	Input DWORD Parameter 2
Non-scaled Counter	Raw Count	Not used
Scaled Counter	Scaled Count	Raw Count
Non-scaled Counter with Capture	Raw Count	Captured Value
Scaled Counter with Capture	Scaled Count	Captured Value
Non-scaled Timer	Previous Time (us)	In Progress Time (us)
Scaled Timer	Scaled Interval	In Progress Time (us)
Pulse Catch	Not used	Not used

Controlling CTRIO Functions

In CTRIO Workbench, status and control bit addresses will be defined in the I/O Map section under the corresponding CTRIO Channel and Function ID.

CONTROL BIT	BIT OFFSETs	VMemory Offset from Output Start (PLC in Octal)	READ as:
Enable Count Capture	0, 8, 16, 24	24.0, 24,8, 25.0, 25.8	Level
Enable Timer Capture	0, 8, 16, 24	24.0, 24,8, 25.0, 25.8	Level
Enable Pulse Catch	0, 8, 16, 24	24.0, 24,8, 25.0, 25.8	Level
Reset	1, 9, 17, 25	24.1, 24,9, 25.1, 25.9	Level

STATUS BIT	BIT OFFSETs	VMemory Offset from Input Start (PLC in Octal)
Counter Capture Complete Bit Counter Function is At Reset Value	0, 8, 16, 24 1, 9, 17, 25	20.0, 20.8, 21.0, 21.8 20.1, 20.9, 21.1, 21.9
Timer Capture Start Timer Capture Complete	0, 8, 16, 24 1, 9, 17, 25	20.0, 20.8, 21.0, 21.8 20.1, 20.9, 21.1, 21.9
Pulse Catch Output Pulse State Pulse Catch Start	0, 8, 16, 24 1, 9, 17, 25	20.0, 20.8, 21.0, 21.8 20.1, 20.9, 21.1, 21.9

Bit of Word Convention: If PLC Location V3024 = 514 = 0202 Hex (0000 0010 0000 0010 Binary), the convention V3024.1 is used to represent the 2nd to least significant data bit (1 in this example). Likewise, V3024.9 refers bit position 9 (1 in this example).

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V3024	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0

V3024.9 = 1 V3024.1 = 1

So if a PLC program with CTRIO Vmemory Outputs beginning at V3000 needs to Reset the counter at Channel 1 Function 1, it should write V3024.1 to a 1 (Set V3024 to K0002 Hex = 2). To perform a Reset of the counter at Channel 1 Function 2, the program needs to write V3024.9 to a 1 (Set V3024 to K0200 Hex = 512). If both Functions are to be Reset simultaneously, the program can Set V3024 to K0202 Hex = 514). The program must leave the Reset value(s) set one of the DWord Input value has returned to their Reset condition. This assures that the CTRIO has read the control bits. In order to resume counting, these Reset locations must be written back to 0.

Enable Count Capture (Function control bit 0): When this bit is read as a 1, the CTRIO will then snapshot the count value in Function DWord Parameter 1 when the D input goes from inactive to active. This snapshot data is returned in Function DWord Parameter 2. Per the configuration, this can trigger on either the rising or falling edge of the D input. The Capture Complete bit is available to indicate that the acquisition has occurred. The program will need to turn off the Enable Capture, and watch for the Capture Complete flag to reset to prepare for the next capture cycle.

Enable Timer Capture (Function control bit 0): When this bit is read as a 1, the CTRIO will begin timing when the configured input edge occurs. (If the Free Run Timer option was configured, this Timer control bit is not available). Capture Start status will be reported until the next configured input edge occurs, when Capture Complete comes ON also. The program will need to turn off the Enable Capture, and watch for the Capture Start and Complete flags to reset to prepare for the next cycle.

Enable Pulse Capture (Function control bit 0): When this bit is read as a 1, the CTRIO will begin timing when the configured input edge occurs and return the Pulse Catch Start status bit. If the input signal remains active for the qualification period, the Output Pulse bit and the physical Output, if configured, will turn ON for the pre-configured duration. Unlike the Count or Time capture, the Pulse Capture is automatically re-armed as long as the Enable Pulse Capture bit remains ON.

