Introduction to the CTRIO & CTRIO2 Modules

In This Chapter...

Introduction

The Purpose of this Manual

This manual is intended as a help for the user to install, program, and maintain the CTRIO(2) module in their system. This manual contains important information for personnel who will install the CTRIO(2) high-speed counter module as well as for the PLC programmer. This manual will provide all the information needed for the novice and seasoned automation professional alike to start and keep your system up and running.

Online Help Files and Other Documentation

Regardless of the platform you are using, the programming software needed for the CTRIO(2) modules is available as a download from our website.

http://www.aboutplcs.com/

Each programming software includes searchable online help topics covering all aspects of the software, instruction set, module setup, and communications.

Technical Support

We strive to make our manuals the best in the industry. We rely on your feedback to let us know if we are reaching our goal. If you cannot find the solution to your particular application, or, if for any reason you need technical assistance, please call us at:

1-770–844–4200

Our technical support group will work with you to answer your questions. They are available Monday through Friday from 9:00 A.M. to 6:00 P.M. Eastern Time. We also encourage you to visit our web site where you can find information about our company and specific technical information about a wide array of our products, **www.automationdirect.com.**

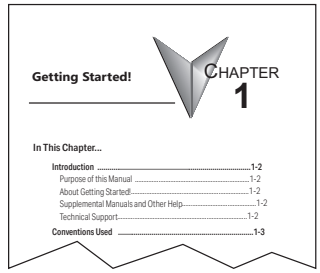
Conventions Used

NOTE: *When you see the "note pad" icon in the left-hand margin, the paragraph to its immediate right will be a special note. Notes represent information that may make your work quicker or more efficient. The word* ***NOTE*** *in boldface will mark the beginning of the text.*

WARNING! When you see the "exclamation point" icon in the left-hand margin, the paragraph to its immediate right will be a warning. This information could prevent injury, loss of property, or even death in extreme cases. Any warning in this manual should be regarded as critical information that should be read in its entirety. The word WARNING in boldface will mark the beginning of the text.

Key Topics for Each Chapter

The beginning of each chapter will list the key topics that can be found in that chapter.


Getting Started!
CHAPTER 1
In This Chapter...
Introduction 1-2
Purpose of this Manual 1-2
About Getting Started 1-2
Supplemental Manuals and Other Help 1-2
Technical Support 1-2
Conventions Used 1-3

Icons

CTRIO(2) modules are available for several hardware platforms, including DL05/06, DL205, DL405 and Terminator. Among these four hardware platforms, there are a variety of CPUs that can occupy the CPU slot, including, Do-more, *Direct*LOGIC or WinPLC. There are also several communication interface modules that could occupy the CPU slot, including EBCs, Modbus, DeviceNet or Profibus.

Throughout this manual, a set of icons (on right) is used to designate which hardware platform a topic applies to, based on what module is in the CPU slot.

☑ DM
☑ DL
☑ Win
☑ NI

Icon Legend:

Do-more icon- Topic is applicable when CTRIO(2) is used with a Do-more CPU or in a slave on a Do-more CPU's Ethernet I/O network.

☑ DM

DirectLOGIC icon- Topic is applicable when CTRIO(2) is used with a DirectLOGIC CPU.

☑ DL

WinPLC icon- Topic is applicable when CTRIO(2) is used with a WinPLC CPU.

☑ Win

Network Interface icon- Topic is applicable when CTRIO(2) is used with any of the network interfaces: EBC (see **Do-more icon** instead if EBC is a slave on Do-more Ethernet I/O network) DeviceNet, Profibus or Modbus.

☑ NI

CTRIO and CTRIO2 Module Overview

A CTRIO(2) module is a programmable motion co-processor capable of accepting a variety of encoder or discrete sensor inputs, accepting commands from the CPU, natively executing simple control algorithms, and generating a variety of pulse-type motion control signals or discrete actuator outputs. A CTRIO can be used for a wide variety of basic motion tasks. Most commonly, a CTRIO module is used to:

- Track an encoder
- Calculate rate from an encoder
- Execute homing routines
- Generate simple motion profiles
- Send pulse train control signals to a stepper or servo amplifier
- Precisely fire a discrete output based on the position read from an encoder


H0-CTRIO(2)


H2-CTRIO(2)


H4-CTRIO


T1H-CTRIO(2)

NOTE: *The T1H-CTRIO(2) is only supported by the T1H-EBC, T1H-EBC100 and T1H-PBC (Retired 08/20).*

Available Functions

The various functions available in a CTRIO(2) module are enumerated in the following text. There are however, limitations and dependencies to keep in mind.

