ClearCore Hardware and Wiring Manual
Includes CCIO-8 (ClearCore I/O Expansion Board)

Rev. 1.03, June 25, 2020
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Introduction

Welcome

Thank you for purchasing a ClearCore programmable, multi-function mini-controller. This document is a hardware reference manual for both the ClearCore controller and the CCIO-8 I/O expansion board.

For programming information, please see the ClearCore programming reference.

What's in this Document

- Parts identification
- Wiring diagrams for common I/O and motor devices
- Power supply requirements
- Mating hardware information
- Product specifications
- Mechanical dimensions
- Mounting information
Safety Information

Please read this safety information before using a ClearCore controller.

Precautionary Statement

Always follow appropriate safety precautions when installing and using any automated motion control equipment. Motion control systems should be designed and utilized to prevent personnel from coming into contact with moving parts and electrical contacts that could potentially cause injury or death. Read all cautions, warnings, and notes before attempting to install or operate this device. Follow all applicable codes and standards when using this equipment. Failure to use this equipment as described may impair or neutralize protections built into the product.

General Disclaimer

The User is responsible for determining the suitability of this product for his or her application. The User must ensure that Teknic’s products are installed and utilized in accordance with all local, state, federal and private governing bodies and meet all applicable health and safety standards.

Teknic has made all reasonable efforts to accurately present the information in the published documentation and shall not be responsible for any incorrect information which may result from unintentional oversights.

Due to continuous product improvements, the product specifications as stated in the documentation are subject to change at any time and without notice. The User is responsible for consulting a representative of Teknic for detailed information and to determine any changes of information in the published documentation.

Should Teknic’s products be used in an application that is safety critical, the User must provide appropriate safety testing of the products, adequate safety devices, guarding, warning notices and machine-specific training to protect the operator and/or bystanders from injury.
Parts Overview

Parts of a ClearCore

- Digital Inputs or 0-10V Analog Inputs (4x)
- Digital Inputs (3x)
- Communication Ports (2x)
  - RJ-45 connectors compatible with SPI, UART, or RS-232 devices
- User Mounting Holes (2x)
- Case Screw (1x)
  - 4-40 x 3/8” use Torx T10 screwdriver
- Combined I/O Header
  - see description below

-Dedicated plug-in terminal blocks for each I/O point
-Ethernet Port
-USB Host / Programming Port
  - USB type B
-Reset Switch
-Motor Connectors (4x) M0-M3 Control ClearPath motors or step motor drives
-Digital Input, Digital Output*, or Analog Output (4-20mA or 0-20mA)
-Digital Inputs or Digital Outputs* (3x)
-Digital Inputs, Digital Outputs*, or Speaker / DC motor drive (2x)
-DC Power Input
  - 12-24VDC

*All digital outputs (I/O-0 through I/O-5) have built-in clamping circuitry and are capable of driving coils of up to 9-watts max.

-Micro SD Card Slot
  - Read/write capable, data storage, data logging

-Left side view
-Right side view

**Combined I/O Header
  - For alternate hookup of all 13 I/O points (for use with custom break-out boards, bulkhead connectors, harness, etc.)

ClearCore top and side views
Parts of a CCIO-8 (I/O Expansion Board)

- **COM IN (RJ-45)**: Serial communication input from ClearCore or previous CCIO-8.
- **COM OUT (RJ-45)**: Serial communication output to next CCIO-8 if applicable.
- **Combined I/O Header**: For alternate hookup of I/O points (for use with custom break-out boards, bulkhead connectors, harness, etc.).
- **Mounting Plate**: Aluminum, 2mm.
- **Digital Inputs or Digital Outputs (8 total)**
- **DC Power Input**: 12-24VDC.
Powering ClearCore and CCIO-8

ClearCore and CCIO-8 are 12-24VDC compatible. This section includes ClearCore power supply recommendations and wiring instructions.

