USER MANUAL

RIO-574x0

Manual Revision 1.0e

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EtherCAT®

Using This Manual

This user manual provides information for proper operation of the RIO-574x0 EtherCAT® slave. A separate supplemental manual, the RIO-574x0 Command Reference, contains detailed descriptions of the commands available for use with this EtherCAT slave. It is recommended that the user download the latest version of the Command Reference and User Manual from the Galil website.

http://www.galil.com/downloads/manuals-and-data-sheets

Note: The RIO-574x0 Command Reference only documents commands valid over USB for troubleshooting and configuration.

The RIO-574x0 is a Beckhoff confomance tested, EtherCAT slave and is intended to operate with an EtherCAT Master. Galil's EtherCAT masters, the DMC-500x0 and the DMC-52xx0, are designed to easily operate with the RIO-574x0. For more detail on Galil's line of EtherCAT products, refer to the following link on the Galil website.

http://www.galil.com/ethercat

WARNING!	**Machinery in motion can be dangerous!** It is the responsibility of the user to design effective error handling and safety protection as part of the machinery. Galil shall not be liable or responsible for any incidental or consequential damages.

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https://www.ethercat.org

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Chapter 1: Overview

Introduction

The RIO-574x0 is a remote EtherCAT I/O slave module that provides digital inputs and outputs, with the option of analog inputs and outputs as well. This product is intended to be part of a system with an EtherCAT master such as the DMC-500x0 or DMC-52xx0 series controllers. On-board programs can not be run on the RIO-574x0.

Part Numbering Overview

The RIO-574x0 is available in two base models. These models and their options are summarized in Table 1.1.

For full part number information on the RIO-574x0 product line, see the RIO-574x0 part number generator:
http://www.galil.com/order/part-number-generator/rio-574x0

Base Model	Features	Standard Options
RIO-57410	USB micro And RJ45 EtherCAT In and Out 16 optoisolated digital inputs 16 optoisolated digital outputs Screw terminal connectors	NO DIN
RIO-57420	USB micro And RJ45 EtherCAT In and Out 16 optoisolated digital inputs 16 optoisolated digital outputs 8 ±10V configurable analog inputs 8 ±10V configurable analog outputs Screw terminal connectors	4-20mA 16Bit NO DIN

Table 1.1: RIO-574x0 Part Number Features and Standard Options

Option	Brief Description	Notes
NO DIN	Remove DIN rail mount	Standard configuration includes DIN rail clips
4-20mA	4-20mA analog inputs	
16Bit	16-bit analogs	12-bit standard. This option is applied to both inputs and outputs

Table 1.2: Description of Standard Options

Chapter 2: Getting Started

Installing the RIO-574x0

Installation of a complete, operational RIO-574x0 in an EtherCAT system consists of 2 steps:

Step 1: Connect Power
Step 2: Establish Communications Between RIO- 574x0 and Galil EtherCAT Master

Step 1: Connect Power

The RIO- 574x0 requires an external DC power supply. Refer to the Pin-out section for pin out location and the RIO- 574x0 Specification List for voltage/power requirements for the external supply.

WARNING!	**Damage will occur if improper voltage is applied to the RIO.** Do not supply voltages larger than the indicated maximum.

Any emergency stop or disconnect switches should be installed on the AC input to the DC power supply. Relays and/or other switches should not be installed on the DC line between the Galil and the Power supply.

WARNING!	**Do not apply or cut power to the DC side of the power supply.** When powering on or off the RIO-574x0, make sure to switch the AC side of the external power supply.

Step 2: Establish Communications Between RIO- 574x0 and Galil EtherCAT Master

The following section will cover a basic setup with Galil's DMC-500x0 or DMC-52xx0 EtherCAT master controller. For other EtherCAT masters, refer to its setup documentation and/or use the Appendix for EtherCAT packet structure. For more information regarding setup, refer to the DMC-500x0 and DMC-52xx0 documentation.

http://www.galil.com/motion-controllers/multi-axis/dmc-500x0
http://www.galil.com/motion-controllers/multi-axis/dmc-52xx0

Note: The rest of the manual will refer to the DMC-500x0 or the DMC-52xx0 as "Galil EtherCAT Master".

Note: This section assumes that the user has a basic understanding and access to a Galil EtherCAT Master. For other 3rd party EtherCAT masters, refer to the Quick Start with TwinCAT 3 section in the Appendix for more information.

Setup

- Establish communication with the Galil EtherCAT Master and a PC.
- Set the station ID for the RIO-574x0 using the rotary switches labeled “ECAT ID”. Each slave must have a unique ID.
- Connect a CAT5 cable between the Galil EtherCAT Master's EtherCAT port and the RIO-574x0's EtherCAT port labled “In”.
- Enter the following commands to the Galil EtherCAT Master

```
:EH
 POS     ID     VENDOR    PRODUCT
------------------------------
   1 $0000 $00000599 $00057000
```

When connected to the Galil EtherCAT Master, the `EH` command will report the hardware position, station ID, vendor ID and product code. The position and station ID will vary depending on the positional order of the slaves and the slave's rotary switches, respectively. The vendor ID and product code depend on the manufacturer and the particular product of the slave module. The following table shows the vendor ID and product code for the RIO-574x0.

Galil Vendor ID	RIO-574x0 Product Code
0x00000599	0x00057000

Table 2.1: RIO-574x0 Vendor and Product ID

```
:IO -1
```

The `IO` command is used to assign the RIO-574x0 module as an EtherCAT I/O slave on the EtherCAT network. The argument after the `IO` command is interpreted as the station ID when positive. When negative, the argument is interpreted as the cable position.

```
:EU 1
```

The `EU` command will bring up the RIO-574x0 on the Galil EtherCAT Master's EtherCAT network.

```
:SB 11017
```

The `SB` command is used to set the digital output on the RIO-574x0. The on-board LED on the RIO-574x0 next to the label "IO17" should turn on to verify operation.

CHAPTER 3: I/O

Pin-out

Each RIO- 574x0 has a collection of analog and digital I/O. Refer to Table 1.1 for the type and quantity of I/O available with a particular RIO- 574x0 part number.

All connectors used on the RIO- 574x0 are screw-terminal. The exact pin-out is labeled on the silk-screen of the module. The following table provides a description for each terminal label.

> **Note:** Digital inputs and outputs are labeled as I/O points 1-32. The I/O are not user-configurable; the first 16 are inputs and the last 16 are outputs. Contact Galil if a different I/O configuration is required.

Communication Ports

The RIO-574x0 has two EtherCAT ports (In & Out) and a USB port. If needed, the USB port can be used for configuration and troubleshooting. Refer to the USB Communication section in the Appendix for more detail.

For an EtherCAT application, the EtherCAT ports are used to daisy chain the EtherCAT slaves together on the EtherCAT master's network. Refer to Figure 4.1 below for hardware setup for an EtherCAT network. Standard CAT5 cables are used in-between EtherCAT devices.