- An H0-CTRIO(2) module has 4 input points on its single channel. The H2-CTRIO(2) modules have 8 input points split between two channels. Although each channel of a CTRIO(2) module has four input points, a channel may have only two counters/quad counters defined. The counter/quad counter inputs appear as Function 1 and Function 2 in CTRIO Workbench.
- Some functions rely on another function being enabled. For example, scaling cannot be selected until other inputs have been configured as a counter or quad counter. The dependencies are enforced by CTRIO Workbench software to ensure that an invalid configuration cannot be created.

If a function cannot be found in CTRIO Workbench, try enabling the function(s) on which it might depend.

Inputs:

Input types accepted:

- Quadrature encoder with AB or ABZ
- Counter (tachometer)
- Discrete (photo eye, limit switch, Z pulse, etc.)

Functions available for discrete inputs:

- Pulse catch (high-speed discrete input with programmable filter)
- Timing: edge timer (period), dual edge timer (time difference of two inputs)
- Reset counts (Z input from encoder)
- Capture counts (copy counts of one of the counter inputs to a register)
- Inhibit counting (freeze one of the counter inputs)
- Limit for pulse output functions (CTRIO2, home switch on an axis)

Scaling of timing functions or encoder inputs:

- Rate scaling (allows the CTRIO(2) to provide encoder data to the PLC in engineering units)
- Position scaling (allows the CTRIO(2) to provide encoder data to the PLC in engineering units)

Outputs:

Assign the output points:

- Stepper control: Step/Direction or CW/CCW
- Discrete

Pulse profiles for stepper outputs to follow:

- Dynamic Position Plus, Trapezoid Plus, Trapezoid with Limits (homing) (CTRIO2 only and CTRIO, Workbench v2.2.0 or later required)
- Trapezoid, S-curve, Symmetrical S-curve, Dynamic Position, Dynamic Velocity
- Home Search, Free Form

Associate output functions with inputs

- Programmable Limit Switch or 'PLS' (CTRIO2 only and CTRIO Workbench v2.2.0 or later required)
- Preset tables.

Unsuitable Applications

There are some applications the CTRIO(2) specifications appear to support that are not feasible. Common applications a CTRIO(2) cannot readily handle are listed below. If in doubt regarding your application, please contact Automationdirect Tech Support for assistance.

Closed loop control: CTRIO2 modules are capable of very basic closed loop control. However, they do not have full functionality expected of a typical dedicated closed loop controller. Most notably, position or velocity errors are not reported and there is no built-in error alarming.

- CTRIO modules do not support any closed loop control. Trying to use the CPU to close the control loop will produce unacceptable results due to excessive latency.

Coordinated motion: Some CTRIO(2) modules have enough outputs to control multiple axes, but there is no internal mechanism to coordinate them. Axes can move simultaneously, but not with coordination.

Follower: CTRIO(2) modules cannot support follower applications natively. Trying to use the CPU to close the control loop will produce unacceptable results due to excessive latency.

Precise registration: There is no means for precisely timing the start of a motion profile. Motion profiles are initiated by the controller in the base, so scan time latency of the controller is always a factor.

Absolute encoders: A CTRIO(2) module cannot read an absolute encoder.

Mechanical contacts as counter or encoder inputs: Reliable readings are not possible using mechanical contacts. The bounce of mechanical contacts will cause the CTRIO(2) to see more edges than intended.

Direct connection to TTL, line driver or differential encoders: A CTRIO(2) module cannot accept these low voltage inputs directly. These signals need to be level shifted as shown in Chapter 3: *Installation and Field Wiring*.