Important: Do not use your ClearCore power supply to also supply DC bus power to servo or stepper drives attached to ClearCore (this applies to ClearPath motors as well). Always use a separate, dedicated supply, such as the IPC-5, designed to handle the power and regenerated energy requirements of servo or step motor drives.

Recommended Power Supply

PWR-IO-24VDC

The PWR-IO-24VDC power supply (Mean Well PN LRS-150-24) is an inexpensive, 24VDC, 6.5A (156W) switching supply capable of powering most ClearCore applications. Click here to view product datasheet.

Why choose a "higher current" power supply?

A power supply of 6.5A or more is recommended for ClearCore applications to ensure that the ClearCore processor remains powered under adverse operating conditions such as overloads or shorts. Note: Lower current supplies will work perfectly well with ClearCore, but may experience shutdowns or brown outs if ClearCore is overloaded or shorted due to user error.
Wiring DC Power to ClearCore and CCIO-8

See below for instructions on wiring 12-24VDC power to ClearCore and CCIO-8.

Tools Required

- Slotted screwdriver with 2mm blade
- Wire cutter/stripper
- 3-position screw terminal connector, Molex part # 0395105003

Procedure

1. Turn off power supply.
2. Strip DC output wires from power supply. Expose approximately 6.5mm (0.25") of bare wire.
3. Fully insert V+ and V- wires fully into terminal block "+" and ground positions.
4. Tighten terminal screws.
5. Inspect connector for good wire capture. Verify that no wire insulation is captured in the closure, and that no loose wire strands are sticking out of the connector.
6. Recommended: Before connecting the terminal block to ClearCore, test for correct voltage polarity between "+" and ground terminals.

Connecting power to ClearCore and CCIO-8

Chassis Connection

Mount ClearCore and CCIO-8 to a machine frame or chassis continuous with Protective Earth. Alternately, connect the chassis terminal on the 3-position power connector to machine frame using conductive hardware.
I/O Wiring

Introduction

This section discusses the function and wiring of ClearCore and CCIO-8 user-configurable I/O points.

I/O Overview Table

The table below lists all ClearCore and CCIO-8 I/O connectors and their supported I/O types. Please refer to the ClearCore programming reference for instructions on how to configure ClearCore and CCIO-8 I/O connectors.

<table>
<thead>
<tr>
<th>Label</th>
<th>Digital Input</th>
<th>Digital Output</th>
<th>0-10V Analog Input</th>
<th>4-20 mA Output</th>
<th>Servos or Steppers</th>
<th>Speaker Tones</th>
<th>DC Motor Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O-0</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-1</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-2</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-3</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-4</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td>yes</td>
<td>yes</td>
<td></td>
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<tr>
<td>I/O-5</td>
<td>yes</td>
<td>yes</td>
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<td></td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>DI-6</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A-9</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-10</td>
<td>yes</td>
<td></td>
<td>yes</td>
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<td></td>
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<tr>
<td>A-11</td>
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<td></td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A-12</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-0</td>
<td></td>
<td></td>
<td></td>
<td>yes³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-1</td>
<td></td>
<td></td>
<td></td>
<td>yes³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-2</td>
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<td></td>
<td></td>
<td>yes³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-3</td>
<td></td>
<td></td>
<td></td>
<td>yes³</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CCIO-8</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: All digital outputs are PWM capable (except for those on the CCIO-8 expansion board).
Note 2: This output can also provide 0-20mA, which is less commonly used.
Note 3: Each motor connector has 3 digital outputs (step, dir., enable) and 1 digital input.
Note 4: There are 8 of these I/O points on the CCIO-8 expansion module.
Wiring I/O Devices to ClearCore

This section explains how to wire common I/O devices to a ClearCore controller. Each subsection includes a diagram of the ClearCore internal circuitry and several example hookup diagrams.