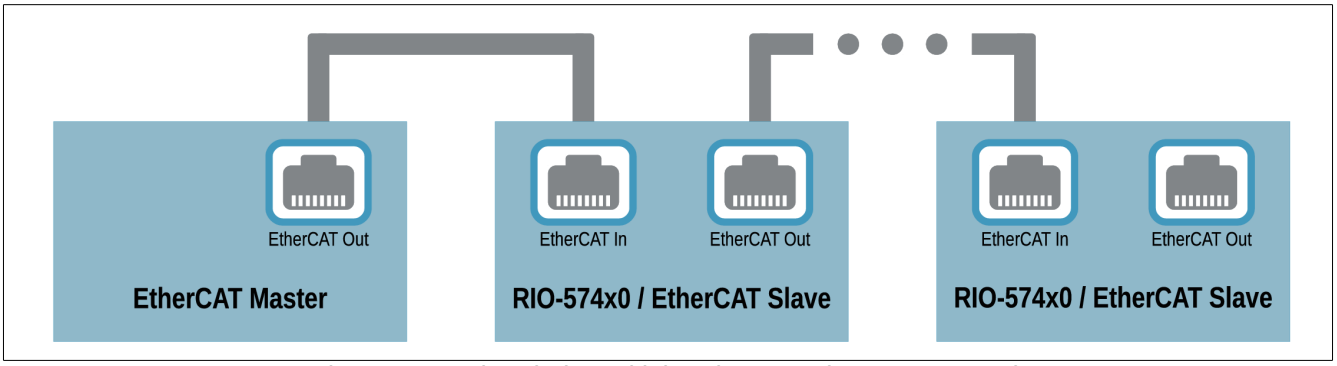


Figure 4.1: Daisy chain multiple EtherCAT slaves on network

I/O & Power Pinout

Pin Labels and Descriptions			
Label	**Description**	**Label**	**Description**
OP1A	Input Common (Bank 1)	OP3A	Output Power (Bank 3)
IO1	Digital I/O 1 - Input	IO17	Digital I/O 17 - Output
IO2	Digital I/O 2 - Input	IO18	Digital I/O 18 - Output
IO3	Digital I/O 3 - Input	IO19	Digital I/O 19 - Output
IO4	Digital I/O 4 - Input	IO20	Digital I/O 20 - Output
IO5	Digital I/O 5 - Input	IO21	Digital I/O 21 - Output
IO6	Digital I/O 6 - Input	IO22	Digital I/O 22 - Output
IO7	Digital I/O 7 - Input	IO23	Digital I/O 23 - Output
IO8	Digital I/O 8 - Input	IO24	Digital I/O 24 - Output
OP1B	NC	OP3B	Output Return (Bank 3)
OP2A	Input Common (Bank 2)	OP4A	Output Power (Bank 4)
IO9	Digital I/O 9 - Input	IO25	Digital I/O 25 - Output
IO10	Digital I/O 10 - Input	IO26	Digital I/O 26 - Output
IO11	Digital I/O 11 - Input	IO27	Digital I/O 27 - Output
IO12	Digital I/O 12 - Input	IO28	Digital I/O 28 - Output
IO13	Digital I/O 13 - Input	IO29	Digital I/O 29 - Output
IO14	Digital I/O 14 - Input	IO30	Digital I/O 30 - Output
IO15	Digital I/O 15 - Input	IO31	Digital I/O 31 - Output
IO16	Digital I/O 16 - Input	IO32	Digital I/O 32 - Output
OP2B	NC	OP4B	Output Return (Bank 4)
AI1	Analog Input 1[1]	AO1	Analog Output 1[1]
AI2	Analog Input 2[1]	AO2	Analog Output 2[1]
AI3	Analog Input 3[1]	AO3	Analog Output 3[1]
AI4	Analog Input 4[1]	AO4	Analog Output 4[1]
AI5	Analog Input 5[1]	AO5	Analog Output 5[1]
AI6	Analog Input 6[1]	AO6	Analog Output 6[1]
AI7	Analog Input 7[1]	AO7	Analog Output 7[1]
AI8	Analog Input 8[1]	AO8	Analog Output 8[1]
AGND	Analog Ground	AGND	Analog Ground
+12	+12V Output Reference	GND	Digital Ground
-12	-12V Output Reference	9-48	Power Supply Input
+5	+5V Output Reference	GND	Digital Ground

Table 3.1: RIO-574x0 Pinout and description

[1] Only available on RIO-57420

Digital I/O

All digital I/O for the RIO- 574x0 are optoisolated and set up in banks of 8 I/O points. Each digital I/O point has a dedicated on-board LED to visually display its active state.

> **Note:** The following sections discuss Galil Commands relating to the relevant digital I/O. Commands that are used with the Galil EtherCAT Master are highlighted in `blue` while commands used with the RIO-574x0 over USB are highlighted in `red`.

Digital Inputs

The RIO- 574x0 has a number of optoisolated digital inputs (refer to Table 1.1 for number of inputs per model). When connected via USB, these inputs can be read individually using the command `@IN[]`, or in banks using the command `TI`. When configured on an EtherCAT network with a Galil EtherCAT master, the inputs can be read individually using the command `@IN[]`, or as a series of inputs using the command `RR`.

Each bank of inputs has its own common reference. To activate an input, apply a voltage in the range of 5-24 VDC to a digital input and its common reference. Refer to Table 4.2 for a list of input commons for the RIO-574x0 model.

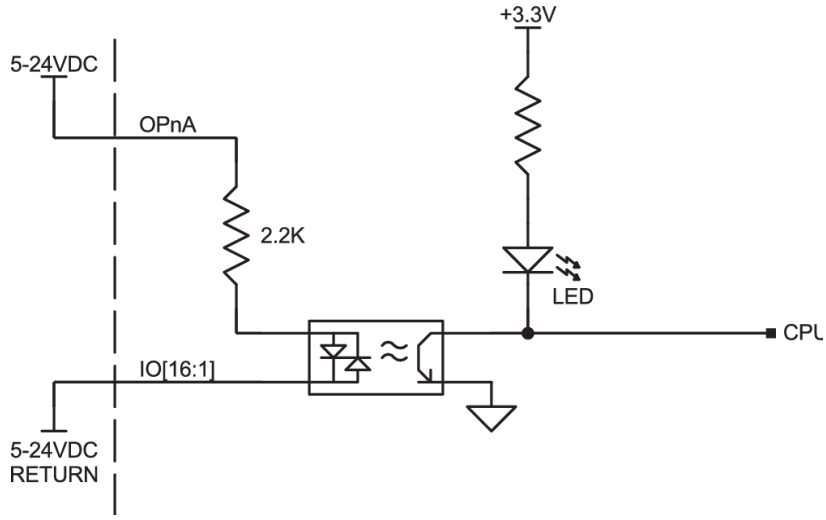
Input Common		
RIO Model	**Bank 1, IO[8:1]**	**Bank 2, IO[16:9]**
RIO-57410, RIO-57420	OP1A	OP2A

Table 4.2: List of Input Commons for each bank given RIO- 574x0 base model

Wiring the Digital Inputs

To take full advantage of optoisolation, an isolated power supply should be used to provide the voltage at the input common connection. Connecting the ground of the isolated power supply to the ground of the module will bypass optoisolation and is not recommended if true optoisolation is desired.

Banks of inputs can be wired as either active high or low. Connecting $+V_s$ to the Input Common will configure the inputs for active low as current will flow through the diode when the inputs are pulled to the isolated ground. Connecting the isolated ground to the Input Common will configure the inputs for active high as current will flow through the diode when the inputs are pulled up to $+V_s$.



Input Bank (n)	Digital I/O
1	IO[8:1]
2	IO[16:9]

Figure 4.2: Optoisolated digital input schematic (active low wiring)

Electrical Specifications

Refer to the RIO- 574x0 Specification List in the Appendix for electrical specifications.

Input Common Jumpers

The input common jumpers provide the flexibility of using the RIO-574x0's internal 5V reference as the power supply for a particular bank's inputs. This will bypass optoisolation and is not recommended for field use. Galil recommends that the input common jumpers only be used for testing when an external power supply is not available.

WARNING!	**Do not connect any power to the Input Common pins (OPnA) when the Input Common jumpers are installed; damage will occur to the unit.**

Each bank requires 2 jumpers to be correctly wired. To install, place one jumper on the location marked nA, and one on nB, where n is the bank number. To activate an input with the input common jumpers installed, short the input to its input reference ground (labeled OPnB).

Digital Outputs

The RIO- 574x0 has a number of optoisolated digital outputs (refer to Table 1.1 for number of inputs per model). When connected via USB, these outputs can be set and cleared individually using the commands SB and CB , or in banks using the command OP. The state of the outputs can similarly be read individually using @OUT[], or in banks using _OPn. When configured on an EtherCAT network with a Galil EtherCAT master, the outputs can be set and cleared individually using the commands SB and CB, or as a series of outputs using the command SR. The state of the outputs can be read individually using @OUT[].

Each bank of outputs has its own common power and reference. To provide power to the digital outputs, the user must supply power to the bank's output power and output return connections Refer to Table 4.3 for a list of input commons for the RIO- 574x0 model.

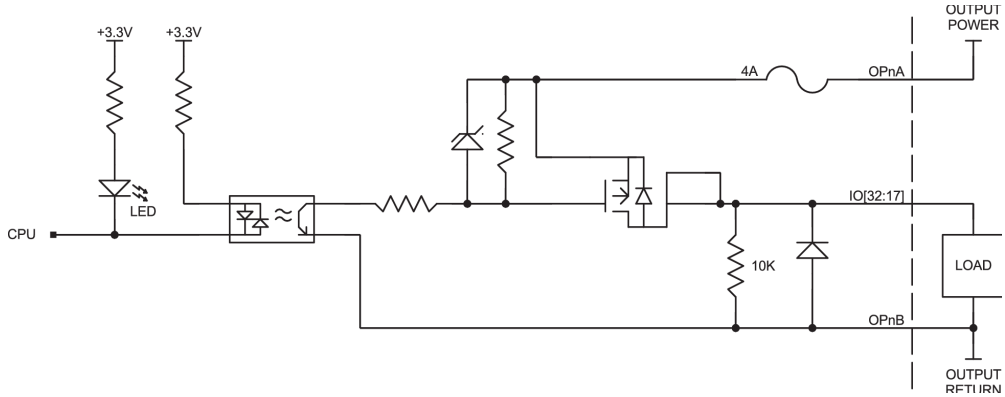
Output Power Connections				
RIO Model	Bank 3, IO[24:17]		Bank 4, IO[32:25]	
	Output Power	Output Return	Output Power	Output Return
RIO-57410, RIO-57420	OP3A	OP3B	OP4A	OP4B

Table 4.3: List of Output Power Connections for each bank given RIO- 574x0 base model

Wiring the Digital Outputs

To take full advantage of optoisolation, an isolated power supply should be used to provide power for the digital outputs. Connecting the reference of the isolated power supply to the ground of the module will bypass optoisolation and is not recommended if true optoisolation is desired.