Support Systems for the CTRIO(2) Modules

The CTRIO(2) modules are compatible with several CPU-slot interfaces. Consideration must be given to the firmware versions of the CPU-slot interfaces to assure their compatibility with the CTRIO(2) (See Chapter 3 for CPU/CTRIO compatibility listings). Multiple CTRIO(2) modules can reside in the same base provided that the backplane power budget is adequate.

Support Systems for the H0-CTRIO(2):

- DirectLOGIC 05/06 PLC systems

Support Systems for the H2-CTRIO(2):

- DirectLOGIC 205 PLC systems (D2-240, D2-250-1, D2-260, D2-262)
- DL205 WinPLC systems (H2-WPLCx-xx)
- PC-based control strategies using the H2-EBC(100) interface module
- Hx-ERM networks using the H2-EBC(100) interface module
- Profibus systems using the H2-PBC slave interface module
- Do-more PLC systems (H2-DM1, H2-DM1E); See Do-more Designer help file.
- Do-more PLC Ethernet I/O network using H2-EBC100; See Do-more Designer help file.

Support Systems for the H4-CTRIO:

- ***Direct***LOGIC 405 PLC systems (D4-450 OR D4-454 only)
- PC-based control strategies using the H4-EBC interface module
- Hx-ERM networks using the H4-EBC interface module

Support Systems for the T1H-CTRIO:

- PC-based control strategies using the T1H-EBC interface module
- Profibus systems using the T1H-PBC slave interface module (Discontinued 08/2020)
- Hx-ERM networks using the T1H-EBC interface module
- Do-more PLC Ethernet I/O network using T1H-EBC100

CTRIO(2) Specifications

The tables following show general and specific information associated with CTRIO modules.

General						
Module	**H0-CTRIO**	**H0-CTRIO2**	**H2-CTRIO**	**H2-CTRIO2**	**H4-CTRIO**	**T1H-CTRIO**
Module Type	Intelligent					
Modules Per Base	Limited only by power consumption					
I/O Points Used	None, I/O map directly in PLC memory (V-memory for ***Direct***LOGIC PLCs and Data structures for Do-more PLCs) or PC control access					
Field Wiring Connector	Standard removable terminal block					
Internal Power Consumption	250mA at +5V from Base Power Supply (All I/O in ON State at Max Voltage/Current)		400mA Max at +5V from Base Power Supply (All I/O in ON State at Max Voltage/Current)	275mA Max at +5V from Base Power Supply (All I/O in ON State at Max Voltage/Current)	400mA Max at +5V from Base Power Supply (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	1500V I/O to Logic, 1000V among Input Channels and All Outputs	2500V I/O to Logic, 1000V among Input Channels and All Outputs	1500V I/O to Logic, 1000V among Input Channels and All Outputs	2500V I/O to Logic, 1000V among Input Channels and All Outputs	

CTRIO(2) Specifications, cont'd

CTRIO(2) Input Specifications						
Module	**H0-CTRIO**	**H0-CTRIO2**	**H2-CTRIO**	**H2-CTRIO2**	**H4-CTRIO**	**T1H-CTRIO**
Inputs	4 pts. sink/ source 100kHz Max	4 pts. sink/ source 250kHz Max	8 pts. sink/source 100kHz Max	8 pts. sink/source 250kHz Max	8 pts. sink/source 100kHz Max	
Minimum Pulse Width	5 µsec	0.5 µsec	5 µsec	0.5 µsec	5 µsec	
Input Voltage Range	9-30 VDC					
Maximum Voltage	30VDC					
Input Voltage Protection	Zener Clamped at 33VDC					
Rated Input Current	8mA typical, 12mA maximum					
Minimum ON Voltage	9.0 VDC					
Maximum OFF Voltage	2.0 VDC					
Minimum ON Current	5.0 mA (9VDC required to guarantee ON state)					
Maximum OFF Current	2.0 mA					
OFF to ON Response	Less than 3 µsec	Less than 0.5 µsec	Less than 3 µsec	Less than 0.5 µsec	Less than 3 µsec	
ON to OFF Response						
Counter/Timer	2, (2 per single 4 input channel); supports 1 quadrature counter max.		4, (2 per each 4 input channel group); supports 2 quadrature counters max.			
Resource Options	1X, 2X, or 4X Quadrature, Up or Down Counter, Edge Timer, Dual Edge Timer, Input Pulse Catch, Reset, Inhibit, Capture					
Timer Range/ Resolution	4.2 billion (32 bits); 1 µsec (70 minutes)					
Counter Range	±2.1 billion (32 bits or 31 bits + sign bit)					