ClearCore I/O connectors

ClearCore I/O

- 13 software configurable I/O points
- Up to 13 digital inputs
- Up to 4 analog inputs
- Up to 6 digital outputs (with PWM)
- Up to 1 4-20mA (or 0-20mA) output
- Separate ground and power for all I/O points (grounds not isolated)
- Dedicated LED for every discrete I/O point to indicate status
- Add up to 64 more digital in/out points with CCIO-8 I/O expansion modules
I/O-0 through I/O-5 configured as DIGITAL INPUTS

Note: The wiring shown in this section also applies to all CCIO-8 I/O points configured as digital inputs.

**Input Equivalent Circuit**

```
IN[NN]n  169k  3V3
        +
Vsupply (12-24V)  10k
        |
Vsupply (12-24V)  GS
```

**IMPORTANT:**
- Inputs are “negative true”:
  - On<~1.0V, Off>=~1.0V

**“Ease of Use” Note: 5V Sensors**
If you are planning to use 5VDC sensors, consider instead:
1) sourcing 24V alternatives, or
2) providing a separate 5VDC supply to power your 5V sensors.

**Typical Sensor Hookup Details**

**Digital “NPN” Sensor:** Proximity, Optical, Hall-Effect, etc.

```
<table>
<thead>
<tr>
<th>BLK *</th>
<th>BLU</th>
<th>BRN</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

* Wire colors listed are typical of industrial sensors

**Switch or Relay Contact**

**5V/3.3V Logic System**

```
<table>
<thead>
<tr>
<th>BLK *</th>
<th>BLU</th>
<th>BRN</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

* Wire colors listed are typical of industrial sensors
A-9 through A-12 and DI-6 through DI-8 configured as **DIGITAL INPUTS**

**Input Equivalent Circuit**

**Typical Sensor Hookup Details**

**Digital “NPN” Sensor**
- Proximity
- Optical
- Hall-Effect, etc.

**Switch or Relay Contact**

**5V/3.3V Logic System**

**Digital “PNP” Sensor**
- Proximity
- Optical
- Hall-Effect, etc.

**IMPORTANT:**
Inputs are “negative true”:
On<~1.0V, Off>=~1.0V
A-9 through A-12 configured as ANALOG INPUTS

ClearCore is compatible with a variety of analog sensors (transducers) including the following:

- Pressure
- Temperature
- Distance
- Mass
- Force
- Angle
- Level
- Torque
- Inclination
- Velocity
- Flow
- Electric current

**Input Equivalent Circuit**

**Typical Sensor Hookup Details**

**Potentiometer**

Note:

The repeatability of this circuit will be affected by the drift and regulation of the power supply connected to Vsupply. (Values shown for a 24V supply.)

**Sensor Notes:**

- 0-5V output sensors can be used with loss of 1 bit of resolution (provided they are compatible with the ClearCore supply voltage (Vsupply).
- 0-20mA sensors (as opposed to 4-20mA) can be used with some loss of linearity near zero current (sensor dependent).
I/O-0 through I/O-5 configured as DIGITAL OUTPUTS

Note: The wiring shown in this section also applies to all CCIO-8 points configured as digital outputs.

Output Equivalent Circuit

Typical Actuator Hookup Details

**IMPORTANT:**
- Outputs are “negative true”:
  - On state turns on transistor, enabling current in load, pulling output <0.5V

Typical Actuator Hookup Details

LED Indicator

Solid State Relay

5V/3.3V Logic System

External clamping diode to logic supply may be required, consult logic IC datasheet.
I/O-4 or I/O-5 configured as Variable, Bi-directional Drive (PWM)

Output Equivalent Circuit

Average output voltage equation
\[ V_{\text{supply}} \times (\text{Duty Cycle of PolarityS} - \text{Duty Cycle of Polarity}) \]

Notes:
1. For use with loudspeaker/shaker loads the maximum RMS current must not exceed 1A
2. Exceeding output current ratings will require resetting both IO-4 and IO-5 outputs by cycling the OverV_DISABLEn signal
I/O-0 configured as a 4-20mA (or 0-20mA) OUTPUT

ClearCore's I/O-0 connector can be configured to supply a variable 4-20mA analog signal to control a wide variety of analog actuators. A few examples of devices that can be controlled using 4-20mA signaling include:

- Damper control
- Pressure regulator
- Rotary position actuator
- Variable speed display
- Proportional valve
- Linear position actuator
- Process meter (display)

Output Equivalent Circuit

Output produces positive current flow through the S (signal) pin as shown, i.e., output is “sourcing”

Typical Actuator Hookup Details

**4-wire Actuator**

<table>
<thead>
<tr>
<th>S</th>
<th>G</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-20mA</td>
<td>4-20mA RET.</td>
<td>V+ SUPPLY</td>
</tr>
</tbody>
</table>

Notes:
- Connect signal and supply return wires close to output terminal block
- Use twisted pair as shown for best noise immunity

**3-wire Actuator**

<table>
<thead>
<tr>
<th>S</th>
<th>G</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-20mA</td>
<td>COM</td>
<td>V+ SUPPLY</td>
</tr>
</tbody>
</table>

**2-wire Control**

<table>
<thead>
<tr>
<th>S</th>
<th>G</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-20mA</td>
<td>COM</td>
<td></td>
</tr>
</tbody>
</table>

May be required depending on device

**3-wire 0-10V Actuator**

<table>
<thead>
<tr>
<th>S</th>
<th>G</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10V</td>
<td>COM</td>
<td>V+ SUPPLY</td>
</tr>
</tbody>
</table>

Note:
Place 499 Ohm shunt resistor close to actuator
ClearCore Combined I/O Header

The ClearCore I/O header (labeled "Combined I/O" on the case) provides an alternate, functionally identical way to connect I/O devices to ClearCore's I/O points.

Mating Connector (for use with ribbon cable)
- Housing: OST/101-206
- Ribbon cable: CnC Tech/304-28-20-MC-0250F

Mating Connector (crimp style)
- Housing: AMP/102387-4
- Terminals: AMP/87756-4 (22-26AWG)
Wiring I/O Devices to CCIO-8

**IMPORTANT NOTES!**

- All CCIO-8 I/O points are electrically identical to ClearCore I/O points I/O-1, I/O-2, and I/O-3. The only functional difference is that the CCIO-8 points cannot output PWM signals.
- CCIO-8 I/O points can be configured as either digital inputs or digital outputs.

### I/O-0 through I/O-7 configured as DIGITAL INPUTS

Wiring is the same as ClearCore wiring section [I/O-0 through I/O-5 configured as DIGITAL INPUTS](#).

### I/O-0 through I/O-7 configured as DIGITAL OUTPUTS

Wiring is the same as ClearCore wiring section [I/O-0 through I/O-5 configured as DIGITAL OUTPUTS](#).

### CCIO-8 Combined I/O Header

The CCIO-8 I/O header (labeled "Combined I/O" on the board) provides an alternate, functionally identical way to connect I/O devices to ClearCore's I/O points.

---

**Combined I/O**

10x2 Header, 0.10" pitch

- GND
- Vsupply
- Vsupply
- I/O-6
- I/O-7
- I/O-1
- I/O-2
- I/O-3
- I/O-0
- Vsupply
- GND
- I/O-4
- I/O-5

---

**Mating Connector** *(for use with ribbon cable)*

- Housing: OST/101-206
- Ribbon cable: CnC Tech/304-28-20-MC-0250F

**Mating Connector** *(crimp style)*

- Housing: AMP/102387-4
- Terminals: AMP/87756-4 (22-26AWG)

---

**CCIO-8 I/O Header**
Motor Connectors (M-0, M-1, M-2, M-3)

ClearCore includes four multi-function motor connectors that each feature three (3) specialized outputs and one (1) specialized input. They are plug and play compatible with Teknic ClearPath motors, but are not limited to only ClearPath motors.