To supply power to a bank of outputs, connect +V_s of the isolated power supply to the bank's output power and the reference of the isolated power supply to the bank's output return. The output's load should be connected from the digital output to the bank's output return. Refer to the digital output schematic shown below in Figure 4.3.



Output Bank (n)	Digital I/O
3	IO[24:17]
4	IO[32:25]

Figure 4.3: Optoisolated digital output schematic

Electrical Specifications

Refer to the RIO- 574x0 Specification List in the Appendix for electrical specifications.

> **Note:** These outputs are capable of driving inductive loads such as solenoids or relays.

Analog I/O

This section applies to certain RIO- 574x0 modules that support analog I/O. Refer to Table 1.1 for a list of base models that support analog I/O.

> **Note:** The following sections discuss Galil Commands relating to the relevant analog I/O. Commands that are used with the Galil EtherCAT Master are highlighted in `blue` while commands used with the RIO-574x0 over USB are highlighted in `red`.

Analog Inputs

The RIO- 57420 has 8 analog inputs. When connected via USB, these inputs can be read individually using the command `@AN[]`. Similarly, when configured on an EtherCAT network with a Galil EtherCAT master, the inputs can be read individually using the same `@AN[]` command.

Analog inputs have a configurable voltage range that is set using the `AQ` command. There are four different voltage ranges possible with these inputs: 0-5V, 0-10V, ±5V or ±10V. Refer to the `AQ` command in the command reference for more details.

Wiring the Analog Inputs

The analog inputs are measured in reference to Analog Ground. Analog Ground is the same voltage potential as the RIO-57420's Digital Ground, only on a separate ground plane to minimize noise.

Electrical Specifications

Refer to the RIO- 574x0 Specification List in the Appendix for electrical specifications.

Analog Outputs

The RIO- 57420 has 8 analog outputs. When connected via USB, these outputs can be set individually using the command `AO` and read with the command `@AO[]`. Similarly, when configured on an EtherCAT network with a Galil EtherCAT master, the inputs can be set individually using the same `AO` command and read with `@AO[]`.

Analog outputs have a configurable voltage range that is set using the `DQ` command. There are four different voltage ranges possible with these outputs: 0-5V, 0-10V, ±5V or ±10V. Refer to the `DQ` command in the command reference for more details.

Wiring the Analog Outputs

The analog outputs are measured in reference to Analog Ground. Analog Ground is the same voltage potential as the RIO-57420's Digital Ground, only on a separate ground plane to minimize noise.

Electrical Specifications

Refer to the RIO- 574x0 Specification List in the Appendix for electrical specifications.

Chapter 4: Troubleshooting

Firmware Download

Occasionally, the RIO-574x0's firmware may need to be upgraded while the unit is in the field, typically due to additional features or certain bug fixes. To download firmware to the RIO-574x0, connect over USB with Galil Software, use the download firmware selection for that software and point to the appropriate hex file. For hex file downloads, release notes, and RSS feed subscriptions refer to http://www.galil.com/downloads/firmware.

Note: If firmware download fails, refer to the Upgrade Jumper section in the Troubleshooting chapter.

Master Reset and Upgrade Jumpers

Master Reset Jumper

When a master reset is performed, the module is brought back to factory default settings. Any settings burned in with BN will be lost.

To perform a master reset, locate the MR jumper pins and follow the procedure listed below:

1. Power down the RIO-574x0
2. Install a jumper on the MR pins
3. Power on the RIO-574x0
4. Wait for the red ERR light to turn off (this may take a few seconds)
5. Power down RIO-574x0 and remove jumper

Upgrade Jumper

The upgrade jumper can be used to download firmware if previous download attempt was unsuccessful. The upgrade jumper is **not** required for firmware download. However, if firmware download is not successful (e.g. if power is cut before download is complete), then the upgrade jumper must be used to properly download firmware. To do so, perform the following items the the procedure listed below:

1. Power down the RIO-574x0
2. Install a jumper on the UG pins and power RIO-574x0 on (the red ERR light should be on)
3. Connect to RIO-574x0 over USB using Galil Software
4. Download firmware using Galil Software
5. Power down RIO-574x0 and remove jumper

APPENDIX

USB Communication

The USB port on the RIO-574x0 is available for device configuration and troubleshooting.

A USB micro cable is required to establish a connection between the RIO- 574x0 and the PC. Use the supported Galil software mentioned in Step 2 to connect.

Windows 7, 8, 10, and a select number of Linux distributions (refer to the documentation of Galil Software) will automatically download and install USB drivers to allow communication. For Windows PCs, the Found New Hardware wizard should not be prematurely canceled.

> **Note:** For Windows 7 machines, the OS needs to search for the USB driver. Ensure Internet access. Installation occasionally takes more than a couple minutes.

For a complete description of all RIO- 574x0 commands, refer to the Command Reference document mentioned in the Using This Manual section.

When using the USB connection to configure the RIO-574x0, the BN command should be used to burn all parameters into the module's non-volatile memory.

Galil Software

Terminal Application Software

The following is the current generation Galil software packages that support the RIO-574x0 .

GDK

> **Note:** Because the RIO- 574x0 does not support a data record or program space, the only supported tools for GDK are the Terminal and Setup.

For more information regarding Galil software packages, refer to Galil's website:

http://www.galil.com/downloads/software

Legacy softwares that support the RIO-574x0:

GalilTools

API Library Support

The following is the current generation Galil API libraries that support the RIO-574x0

gclib

Note: gclib only supports the following functions with the RIO-574x0: gOpen(), gClose(), gCommand(), and gFirmwareDownload().

For more information regarding Galil API libraries, refer to Galil's website:

http://www.galil.com/downloads/api

EtherCAT Overview

CANopen over EtherCAT allows for fast and deterministic communication between a master and slave, which is useful in the broad range of automation industries. Data is accessed on the slave as objects and messages, which allows for the reading and writing of those objects. These sections cover a basic understanding of communication over the EtherCAT network, as well as the Object Dictionary of the RIO-574x0.

For users with Galil's DMC-500x0 or DMC-52xx0 EtherCAT masters, the reader can follow the steps outlined in Chapter 2: Getting Started and use this chapter as reference if needed.

Objects

An object can be thought of as a piece of memory on an EtherCAT slave. The slave can use the memory to perform certain tasks. These objects can be readable, writable, or both as viewed from the EtherCAT master. This is done through the different messages that are used on the EtherCAT network.

Messages

There are two types of messages used to access the object data: Service Data Object (SDO) and Process Data Object (PDO). These are briefly described in the below sections.

SDO

SDO messages are initiated by the EtherCAT master in an outgoing message and a reply from the EtherCAT slave. These messages are used in time insensitive communication portions of the system such as configuration.

PDO

PDO messages are used for the deterministic, time sensitive portions of communication on the EtherCAT network. Unlike an SDO message, PDO messages do not have a reply. Because of this, PDO messages must be configured prior to use.

There are two types of PDO messages: Transmit PDO (TPDO) and Receive PDO (RPDO). The TPDO message transmits object data from slave to master and cannot write any object data. The RPDO messages allow the slave to receive and write object data sent by the master.

EtherCAT State Machine

For each RIO- 574x0 on an EtherCAT network a state machine is implemented shown below in Figure A.1. The EtherCAT master controls the RIO- 574x0 state machine.

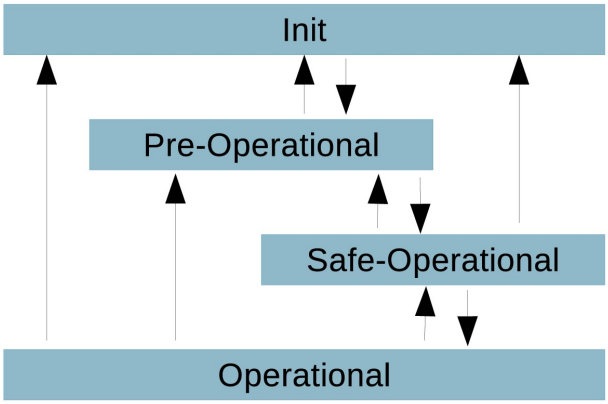


Figure A.1: RIO- 574x0 State Machine

The state determines what type of communication is valid between the EtherCAT master and slave. This is shown below in Table A.1.