Reset (Function control bit 1): When the CTRIO Reads this bit high, the DWord input values of Scaled Count/Time, and Raw Count/Time will be returned to the reset value defined in the configuration. The last captured value, if applicable, will remain.

Discrete Output Commands

Preset Table Control

Preset tables for discrete outputs can be manipulated by the command interface described below. The CTRIO Workbench utility can create up to 255 Preset Tables (File Number 1-255). Entries in any of these tables can be edited (in RAM) by the Edit Table Entry command. Modified Tables can be saved to Flash ROM with the Write RAM to ROM command.

Note: *The Write ROM to RAM command copies the entire configuration from RAM to ROM and will leave the CTRIO offline for several seconds. Because the CTRIO Flash ROM is rated for only 100,000 write cycles, it is not wise to perform this command more than a few times per day.*

To add entries to a table via this command interface, the table must first be copied into the RAM scratchpad (RAM Table 0). Tables so edited or created are valid for use, but cannot be written back to ROM.

Commands 10-13 (Load, Clear, Initialize, and Add) operate only on the RAM scratchpad (Table 0).

(Output Control and Status Offsets are always listed in the order of Output 0, Output 1, Output 2, Output 3)

CONTROL BIT	BIT OFFSETs	VMemory Offsets from Output Start (PLC in Octal)	READ as:
Enable Output	32, 40, 48, 56	26.0, 26.8, 27.0, 27.8	Level
Process Command	39, 47, 55, 63	26.7, 26.15, 27.7, 27.15	Rising Edge

STATUS BIT	BIT OFFSETs	VMemory Offsets from Input Start (PLC in Octal)
Command Error	38, 46, 54, 62	22.6, 22.14, 23.6, 23.14
Command Complete	39, 47, 55, 63	22.7, 22.15, 23.7, 23.15

In order to process a command, first the program must load the Command Code and Required Word and DWord 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 an illegal value in either the Command Code or Parameter fields.

WORD CONTROL	WORD OFFSETs	VMemory Offsets from Output Start (PLC in Octal)
COMMAND CODE	0, 3, 6, 9	10, 13, 16, 21
WORD PARAMETER 1	1, 4, 7, 10	11, 14, 17, 22
WORD PARAMETER 2	2, 5, 8, 11	12, 15, 20, 23

DWORD CONTROL	WORD OFFSETs	VMemory Offsets from Output Start (PLC)
DWORD PARAMETER 3	0, 1, 2, 3	0, 2, 4, 6

COMMAND	CODE	WORD PARAMETER1	WORD PARAMETER 2	DWORD PARAMETER 3
Load Table from ROM	10	File Number	-	-
Clear RAM Table	11	-	-	-
Initialize RAM Table	12	-	-	-
Add Table Entry	13	Entry Type	Pulse Time (if applicable)	Preset Count/Time
Edit Table Entry	File & 14	Entry Number & Entry Type	Pulse Time (if applicable)	Preset Count/Time
Edit Table Entry and Reload	File & 15	Entry Number & Entry Type	Pulse Time (if applicable)	Preset Count/Time
Write RAM to ROM	99	-	-	-
Edit Level Response	30	Level Behavior	Deadband	Level Rate Setting

The Load, Clear, Initialize, and Add Entry commands operate on the RAM scratchpad table (File = 0). This table is always the active table. The Edit Table Entry commands operate on the inactive tables in RAM. Tables other than 0 can be written back to ROM with the Write RAM to ROM command.

Fields above separated by a "&" indicate Word Parameters where each byte has a different definition, (High byte & Low byte). For example, to enter the Edit Table Entry command, set the high byte of the command code to the Table File Number you wish to edit, and set the low byte to the Command Code = 14 in hex.

The Entry Number for the Edit Table Entry command is 0 for the first entry and one higher for each following entry.

Entry Type	Code
Write Output ON	0
Write Output OFF	1
Pulse Output ON	2
Pulse Output OFF	3
Toggle Output	4
Reset Function	5

Pulse Time (if applicable) is given in milliseconds (ms).

The format of the Preset Count/Time to be loaded in a step entry is equal to the format of Input DWord Parameter 1 from the associated Input Function. See section on Accessing CTRIO Data.