ClearCore can be programmed to send different types of signals to the motor connectors, including:

- Step & Direction signals to ClearPath-SD (Step & Dir) series motors
- Step & Direction signals to third-party compatible servo or step motor drives
- Digital control signals to ClearPath-MC (Motion Controller) series motors

**Note:** ClearCore motor connectors are designed to send and receive low power signals only. They are not designed to directly power the phase windings of servo or stepper motors.
How to Wire a ClearPath Motor to ClearCore

Connect ClearPath motors to ClearCore with a Teknic controller cable (or make your own).

ClearPath Controller Cables

Order from Teknic. The quickest way to connect a ClearPath motor to ClearCore is with a ClearPath controller cable available from teknic.com. See links below for information and pricing.

- **CPM-CABLE-CTRL-MU120** 10 ft. ClearPath controller cable
- **CPM-CABLE-CTRL-MM660** 55 ft. ClearPath controller cable

Build your own. ClearPath controller cables can also be built with off-the-shelf components available from electronics distributors like Dig-Key. See Appendix C for a full list of parts and tools required to build ClearPath controller cables.

---

**ClearPath motor connected to ClearCore**
Wiring a Stepper Motor Drive to ClearCore

Typical Stepper Motor Drive

Stepper motor drive wired to ClearCore controller
Serial COM Ports (COM-0, COM-1)

ClearCore includes two multi-function serial ports: COM-0 and COM-1. These ports are accessed through RJ-45 connectors as shown below. Each port is individually configurable for use with SPI devices, UART devices, or RS-232 transceivers. Each port includes a 5V power pin to power the remote device if needed.

**Notes**

- The CCIO-8 (I/O expansion board) can be connected to ClearCore at COM-0 or COM-1 using a standard CAT-5e cable.
- Only one branch of CCIO-8 expansion boards is supported (i.e. you can’t connect a CCIO-8 board to both ports simultaneously).
COM-0, COM-1 with 5V compatible RS-232 transceivers

**COM Port Equivalent Circuit**

**COM-[N] For use with 5V compatible RS-232 transceivers**

(CfgCom[N]_UART_SPIn = Low, CfgCom[N]_Polarity = Hi)

![COM Port Equivalent Circuit Diagram]

**Typical Hookup Details**

*IMPORTANT: Mating serial ports must be compatible with 0-5V signals or a converter must be used.*

**DCE/Modem**

Male Connector Shown
(e.g. Amphenol/DE09P064TXLF)

Female Connector Shown
(e.g. Amphenol/DE09S064TLF)

![DCE/Modem Hookup Diagram]

**DTE/Host**

*COM-0, COM-1 configured for RS-232*
COM-0, COM-1 configured for 5V logic UART devices

COM Port Equivalent Circuit

COM-\([N]\) For use with 5V logic UART devices
\((\text{non-inverting})\) \((\text{CfgCom}[N]_{\text{UART}_\text{SI}} = \text{Low}, \text{CfgCom}[N]_{\text{Polarity}} = \text{Low})\)

Typical Hookup Details

- 5VOB supplies 5V power for any loads connected to COM-0 and COM-1 connectors
- 5VOB also supplies the optional XBee module if installed
- Total current available from 5VOB is 450mA
- See block diagram in appendix E for details

COM-0, COM-1 configured for 5V UART devices
COM-0, 1 configured for SPI devices

COM Port Equivalent Circuit

COM-[N] For use with SPI devices
(CfgCom[N]_UART_SPIIn = Hi, CfgCom[N]_Polarity = Low)

Typical Hookup Details

- 5VOB supplies 5V power for any loads connected to COM-0 and COM-1 connectors
- 5VOB also supplies the optional XBee module if installed
- Total current available from 5VOB is 450mA
- See block diagram in appendix E for details

COM-0, COM-1 configured for use with SPI devices
Other Ports and Connectors

USB Port

The USB (type-B) serial port can be used for uploading application code as well as serial communication with a PC or other device.

Ethernet Port

ClearCore includes a 10Base-T/100Base-TX Ethernet connector to provide network connectivity to your ClearCore. Access is through a standard RJ-45 jack. Use only CAT5e cable or better (non-crossover type).