State	Communication Validity
Init	No SDO No PDO
Pre-Operational	SDO messages valid No PDO
Safe-Operational	SDO messages valid PDO messages valid • Digital and Analog Inputs are readable • Digital and Analog Output commands are ignored
Operational	SDO messages valid PDO messages valid

Table A.1: EtherCAT communication validity

Station ID

The two rotary switches are used to set the station ID in hexadecimal.

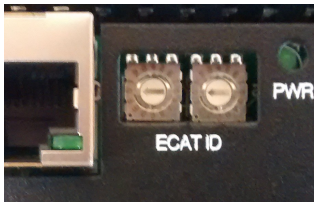


Figure A.2: Location of Rotary Switches

EtherCAT LED Indicators

The RUN and ERR LEDs on the RIO- 574x0 shows the status of the EtherCAT communication. The LED flash pattern displays the run or error state of the RIO- 574x0 on the EtherCAT network.

RUN LED

The RUN LED displays the active state of the RIO- 574x0 on the EtherCAT network. Use Table A.2 below to determine the state by the LED's flash pattern.

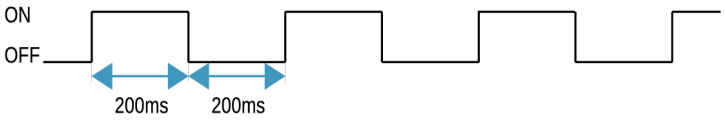
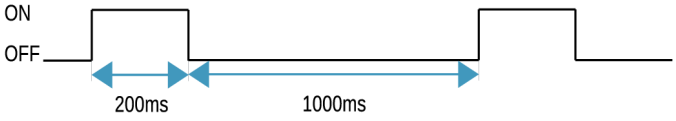
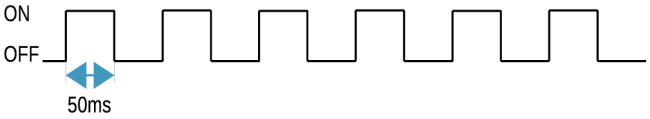
LED Pattern	Pattern Diagram (not drawn to scale)	State Description
Off	Solid Off	The RIO- 574x0 is in the Init state
Blinking		The RIO- 574x0 is in the Pre-Operational state
Single flash		The RIO- 574x0 is in the Safe-Operational state
On	Solid On	The RIO- 574x0 is in the Operational state
Flickering		The RIO- 574x0 is booting and has not yet entered the Init state

Table A.2: RUN LED flash pattern and description

ERR LED

The ERR LED displays the error state of the RIO- 574x0 on the EtherCAT network. Use Table A.3 below to determine the error state by the LED's flash pattern.

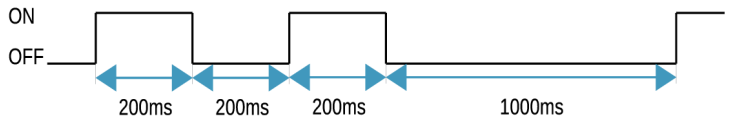
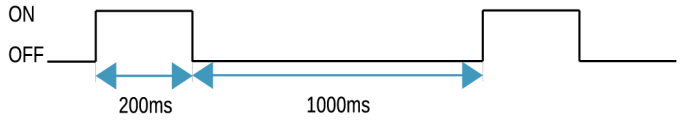
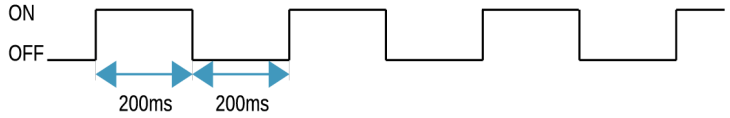
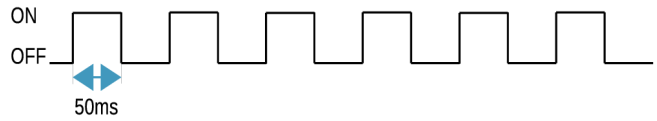
LED Pattern	Pattern Diagram (not drawn to scale)	Error State Description
On	Solid On	A critical communication error or application controller error has occurred
Double Flash		An EtherCAT watchdog timeout has occurred
Single Flash		RIO- 574x0 has changed the EtherCAT state due to local error
Blinking		Invalid EtherCAT configuration
Flickering		Boot error was detected (possible EEPROM error)
Off	Solid Off	EtherCAT communication is in working condition

Table A.3: ERR LED flash pattern and description

Object Dictionary

Index	Object Dictionary Area
0x0000 ... 0x0FFF	Data Type Area
0x1000 ... 0x1FFF	Communication Area
0x2000 ... 0x5FFF	Manufacturer Specific Area
0x6000 ... 0x6FFF	Input Area
0x7000 ... 0x7FFF	Output Area
0x8000 ... 0x8FFF	Configuration Area
0x9000 ... 0x9FFF	Information Area
0xA000 ... 0xAFFF	Diagnosis Area
0xB000 ... 0xBFFF	Service Transfer Area
0xC000 ... 0xEFFF	Reserved Area
0xF000 ... 0xFFFF	Device Area

Table A.4: Object dictionary indexes

Device Type

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1000	0x00	Device Type	UDINT	M RO	0x92010000	Fixed value

Table A.5: Device type

Error Register

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1001	0x00	Error register	USINT	RO	0x00	Error Status of device. 0 = no error.

Table A.6: Error register

Device Name

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1008	0x00	Device Name	String (9)	RO	'RIO-57000'	Base model name

Table A.7: Device name

Hardware Version

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1009	0x00	Hardware version	String (4)	RO	N/A	Hardware revision

Table A.8: Hardware version

Software Version

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x100A	0x00	Software version	String (5)	RO	N/A	Firmware revision

Table A.9: Software version

Identity

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1018	0x00	Number of entries	USINT	RO	0x04	
	0x01	Vendor ID	UDINT	RO	0x99050000	Galil's Vendor ID
	0x02	Product Code	UDINT	RO	0x00700500	RIO-574x0 product ID
	0x03	Revision	UDINT	RO	0x01000000	
	0x04	Serial Number	UDINT	RO	N/A	Serial number of device

Table A.10: Identity

Error Settings

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x10F1	0x00	Number of entries	USINT	RO	0x02	
	0x01	Local Error Reaction	UDINT	RW	0x01000000	
	0x02	Sync Error Counter Limit	UINT	RW	0x0400	Threshold for number of unacknowledged sync pulses before error is thrown

Table A.11: Error settings

Diagnosis History

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x10F3	0x00	Number of entries	USINT	RO	0x05	
	0x01	Maximum Messages	USINT	M RO		
	0x02	Newest Message	USINT	M RO	0x00	
	0x03	Newest Acknowledged Message	USINT	M RW	0x00	
	0x04	New Message Available	BOOL	M RO P	00	
	0x05	Flags	UINT	M RW	0x0000	

Table A.12: Diagnosis history

Output Mapping

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1600	0x00	Number of entries	USINT	RO	0x09	
	0x01	Sub-index 001	UDINT	RO	0x20010070	
	0x02	Sub-index 002	UDINT	RO	0x10010170	
	0x03	Sub-index 003	UDINT	RO	0x10020170	
	0x04	Sub-index 004	UDINT	RO	0x10030170	
	0x05	Sub-index 005	UDINT	RO	0x10040170	
	0x06	Sub-index 006	UDINT	RO	0x10050170	
	0x07	Sub-index 007	UDINT	RO	0x10060170	
	0x08	Sub-index 008	UDINT	RO	0x10070170	
	0x09	Sub-index 009	UDINT	RO	0x10080170	

Table A.13: Output mapping

Input Mapping

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1A00	0x00	Number of entries	USINT	RO	0x09	
	0x01	Sub-index 001	UDINT	RO	0x20010060	
	0x02	Sub-index 002	UDINT	RO	0x10010160	
	0x03	Sub-index 003	UDINT	RO	0x10020160	
	0x04	Sub-index 004	UDINT	RO	0x10030160	
	0x05	Sub-index 005	UDINT	RO	0x10040160	
	0x06	Sub-index 006	UDINT	RO	0x10050160	
	0x07	Sub-index 007	UDINT	RO	0x10060160	
	0x08	Sub-index 008	UDINT	RO	0x10070160	
	0x09	Sub-index 009	UDINT	RO	0x10080160	

Table A.14: Input mapping

Sync Manager Type

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1C00	0x00	Number of entries			0x04	
	0x01	Sub-index 001		RO	0x01	
	0x02	Sub-index 002		RO	0x02	
	0x03	Sub-index 003		RO	0x03	
	0x04	Sub-index 004		RO	0x04	