All Word values for Pulse Table commands are considered unsigned integers. The DWord values are 2's complement integers.

Discrete Outputs Driven from a Scaled Level

If a Counter or Timer function is scaled to produce a rate, then Discrete Outputs may be assigned in the CTRIO Workbench to change state when the function's rate achieves a stated level. 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. For example a Discrete Output set to turn ON when a level gets to 100 with a 10% deadband will turn ON when the level gets to 100. However, because of the 10% deadband, the Output will remain ON until the level falls to 90, where it will turn OFF until the level again reaches 100.

To edit the behavior of a Discrete Output triggered by a Rate Level from a counter or timer source, use the Edit Level Response Command (Command Code = 30 Hex).

The Level Behavior Setting for Word Parameter 1 is given below:

Level Behavior for Discrete Output	Word Parameter 1
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

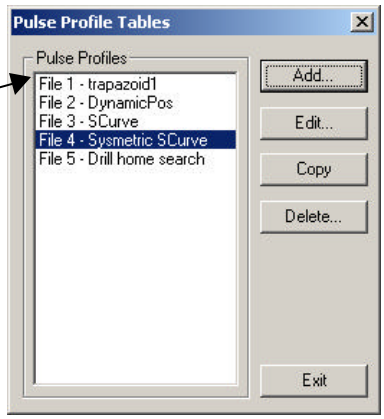
The Deadband is written to Word Parameter 2 as a x10 Integer. For example, to achieve a 10.0% deadband, the program needs to write 100 (=0064 Hex) to Word Parameter 2.

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

Pulse Output Commands

Pulse Outputs can be generated by the command interface described below. The CTRIO Workbench utility can create up to **255** Pulse Profiles (File Number 1-255). The User will assign file numbers in the Workbench utility from 1 to 255 in the order that Preset Tables or Pulse Profiles are created. A given file number will represent either a Preset Table for Discrete Outputs or a Pulse Profile.

The User will assign file numbers that can be loaded from a controller to determine which profile to run.



Per the configuration written by the CTRIO Workbench, either of the two Pulse Output Channels can output Pulses and Direction, or Up Pulses and Down Pulses.
(Pulse Output Control Offsets are always listed in the order of Outputs 0/1, Outputs 2/3)

CONTROL BIT to CTRIO	BIT OFFSETs	VMemory Offsets from Output Start (PLC in Octal)	READ as:
Enable Output	32, 48	26.0, 27.0	Level
Output Direction (1=CCW)	33, 49	26.1, 27.1	Level
Load and Seek New Dynamic Position	34, 50	26.2, 27.2	Rising Edge
Process Command	39, 55	26.7, 27.7	Rising Edge

STATUS BIT from CTRIO	BIT OFFSETs	VMemory Offsets from Input Start (PLC in Octal)
Pulse Active	32, 48	22.0, 23.0
Pulse Error by CTRIO	33, 49	22.1, 23.1
New Dynamic Position Loaded	34, 50	22.2, 23.2
Command Error	38, 54	22.6, 23.6
Command Complete	39, 55	22.7, 23.7

WORD CONTROL to CTRIO	WORD OFFSETs	VMemory Offsets from Output Start (PLC in Octal)
COMMAND CODE	0, 6	10, 16
WORD PARAMETER 1	1, 7	11, 17
WORD PARAMETER 2	2, 8	12, 20

DWORD CONTROL to CTRIO	WORD OFFSETs	VMemory Offsets from Output Start (PLC)
DWORD PARAMETER 1	0, 2	0, 4

COMMAND to CTRIO	CODE	WORD PARAMETER 1	WORD PARAMETER 2	DWORD PARAMETER 3
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 (20-25000 Hz)	Duty Cycle (0 to 99)*	Number of Pulses
Pulse Output to Limit	21	Run Frequency (20-25000 Hz)	Edge & Duty Cycle (0 to 99)*	-
Pulse Output to Position	22	Run Frequency (20-25000 Hz)	Compare Function & Duty Cycle (0 to 99)*	Desired Input Function Value

* A Duty Cycle value of 0 will also generate 50%.