XBee Connector

Note: The ClearCore cover must be temporarily removed to install or remove an XBee module.

The following XBee modules are compatible with ClearCore. Note: Only the through-hole versions of these XBee devices can be used with ClearCore.

- Digi XBee 3
- Digi XBee Wi-Fi (S6B)
- XBee or XBee-PRO Zigbee
- XBee or XBee-PRO DigiMesh 2.4 (S2C)
- XBee or XBee-PRO 802.15.4
- XBee-PRO 900HP (S3B)

Notes

- 2G/3G and 4G-LTE cellular XBee modules are not compatible with ClearCore.
- The ClearCore's polycarbonate cover has holes and knockouts to accommodate select XBee antenna types.
JTAG Connector

An onboard JTAG connector is provided for developers who wish to connect a third-party debugging tool during development. Note: You must remove the ClearCore cover to access the JTAG connector.

**Recommended debugger:** Atmel p/n: ATATMEL-ICE (for use with Atmel Studio 7 IDE)

**Cable for above debugger:** TAG-Connect p/n: TC2030-CTX-LEMTA, 6-Pin, "plug of nails" connector that connects directly to the ClearCore board. The opposite end of this cable connects to the ICE debugger's "SAM" port.

*LEMTA option must be selected for compatibility with the Atmel-ICE debugger.*

Micro-SD Card Drive

ClearCore includes a built-in micro-SD card drive with read/write capability. Typical uses include:

- Data logging for debugging and troubleshooting
- Machine configuration data storage
- General file storage

**Micro-SD Card Compatibility**

Use only Micro SDHC cards (which utilize FAT32 file systems by default) with your ClearCore. These cards typically range from 4Gb to 32Gb of storage capacity. Micro-SD cards with file systems other than FAT32, for example exFAT and NTFS, will not work with ClearCore and must be formatted to FAT32 file systems to be compatible with ClearCore.
Appendix A: Troubleshooting

Note: For ClearCore blink codes, please see the ClearCore software programming reference.

Windows 7 Issues

USB driver management in Windows 7 causes issues in some installations which affect uploading code to ClearCore. Extra manual steps may be required to upload code in these systems.

If you experience problems when using ClearCore with Windows 7, please try the following:

- Press ClearCore reset button
- Turn off USB selective suspend (this is the Windows USB power save feature). Google the above phrase for instructions
- Insert a USB 2.0 hub between the PC and ClearCore
- Load the latest USB 3.0 drivers for your PC’s hardware
Appendix B: Mechanical Reference

ClearCore Mounting and Clearance Dimensions

ClearCore Baseplate Dimensions (actual size)

Note: This page can be printed and used as a drill template. (Set printer to “Do Not Scale”.)

ClearCore Mounting Dimensions

ClearCore Mounting and Clearance Notes

- Leave a minimum of 1.5” (38.1mm) clearance around all ClearCore surfaces (except the mounting plate) for appropriate ventilation.
- Provide appropriate clearance for top and side-mounted cables. Note: some Ethernet and USB cables may require up to 2” clearance.
CCIO-8 Mounting and Clearance Dimensions

**CCIO-8 Baseplate Dimensions** *(actual size)*

*Note: This page can be printed and used as a drill template. (Set printer to "Do Not Scale").*

**CCIO-8 Mounting Dimensions**

**CCIO-8 Mounting and Clearance Notes**

- Leave a minimum of 1.5" (38.1mm) clearance around all CCIO-8 surfaces (except the mounting plate) for appropriate ventilation.
- Provide clearance for top and side-mounted cables. Note: some Ethernet and USB cables may require up to 2" clearance.
## Appendix C: Mating Connectors and Terminals