Table A.15: Sync manage type

Sync Manager 2 Assignment

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1C12	0x00	Number of entries			0x01	
	0x01	Sub-index 001		RO	0x0016	

Table A.16: Sync manager 2 assignment

Sync Manager 3 Assignment

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1C13	0x00	Number of entries			0x01	
	0x01	Sub-index 001		RO	0x001A	

Table A.17: Sync manager 3 assignment

SM Output Parameter

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1C32	0x00	Number of entries	USINT	RO	0x20	
	0x01	Synchronization type	UINT	RW	0x0100	
	0x02	Cycle time	UDINT	RO	0x00000000	
	0x04	Synchronization types supported	UINT	RO	0x0780	
	0x05	Minimum cycle time	UDINT	RO	0x00000000	
	0x06	Calc and copy time	UDINT	RO	0x00000000	
	0x08	Get cycle time	UINT	RW	0x0000	
	0x09	Delay time	UDINT	RO	0x00000000	
	0x0A	Sync0 cycle time	UDINT	RW	0x00000000	
	0x0B	SM-Event missed	UINT	RO	0x0000	
	0x0C	Cycle time too small	UINT	RO	0x0000	
	0x20	Sync error	BOOL	RO	00	

Table A.18: SM output parameter

SM Input Parameter

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x1C33	0x00	Number of entries	USINT	RO	0x20	
	0x01	Synchronization type	UINT	RW	0x2200	
	0x02	Cycle time	UDINT	RO	0x00000000	
	0x04	Synchronization types supported	UINT	RO	0x0780	
	0x05	Minimum cycle time	UDINT	RO	0x00000000	
	0x06	Calc and copy time	UDINT	RO	0x00000000	
	0x08	Get cycle time	UINT	RW	0x0000	
	0x09	Delay time	UDINT	RO	0x00000000	
	0x0A	Sync0 cycle time	UDINT	RW	0x00000000	
	0x0B	SM-Event missed	UINT	RO	0x0000	
	0x0C	Cycle time too small	UINT	RO	0x0000	
	0x20	Sync error	BOOL	RO	00	

Table A.19: SM input parameter

Digital Inputs

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x6000	0x00	Number of entries	USINT	RO	0x01	
	0x01	Digital inputs 1 through 32	BITARR32	RO P	N/A	Bitwise representation of all digital inputs

Table A.20: Digital inputs

Analog Inputs

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x6001	0x00	Number of entries	USINT	RO	0x08	
	0x01	Analog input 1	UINT	RO P	N/A	Analog input value. Refer to Table A.29
	0x02	Analog input 2	UINT	RO P	N/A	
	0x03	Analog input 3	UINT	RO P	N/A	
	0x04	Analog input 4	UINT	RO P	N/A	
	0x05	Analog input 5	UINT	RO P	N/A	
	0x06	Analog input 6	UINT	RO P	N/A	
	0x07	Analog input 7	UINT	RO P	N/A	
	0x08	Analog input 8	UINT	RO P	N/A	

Table A.21: Analog inputs

Digital Outputs

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x7000	0x00	Number of entries	USINT	RO	0x01	
	0x01	Digital Outputs 1 through 32	BITARR32	RW P	0x00000000	Bitwise representation of all digital outputs

Table A.22: Digital outputs

Analog Outputs

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x7001	0x00	Number of entries	USINT	RO	0x08	Number of Analog Outputs
	0x01	Analog output 1	UINT	RW P	0x0000	Analog output value. Refer to Table A.29
	0x02	Analog output 2	UINT	RW P	0x0000	
	0x03	Analog output 3	UINT	RW P	0x0000	
	0x04	Analog output 4	UINT	RW P	0x0000	
	0x05	Analog output 5	UINT	RW P	0x0000	
	0x06	Analog output 6	UINT	RW P	0x0000	
	0x07	Analog output 7	UINT	RW P	0x0000	
	0x08	Analog output 8	UINT	RW P	0x0000	

Table A.23: Analog outputs

Digital Input Information Records

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x9000	0x00	Number of entries	USINT	RO	0x01	
	0x01	Digital inputs 1 through 32	BITARR32	RO P	0x00000000	Bits 31..5: Reserved Bits 4..0: Number of live digital inputs. If number is 0 the value is equivalent to 32

Table A.24: Digital input information records

Analog Input Information Records

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x9001	0x00	Number of entries	USINT	RO	0x08	
	0x01	Analog input 1	UINT	RO P	0x0000	Bits 31..3: Reserved Bits 2..0: Analog input voltage configuration for particular input. Refer to Table A.28.
	0x02	Analog input 2	UINT	RO P	0x0000	
	0x03	Analog input 3	UINT	RO P	0x0000	
	0x04	Analog input 4	UINT	RO P	0x0000	
	0x05	Analog input 5	UINT	RO P	0x0000	
	0x06	Analog input 6	UINT	RO P	0x0000	
	0x07	Analog input 7	UINT	RO P	0x0000	
	0x08	Analog input 8	UINT	RO P	0x0000	

Table A.25: Analog input informations records

Digital Output Information Records

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x9002	0x00	Number of entries	USINT	RO	0x01	
	0x01	Digital Outputs 1 through 32	BITARR32	RO P	0x00000000	Bits 31..5: Reserved Bits 4..0: Number of live digital outputs. If number is 0 the value is equivalent to 32

Table A.26: Digital output information records

Analog Output Information Records

Index	Sub-Index	Name	Type	Access	Default Value	Description
0x9003	0x00	Number of entries	USINT	RO	0x08	
	0x01	Analog output 1	UINT	RO P	0x0000	Bits 31..3: Reserved Bits 2..0: Analog output voltage configuration for particular input. Refer to Table A.28.
	0x02	Analog output 2	UINT	RO P	0x0000	
	0x03	Analog output 3	UINT	RO P	0x0000	
	0x04	Analog output 4	UINT	RO P	0x0000	
	0x05	Analog output 5	UINT	RO P	0x0000	
	0x06	Analog output 6	UINT	RO P	0x0000	
	0x07	Analog output 7	UINT	RO P	0x0000	
	0x08	Analog output 8	UINT	RO P	0x0000	

Table A.27: Analog output information records

Analog Voltage Configuration

Table A.28 below provides the analog configuration for the Analog Input Information Records and the Analog Output Information Records. This setting can only be modified over USB with the AQ or DQ commands.

Value	Voltage Configuration
1	±5 V
2	±10 V
3	0-5 V
4	0-10 V

Table A.28: Analog Voltage Configuration code

Analog Input/Output Values Over EtherCAT

Analog values are represented as a 16 bit value that corresponds to an input or output voltage. The voltage depends on the AQ/DQ setting, which can be read in index 0x9003 over EtherCAT. With standard 12-bit analog hardware, the value is represented as a 16-bit value with the last 4 bits as padded 0s.

AQ/DQ Setting	Voltage Range	Voltage	Decimal	Hex	DQ Formula	AQ Formula
1	±5V	-5	32768	0x8000	$v \geq 0, x = v\frac{32767}{5}$ $v < 0, x = v\frac{32767}{5} + 65535$	$x < 32768, v = x\frac{5}{32767}$ $x \geq 32768, v = (x - 65535)\frac{5}{32767}$
		-2.5	49152	0xC000		
		0	0	0		
		2.5	16383	0x3FFF		
		5	32767	0x7FFF		
2	±10V	-10	32768	0x8000	$v \geq 0, x = v\frac{32767}{10}$ $v < 0, x = v\frac{32767}{10} + 65535$	$x < 32768, v = x\frac{10}{32767}$ $x \geq 32768, v = (x - 65535)\frac{10}{32767}$
		-5	49152	0xC000		
		0	0	0		
		5	16383	0x3FFF		
		10	32767	0x7FFF		
3	0-5V	0	0	0	$x = v\frac{65535}{5}$	$v = x\frac{5}{65535}$
		2.5	32767	0x7FFF		
		5	65535	0xFFFF		
3	0-10V	0	0	0	$x = v\frac{65535}{10}$	$v = x\frac{5}{65535}$
		5	32767	0x7FFF		
		10	65535	0xFFFF		

Table A.29: Analog Scaling Equations

Quick Start with TwinCAT 3

The following is a step by step guide for connecting to the RIO-574x0 using TwinCAT 3. This procedure is not needed when the RIO-574x0 is used with a Galil EtherCAT Master.