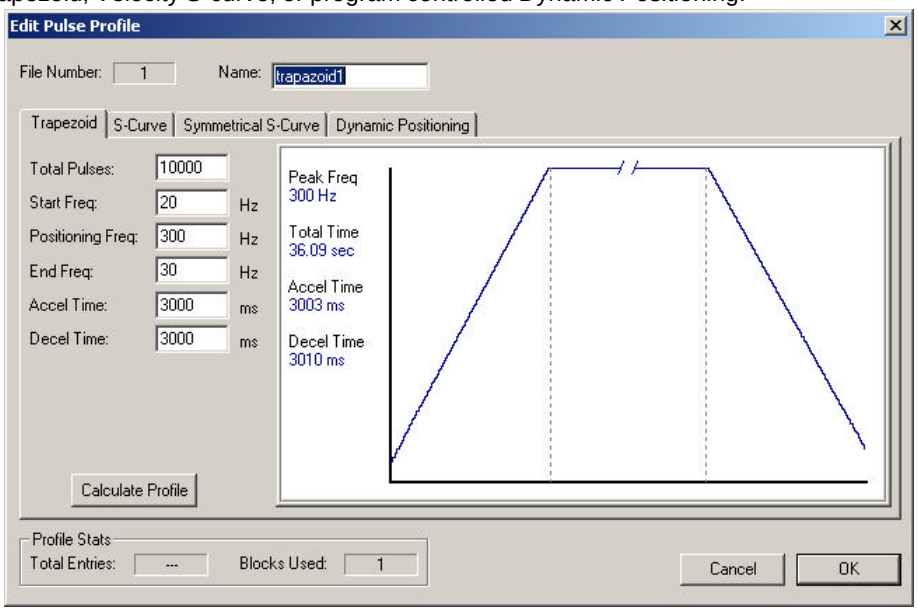
Fields above separated by a "&" indicate a Code where each byte has a different definition, (High byte & Low byte). For example, to enter the Pulse Output to Limit command, set the high byte of the Word Parameter 2 to the Edge you wish to terminate the Output Pulses (see definition following), and set 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 an illegal value in either the Command Code or Parameter fields.

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). 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 (STATUS BIT from CTRIO)

Name	PLC Example 1: V2000 as Base Input Address	PLC Example 2: V40600 as Base Input Address	Value
Output Enabled	V2022.0	V40622.0 or C440	ON when Enable Output is ON
Position Loaded	V2022.1	V40622.1 or C441	Used for Dynamic Positioning
Output Active	V2022.4	V40622.4 or C444	ON when Output is Pulsing
Output Stalled	V2022.5	V40622.5 or C445	CTRIO Output Fault Should Never be ON
Command Error	V2022.6	V40622.6 or C446	ON if Command or Parameters are Invalid
Command Complete	V2022.7	V40622.7 or C447	On if module receives Process Command

Control Registers (From Controller to CTRIO)

Name	PLC Example 1: V2030 as Base Output Address	PLC Example 2: V40650 as Base Output Address	# Format
Command Code	V2040	V40660	Decimal
Parameter 1	V2041	V40661	Decimal
Parameter 2	V2042	V40662	Decimal
Parameter 3	V2031 / V2030	V40651-50	Signed Decimal
Enable Output	V2056.0	V40676.0 or C1740	Discrete
Goto Position	V2056.1	V40676.1 or C1741	Discrete
Direction	V2056.4	V40676.4 or C1744	Discrete
Process Command	V2056.7	V40676.7 or C1747	Discrete

Trapezoid or S-Curve profiles

For pre-defined Trapezoid or S-Curve profiles, the program needs to prepare the Load Table command by selecting **Command Code = 10** and setting Word Parameter 1 to the File number of the profile (*example: **File 1 Trapezoid1***). 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 by 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 data mapped in the word and CR bit areas of CPU Memory:

Easy Steps to Run a Trapezoid or S-Curve Profile on CTRIO Y0 & Y1

		Example 1 Mapped I/O		**Example 2 Mapped I/O**		
Steps	**Name**	**PLC Control Outputs Base Addr = V2030**	**PLC Status Inputs Base Addr = V2000**	**PLC Control Outputs Base Addr = V40650 (C1200)**	**PLC Status Inputs Base Address = V40600 (C0)**	**Action**
1	Command Code	V2040		V40660		Set to K10 (Load Stored Profile)
2	Parameter 1	V2041		V40661		File # of stored profile, User determines
3	Process Command	V2056.7		V40676.7 or C1747		Turn ON until Command Complete Status Bit is Returned (see step 4)
4	Command Status		V2022.7		V40622.7 or C447	When ON, Profile is now Loaded Clear Process Command Bit (step 3)
5	Set Direction	V2056.4		V40676.1 or C1741		Set ON or OFF for Direction of Rotation
6	Enable Output	V2056.0		V40676.0 or C1740		Turn ON to Start Pulses
7	Enable Status		V2022.0		V40622.0 or C440	When ON, module is confirming Enable Output
8	Output Status		V2022.4		V40622.4 or C444	When ON, module is Pulsing, OFF with Enable Status ON = Profile has completed
9	Disable Output	V2056.0		V40676.0 or C1740		Turn OFF when Pulse Status is OFF AND Enable Status is ON

To Re-launch a Loaded Profile, simply 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 state 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.

Easy Steps to Dynamic Positioning on CTRIO Y0 and Y1

		Example 1 Mapped I/O		Example 2 Mapped I/O		
Steps	**Name**	**PLC Control Outputs Base Addr = V2030**	**PLC Status Inputs Base Addr = V2000**	**PLC Control Outputs Base Addr = V40650 (C1200)**	**PLC Status Inputs Base Address = V40600 (C0)**	**Action**
1	Command Code	V2040		V40660		Set to K10 (Load Stored Profile)
2	Parameter 1	V2041		V40661		File # Containing VMin, VMax, and Accel
3	Process Command	V2056.7		V40676.7 or C1747		Turn ON until Command Complete Status Bit is Returned (see step 4)
4	Command Status		V2022.7		V40622.7 or C447	When ON, Profile is now Loaded Clear Process Command Bit (step 3)
5	Enable Output	V2056.0		V40676.0 or C1740		Turn ON to assume 0 position Turn OFF to disable pulses and zero pos.
6	Enable Status		V2022.7		V40622.7 or C447	When ON, Pulses are Now Enabled And Last Position is Retained
7	Parameter 3	V2031/V2030		V40662/V40661		Target position: User defined (DWord)
8	Go To Position	V2056.1		V40676.1 or C1741		Starts Pulses with direction to obtain the new position relative to previous position
9	Position Loaded Status		V2022.1		V40622.1 or C441	When ON, Go To Position is Acknowledged
	Output Active Status		V2022.4		V40622.4 or C444	When ON, module is Pulsing, OFF with Position Loaded Status ON = New Position Move has completed
10	Go To Position	V2056.1		V40676.1 or C1741		Turn OFF to be ready to load a new position

To Seek the Next Position, simply 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). 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 in 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.***

Easy Steps to Run Velocity Control on CTRIO Y0 & Y1

		Example 1 I/O Mapping		Example 2 I/O Mapping		
Steps	**Name**	**PLC Control Outputs Base Addr = V2030**	**PLC Status Inputs Base Addr = V2000**	**PLC Control Outputs Base Addr = V40650 (C1200)**	**PLC Status Inputs Base Address = V40600 (C0)**	**Action**
1	Command Code	V2040		V40660		Set to K20 (Pulse at Velocity)
2	Parameter 1	V2041		V40661		Set Initial Run Frequency (20-25000 Hz)
3	Parameter 2	V2042		V40662		Duty Cycle (1-99) (Can leave 0 for 50%)
4	Parameter 3	V2031/V2030		V40662/V40661		Number of Pulses (DWord) Set to FFFF FFFF for No Limit
5	Set Direction	V2056.4		V40676.1 or C1741		Set ON or OFF for Direction of Rotation
3	Process Command	V2056.7		V40676.7 or C1747		Turn ON until Command Complete Status Bit is Returned (see step 4)
4	Command Status		V2022.7		V40622.7 or C447	When ON, Command has been accepted Clear Process Command Bit (step 3)
6	Enable Output	V2056.0		V40676.0 or C1740		Turn ON to Start Pulses
7	Disable Output	V2056.0		V40676.0 or C1740		Turn OFF to Stop 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 = 21) is very similar to Pulse Output at Velocity. It 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**
Rising	0000, 0 Hex
Falling	0001, 1 Hex
Both	0010, 2 Hex