CTRIO(2) Output Resources						
Module	**H0-CTRIO**	**H0-CTRIO2**	**H2-CTRIO**	**H2-CTRIO2**	**H4-CTRIO**	**T1H-CTRIO**
Pulse output / Discrete outputs	Pulse outputs: 1 channel (2 outputs per single channel) Discrete outputs: 2 pts.		Pulse outputs: 2 channels (2 outputs per each channel) Discrete outputs: 4 pts.			
Resource Options	**Pulse Outputs:** pulse/direction or cw/ccw; Profiles:Trapezoid, S-Curve, Symmetrical S-Curve, Dynamic Positioning, Dynamic Velocity, Home Search, Free Form, Dynamic Positioning Plus (CTRIO2 only),Trapezoid Plus (CTRIO2 only), Trapezoid w/Limits (CTRIO2 only), Velocity Mode, Run to Limit Mode, Run to Position Mode **Discrete Outputs:** configurable for set, reset, pulse on, pulse off, toggle, reset count functions (assigned to respond to Timer/Count input functions). **Raw Mode:** Direct access to discrete outputs from user application program					
Target Position Range	±2.1 billion (32 bits or 31 bits + sign bit)					

CTRIO(2) Specifications, cont'd

CTRIO(2) Output Specifications						
Module	**H0-CTRIO**	**H0-CTRIO2**	**H2-CTRIO**	**H2-CTRIO2**	**H4-CTRIO**	**T1H-CTRIO**
Outputs	2 pts, isolated, either both current sourcing or both current sinking FET Outputs: open drain and source with floating gate drive		4 pts, independently isolated, current sourcing or sinking FET Outputs: open drain and source with floating gate drive			
Pulse Output Control Range	20Hz to 25kHz	20Hz to 250kHz	20Hz to 25kHz	20Hz to 250kHz	20Hz to 25kHz	
Voltage Range	5VDC – 36VDC					
Maximum Voltage	36VDC					
Output clamp voltage	60VDC					
Maximum load current	1.0A	0.5 A at 23°C 0.33 A at 60°C	1.0 A	1.0 A at 23°C, 0.5 A at 60°C	1.0 A	
Maximum load voltage	36VDC	33VDC	36VDC	36VDC	36VDC	
Maximum leakage current	100µA					
Inrush current	5A for 20ms	1A for 10ms	5A for 20ms	2A for 10ms	5A for 20ms	
OFF to ON response	Less than 3 µsec			Less than 1 µsec	Less than 3 µsec	
ON to OFF Response						
ON state V drop	≤ 0.3 V			≤ 0.45 V	≤ 0.3 V	
External power supply	For loop power only, not required for internal module function*					
Overcurrent protection	15A max	15A max; Self resetting overcurrent protection	15A max			
Thermal shutdown	Tjunction = 150°C					
Overtemperature reset	Tjunction = 130°C					
Duty cycle range	1% to 99% in 1% increments (default = 50%)					
Configurable Presets **a) single** **b) multiple**	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					

H0-CTRIO(2) LED Indicators

H0-CTRIO(2) LED Descriptions	
OK	Module OK
ERR	User Program Error
A	Ch1 F1 Resource State
B	Ch1 F2 Resource State
Y0 - Y1	Output Status

H0-CTRIO(2) LED Diagnostics		
LED Status		Status Description
OK	ERR	
ON	OFF	RUN Mode
ON	ON	Hardware Failure
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

H0-CTRIO(2) LED Run Diagnostics Definitions	
A	Blinks when Channel 1 Function 1 is counting or timing
B	Blinks when Channel 1 Function 2 is counting or timing
Y0–Y1	Follow actual output state; ON = output is passing current