Step 1: Install TwinCAT 3

TwinCAT 3 is a software based EtherCAT master developed by Beckhoff. Refer to Beckhoff's website for downloading instructions as well as required hardware. http://www.beckhoff.com/

Add XML File

Download the RIO-574x0 XML file from Galil's website:
http://www.galil.com/fw/pub/57000.rio/doc/rio-57000-r10a.xml

Add the XML to the following directory after installing TwinCAT 3.
C:\TwinCAT\3.1\Config\Io\EtherCAT

Step 2: Create Project

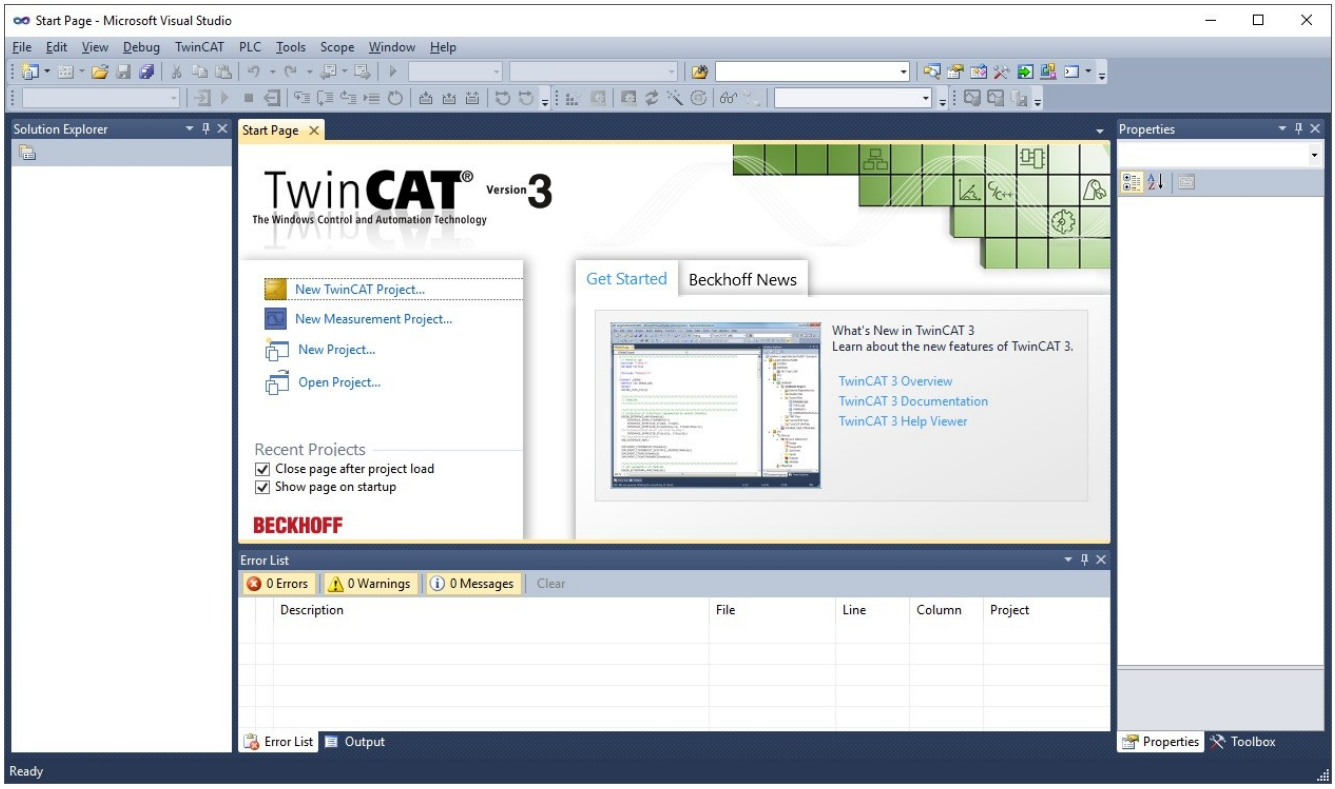


Figure A.3: TwinCAT start-up page

Open *TwinCAT XAE (VS 2010)* from the start menu and click on *New TwinCAT Project*.

Create a Project name and save in the desired location. Click *OK*.

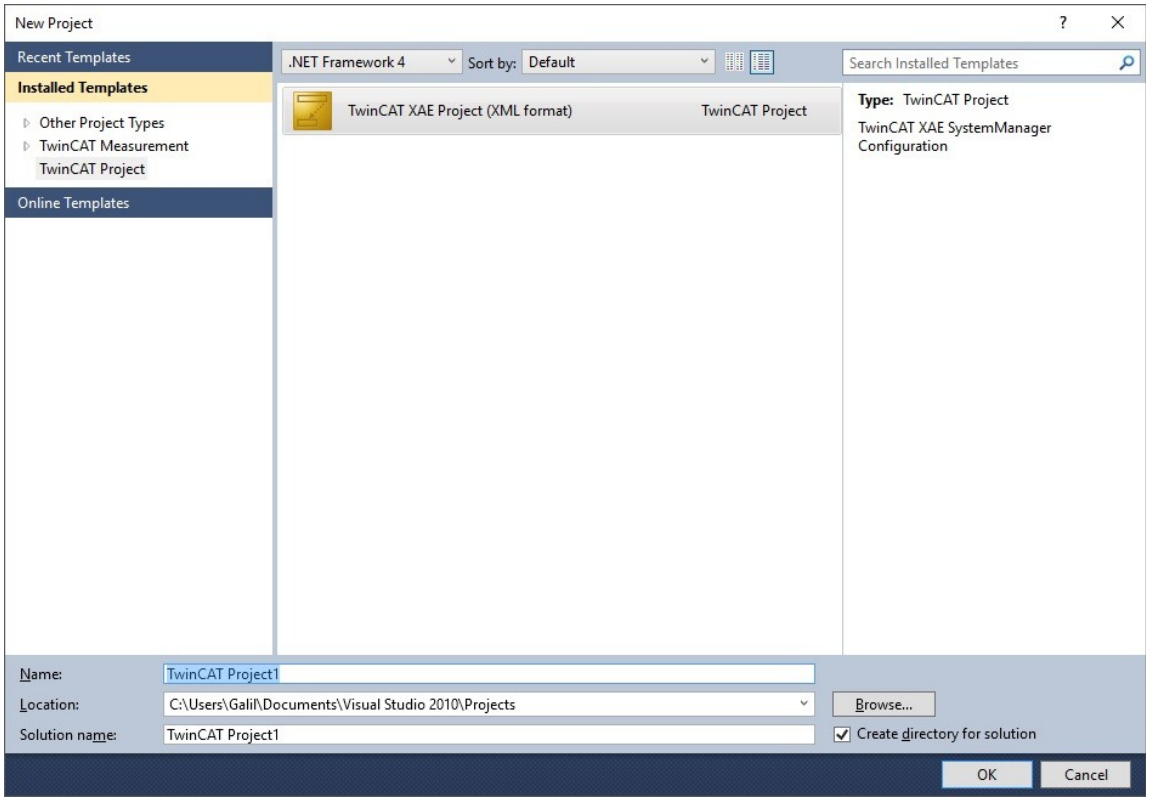


Figure A.4: Create TwinCAT project

Step 3: Scan for RIO-574x0

In the *Solution Explorer*, expand *I/O* and right-click on *Device* and click *Scan*.

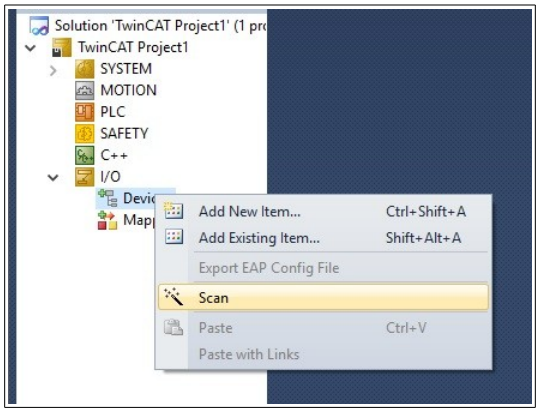


Figure A.5: Scan for devices

Click *OK* for the following window.

Figure A.6: TwinCAT hint window

TwinCAT will find the RIO-574x0 and display it as a new device. Click *OK* on the 'new I/O device found' window.