CTRIO Input	**Bits 11..8**
Ch1 C	0000, 0 Hex
Ch1 D	0001, 1 Hex
Ch2 C	0010, 2 Hex
Ch2 D	0011, 3 Hex

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.

Easy Steps to Run Velocity on CTRIO Y0 & Y1 until Discrete Input Limit

Note: Discrete Input must be Configured for this Function by CTRIO Workbench or else a Command Error will occur.

		Example 1 I/O Mapping		Example 2 I/O Mapping		
Steps	**Name**	**PLC Control Outputs Base Addr = V2030**	**PLC Status Inputs Base Addr = V2000**	**PLC Control Outputs Base Addr = V40650 (C1200)**	**PLC Status Inputs Base Address = V40600 (C0)**	**Action**
1	Command Code	V2040		V40660		Set to K21 (Pulse at Velocity until Discrete Input Limit)
2	Parameter 1	V2041		V40661		Set Initial Run Frequency (20-25000 Hz)
3	Parameter 2	V2042		V40662		Select Discrete Input Edge in High Byte Low Byte is Duty Cycle (1-99) Example: Rising Input 1D at Duty = 45% Set This Parameter to 212D Hex
4	Set Direction	V2056.4		V40676.1 or C1741		Set ON or OFF for Direction of Rotation
5	Process Command	V2056.7		V40676.7 or C1747		Turn ON until Command Complete Status Bit is Returned (see step 4)
4	Command Status		V2022.7		V40622.7 or C447	When ON, Command has been accepted Clear Process Command Bit (step 3)
6	Enable Output	V2056.0		V40676.0 or C1740		Turn ON to Start Pulses
7	Output Active Status		V2022.4		V40622.4 or C444	ON While Pulsing OFF When Limit has Stopped Pulsing

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

Pulse Output to Position

The Pulse Output to Position command (Command = 22) 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	0001, 1 Hex
Less Than	0000, 0 Hex

Input Function	Bits 11..8
Ch1 Fn1	0000, 0 Hex
Ch1 Fn 2	0001, 1 Hex
Ch2 Fn 1	0002, 2 Hex
Ch2 Fn 2	0003, 3 Hex

Easy Steps to Run Velocity on CTRIO Y0 & Y1 until Function Input Value

		Example 1 I/O Mapping		Example 2 I/O Mapping		
Steps	**Name**	**PLC Control Outputs Base Addr = V2030**	**PLC Status Inputs Base Addr = V2000**	**PLC Control Outputs Base Addr = V40650 (C1200)**	**PLC Status Inputs Base Address = V40600 (C0)**	**Action**
1	Command Code	V2040		V40660		Set to K21 (Pulse at Velocity until Discrete Input Limit)
2	Parameter 1	V2041		V40661		Set Initial Run Frequency (20-25000 Hz)
3	Parameter 2	V2042		V40662		Select Compare Function in High Byte Low Byte is Duty Cycle (1-99) Example: Until Greater than or Equal to Ch 2 Function 1 at Duty = 45% Set This Parameter to 2D Hex
4	Parameter 3	V2031/V2030		V40651/V40650		Function DWord Value for Comparison
5	Set Direction	V2056.4		V40676.1 or C1741		Set ON or OFF for Direction of Rotation
6	Process Command	V2056.7		V40676.7 or C1747		Turn ON until Command Complete Status Bit is Returned (see step 4)
7	Command Status		V2022.7		V40622.7 or C447	When ON, Command has been accepted Clear Process Command Bit (step 3)
8	Enable Output	V2056.0		V40676.0 or C1740		Turn ON to Start Pulses
9	Output Active Status		V2022.4		V40622.4 or C444	ON While Pulsing OFF When Limit has Stopped Pulsing

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 12E 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.