H2-CTRIO(2) LED Indicators

H2-CTRIO(2) LED Descriptions	
OK	Module OK
ER	User Program Error
1A	Channel 1 Status
2A	Channel 2 Status
0–3	Output Status

H2-CTRIO(2) LED Diagnostics		
LED Status		Status Description
OK	ER	
ON	OFF	RUN Mode
ON	ON	Hardware Failure (H2-CTRIO)
		Not Used (H2-CTRIO2)
Blinking	Blinking	Boot Mode - Used for Field OS Upgrades
Blinking	OFF	Program Mode
OFF	Blinking	Module Self-diagnostic Failure (Blinks may be coded by counts)
OFF	ON	Module Error Due to Watchdog Timeout
OFF	OFF	No Power to Module

H2-CTRIO(2) LED Diagnostics Definitions	
1A /2A	
Blinking 7 times per second	Input is Configured as Counter and is Changing
Following State of Input	Input is not Configured as Counter
0–3	
Follow actual output state; ON = output is passing current	

H4-CTRIO LED Indicators

H4-CTRIO LED Descriptions	
OK	Module OK
ER	User Program Error
TB	Removed Terminal Block
1A–1D	Ch1A - Ch1D Input Status
2A–2D	Ch2A - Ch2D Input Status
(Ch1) F1–F2	Ch1 Resource State
(Ch2) F1–F2	Ch2 Resource State
Y0–Y3	Output Status

H4-CTRIO LED Diagnostics		
LED Status		Status Description
OK	ER	
ON	OFF	RUN Mode
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
TB		User Terminal Block is not Properly Installed

H4-CTRIO LED Diagnostics Definition	
1A–1D	Follow actual input state / Ch1
2A–2D	Follow actual input state / Ch2
(Ch1) F1	Blinks when Channel 1 Function 1 is counting or timing
(Ch1) F2	Blinks when Channel 1 Function 2 is counting or timing
(Ch2) F1	Blinks when Channel 2 Function 1 is counting or timing
(Ch2) F2	Blinks when Channel 2 Function 2 is counting or timing
Y0–Y3	Follow actual output state; ON = output is passing current

NOTE: *Due to the multiplexed design of the DL405 LED matrix, OFF state LEDs may appear to blink ON slightly. This is to be expected and does not necessarily indicate a transient condition of the function corresponding to the LED.*

T1H-CTRIO LED Indicators

T1H-CTRIO LED Descriptions	
OK	Module OK
ERR	User Program Error
CH1	Channel 1 Status
CH2	Channel 2 Status
1A–1D	Channel 1 A-D Input Status
2A–2D	Channel 2 A-D Input Status
Y0–Y3	Output Status

T1H-CTRIO LED Diagnostics		
LED Status		Status Description
OK	ER	
ON	OFF	RUN Mode
ON	ON	Hardware Failure
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

T1H-CTRIO LED Diagnostics Definitions	
CH1	Blinks when Channel 1 Function 1 is counting or timing
CH2	Blinks when Channel 2 Function 1 is counting or timing
1A–1D	Follow actual input state / Ch1
2A–2D	Follow actual input state / Ch2
Y0–Y3	Follow actual output state; ON = output is passing current

Overview, How it Works as Part of the Control System

Basic Operation

A CTRIO(2) is an intelligent co-processor module. It has to be configured using CTRIO Workbench before it can do anything. It has its own scan time and can be in either program or run mode.

Being an Intelligent Module means that the CTRIO(2) controls its own writes to and reads from CPU memory. The CPU does not directly write to or read from the CTRIO(2). The CTRIO(2) will write to and read from the addresses designated in I/O Map. Understanding this relationship is helpful to understanding the timing (interlocking) requirements for performing operations that require the PLC to make changes to the CTRIO(2) from ladder logic.

Understand that the CPU can only make requests to the CTRIO(2) by turning on specific bits and placing appropriate data in its own memory. The CTRIO(2) reads the data from those addresses in the CPU and then acts on it. The CTRIO(2) provides feedback to the CPU by writing to other CPU memory.