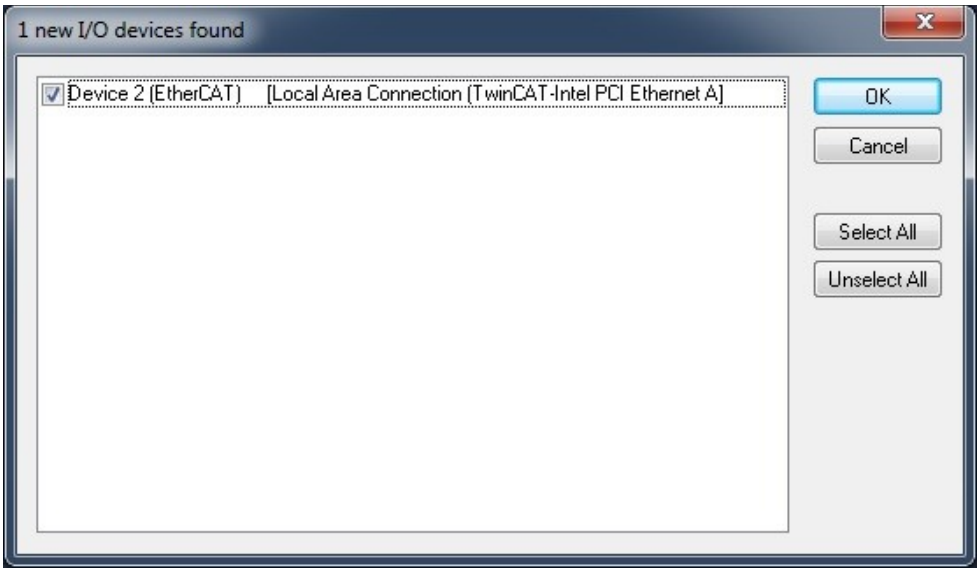


Figure A.7: Devices found window

Click *Yes* to scan for boxes.

Click *Yes* to activate free run.

Step 4: Read and Set I/O on RIO-574x0

Double-click on *Box 1 (RIO-57000)*.

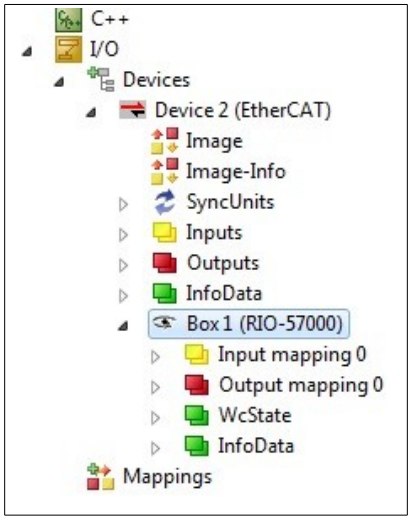


Figure 8: RIO-57000 in TwinCAT

Read Digital and Analog Inputs

In the main window, click on the *Online* tab in the working space. Confirm that the current state is OP. The digital inputs can be read in the first item seen in the list. The Online value is 0 showing that all digital inputs are inactive.

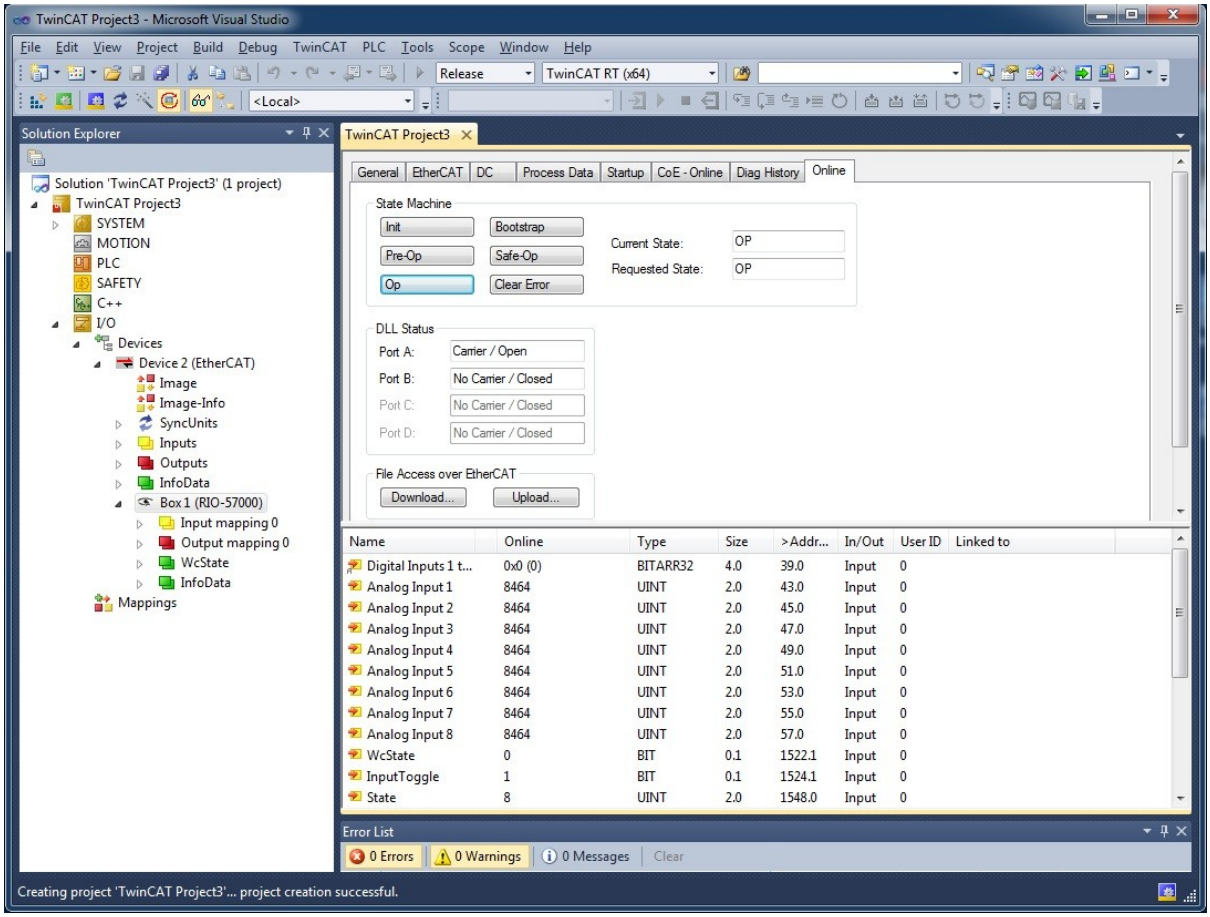


Figure A.9: Read digital and analog inputs

The following 8 items are the 8 analog inputs (only for the RIO-57420) and the Online value can be interpreted with the equations found in Table A.29. The default value for AQ and DQ is 2, therefore the below example shows a ADC reading of 8464, which converts to 2.583V.

Set Digital Outputs

To set the digital outputs, right-click on the Digital Outputs item and click on *Online Write*.

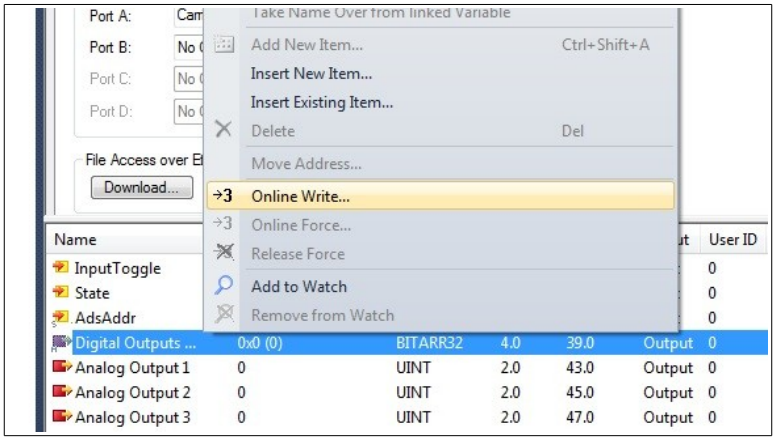


Figure A.10: Write digital outputs

To turn on all outputs, enter the decimal value 65535 (0xFFFF) in the window below and click *OK*. Observe that all the on-board, digital output LEDs turn on.

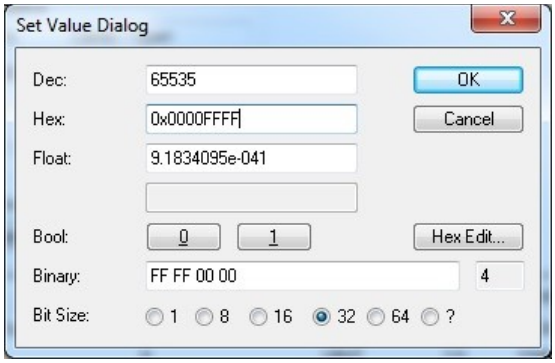


Figure A.11: Write digital value

Set Analog Outputs

To set the analog outputs, right-click on the desired analog output and click *Online Write*.

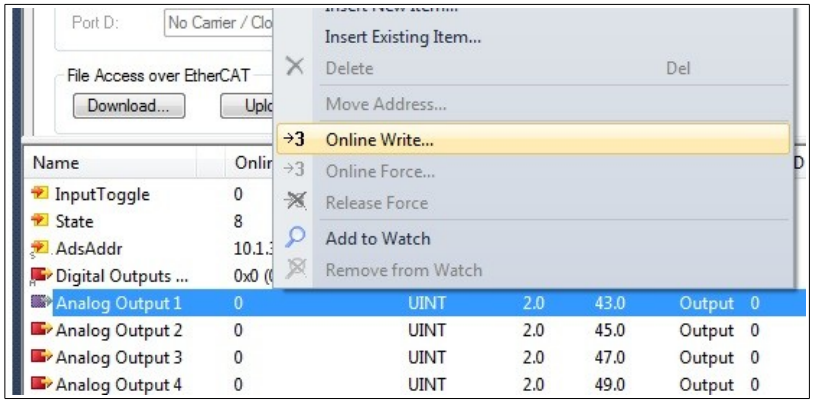


Figure A.12: Set analog outputs

Use Table A.29 to calculate the desired analog value and enter it into the window below and click *OK*. The default value for DQ is 2. In this example, 16383 (0x3FFF) sets an output voltage of 5V.

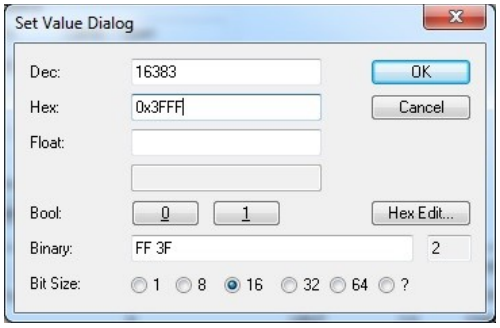


Figure A.13: Set analog output value

Training Seminars

Galil offers two-day product training seminars approximately every quarter. This technical training provides an overview of Galil products, a description of system elements, tuning, motion programming, software, troubleshooting, and hands-on labs with actual hardware. On the afternoon of the second day there is an opportunity to spend time one-on-one with an Applications engineer to ask additional questions or discuss individual applications.

For more information on upcoming training seminars, visit http://www.galil.com/learn/classes.

Warranty

All products manufactured by Galil Motion Control are warranted against defects in material and workmanship. The warranty period for all products is 18 months except for motors and power supplies, which have a 1 year warranty.

In the event of any defects in material or workmanship, Galil Motion Control will, at its sole option, repair or replace the defective product covered by this warranty without charge. To obtain warranty service, the defective product must be returned within 30 days of the expiration of the applicable warranty period to Galil Motion Control, properly packaged and with transportation and insurance prepaid. We will re-reship at our expense only to destinations in the United States.

Any defect in materials or workmanship determined by Galil Motion Control to be attributable to customer alteration, modification, negligence, or misuse is not covered by this warranty.

EXCEPT AS SET FORTH ABOVE, GALIL MOTION CONTROL WILL MAKE NO WARRANTIES EITHER EXPRESSED OR IMPLIED, WITH RESPECT TO SUCH PRODUCTS, AND SHALL NOT BE LIABLE OR RESPONSIBLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

RIO- 574x0 Specification List

Overview:

Feature	57410	57420
Power	External	External
Optoisolated Digital Inputs	16	16
Optoisolated Digital Outputs	16	16
Analog Inputs	None	8
Analog Outputs	None	8
Available Standard Options	None	4-20mA 16Bit

Standard Options	
4-20mA	4-20mA Analog inputs
16Bit	16 Bit resolution for Analog Inputs and Outputs

Communication:

- USB Mini (for configuration only)
- RJ45 EtherCAT In Out

I/O:

	Specification	57410	57420	57420 (w/ Standard Option)
Opto-isolated Digital Outputs	Max Supply Voltage (V)	24	24	-
	Min Supply Voltage (V)	12	12	-
	Max Current per Output (mA)	500	500	-
Opto-isolated Digital Inputs	Internal Impedance (Ω)	2.2k	2.2k	-
	Max Current per Input (mA)	11	11	-
	Recommended minimum voltage to activate input (V)	5	5	-
	Recommended maximum voltage to active input (V)	24	24	-
Analog Outputs	Configurable Voltage Ranges (V)	-	0-5 0-10 ±5 ±10	-
	Resolution	-	12 bit	16 bit (-16Bit)
	Max Current Output (mA sink/source)	-	4	-
Analog Inputs	Configurable Voltage Ranges (V)	-	0-5 0-10 ±5 ±10	-
	Resolution	-	12 bit	16 bit (-16Bit)
	Input Impedance (Ω): Unipolar (0-5V, 0-10V)	-	42k	475 (4-20mA)
	Input Impedance (Ω): Bipolar (±5V, ±10V)	-	31k	475 (4-20mA

Power:

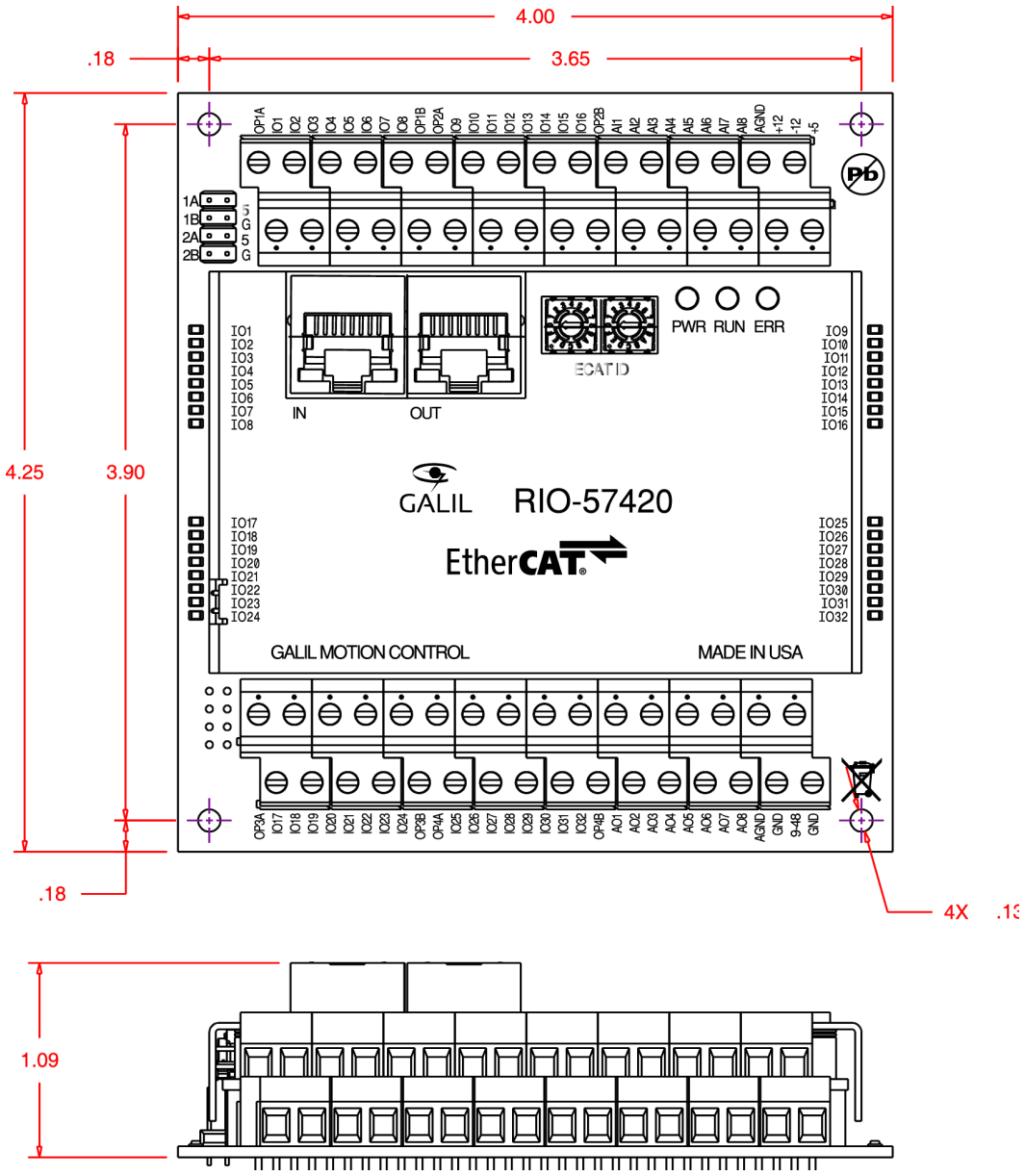
	Minimum	Maximum
External input (VDC)	9	48
Current Draw (A)	N/A	0.25

Environmental:

- Operating Temperature: 0-70 deg C
- Humidity: 20-95% RH, non-condensing

Mechanical:

- No DIN 4.00 × 4.25 × 1.09 inches



- Standard (with DIN) 4.24 × 4.81 × 2.35 inches