NOTE: A CTRIO(2) is an Intelligent Module. It directly writes to and reads from CPU memory. The CPU cannot directly write to or read from CTRIO(2) memory. The CTRIO(2) writes to and reads from the addresses designated in I/O Map.

After being configured by CTRIO Workbench, a CTRIO(2) module is ready to be placed in run mode. Basic input functions of the CTRIO(2) run automatically, such as reporting counts on an input channel. Output functions are initiated by the controller (the PLC CPU). The controller uses Command Codes to control the output functions of the CTRIO(2), such as executing a pulse profile on an output, or loading or editing a preset table. IBox instructions are macros that use Command Codes. Command Codes and the instructions on their use are found later in this manual.

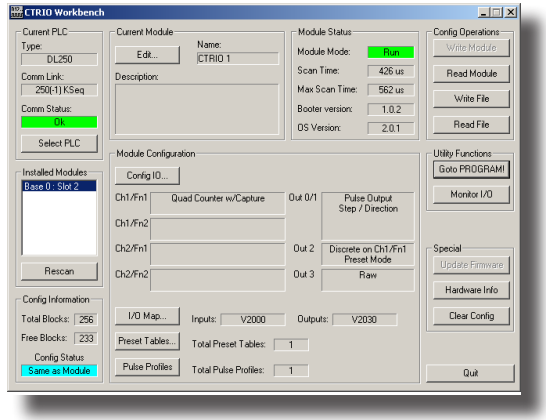
CTRIO Workbench

CTRIO Workbench is the utility used to configure the many functions available for a CTRIO(2) module.

CTRIO Workbench communicates with a CTRIO(2) module through the base controller to configure the CTRIO(2). The configuration is stored in the CTRIO(2) and also stored in a file on your computer. Configuring the CTRIO(2) is a separate process from programming the base controller.

The CTRIO Workbench configuration contains these basic parameters:

- Assignments of the input and output points
- Scaling of inputs (optional)
- Preset Table setup (optional)
- Programmable Limit Switch setup (CTRIO(2), optional)
- Mapping to CPU memory



NOTE: *The CTRIO(2) must be configured in program mode, and the memory must be mapped prior to program execution.*

Command Codes

Command Codes are the instructions available to the CPU to tell the CTRIO what to do. A list of the Command Codes with a brief description of their function are shown in the table below.

Command Code and Parameter Definitions

Command	Code (Hex/BCD)	Word Parameter 1 (decimal)	Word Parameter 2	DWord Parameter 3
Load Table from ROM	10	Trapezoid or S-curve Symmetrical S-Curve Home Search File Number	-	-
Load Table from ROM	10	Dynamic Positioning File Number	-	Target Position (decimal)
Load Table from ROM	10	Dynamic Velocity File Number	-	Target Velocity (decimal)
Velocity Mode	20	Run Frequency (CTRIO: 20Hz - 25KHz CTRIO2: 20Hz - 64KHz)	Duty Cycle (0 to 99)* (decimal)	Number of Pulses (BCD/Hex)
Run to Limit Mode	21	Run Frequency (CTRIO: 20Hz - 25KHz CTRIO2: 20Hz - 64KHz)	Edge & Duty Cycle (0 to 99)* (Hex/BCD)	-
Run to Position Mode	22	Run Frequency (CTRIO: 20Hz - 25KHz CTRIO2: 20Hz - 64KHz)	Compare Function & Duty Cycle (0 to 99)* (Hex/BCD)	Desired Input Function Value (decimal)

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

Those fields 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 turn ON the Process Command bit and look for the CTRIO(2) module to acknowledge the command with the Command Complete bit. Finally, the program should reset the Process Command bit and set the Enable Output bit when appropriate. If the Command Error bit is received, the CTRIO(2) module was unable to process the command due to an illegal value in either the Command Code or parameter files.

DWord and Word values for pulse outputs are unsigned integers (Parameter 3 on some profiles can be signed).

CTRIO(2) Module Work Flow Diagram

The following workflow diagram shows the steps needed, with their associated chapters in this manual, to install and setup a CTRIO(2) module into your system.

DirectLOGIC, WinPLC or EBC