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Mating Connector Description</th>
<th>Mating Connector or Cable PN</th>
<th>Terminal Description</th>
<th>Terminal PN</th>
<th>Tooling</th>
<th>Wire Gauge (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Screw terminal block, 3-position, 3.81mm pitch</td>
<td>Molex/0395105003</td>
<td>OPTIONAL Wire ferrule, 20-24 AWG, white</td>
<td>OPTIONAL American Electrical 1181050</td>
<td>OPTIONAL Crimp Tool American Electrical TRAP 22-10</td>
<td>20-24</td>
</tr>
<tr>
<td>B</td>
<td>Molex MinFit-Jr, receptacle, 8-position</td>
<td>Molex part numbers: 39-01-2080 (natural, UL 94V-2) 39-01-3085 (black, UL 94V-2) 39-01-2085 (natural, UL 94V-0) 39-03-9082 (black, UL 94V-0)</td>
<td>Female crimp terminal, tin plate, 22-28 AWG</td>
<td>Molex/39-00-0046 (reel) Molex/39-00-0047 (loose)</td>
<td>Crimp tool Molex/93819-1000 Extraction tool Molex/11-03-0044</td>
<td>22</td>
</tr>
<tr>
<td>C</td>
<td>Crimp style connector, 20 position, free hanging, panel mount, 0.10” (2.54mm) pitch</td>
<td>TE/102387-4</td>
<td>Socket contact, gold plate, 22-26 AWG crimp</td>
<td>TE/87756-4</td>
<td>Crimp tool TE/169481-1</td>
<td>22-26</td>
</tr>
<tr>
<td>D</td>
<td>JTAG, 6-pin, &quot;Plug-Of-Nails&quot; connector for ARM CORTEX SWD (single wire debug) applications</td>
<td>Teknic cable part number: P/N TC2030-CTX-LEMTA for use with Atmel ICE debugger P/N ATATMEL-ICE-BASIC.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

![Diagram](image_url)

- **A**: Screw terminal block, 3-position, 3.81mm pitch
- **B**: Molex MinFit-Jr, receptacle, 8-position
- **C**: Crimp style connector, 20 position, free hanging, panel mount, 0.10” (2.54mm) pitch
- **D**: JTAG, 6-pin, "Plug-Of-Nails" connector for ARM CORTEX SWD (single wire debug) applications
# Appendix D: Specifications

## ClearCore Specifications

### Mechanical

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>5.0” x 3.5” x 1.0” (127mm x 88.9mm x 25.4mm)</td>
</tr>
<tr>
<td>Weight (with cover)</td>
<td>0.40 lbs (453.6 g)</td>
</tr>
<tr>
<td>Material</td>
<td>3mm thick polycarbonate cover, aluminum mount frame</td>
</tr>
</tbody>
</table>

### Electrical

<table>
<thead>
<tr>
<th>Voltage Input</th>
<th>12-28 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Current Capability</td>
<td>I/O 0,1,2,3 - 375 mA RMS, (750 mA peak)</td>
</tr>
<tr>
<td></td>
<td>I/O 4,5 - 500 mA RMS, (1,000 mA peak)</td>
</tr>
<tr>
<td>Indicator LEDs for each input</td>
<td>yes</td>
</tr>
<tr>
<td>IP rating</td>
<td>IP20</td>
</tr>
<tr>
<td>Operating Temperature/Humidity</td>
<td>-20°C to 50°C, 0-90% non-condensing</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-40°C to 85°C</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>300mA@24V or 500mA@12V. Adding an XBee will add as much as an additional 100mA@24V or 200mA@12V.</td>
</tr>
<tr>
<td>Protection features</td>
<td>Overcurrent protection on all outputs</td>
</tr>
<tr>
<td></td>
<td>Inductive clamping on all outputs</td>
</tr>
<tr>
<td></td>
<td>Board master overvoltage and overcurrent protection</td>
</tr>
<tr>
<td></td>
<td>ESD protection features on all I/O circuits</td>
</tr>
<tr>
<td>Capacitive load (max.)</td>
<td>Capacitance on I/O-0 through I/O-5 (and expansion port power pins)</td>
</tr>
<tr>
<td></td>
<td>collectively not to exceed 250uF.</td>
</tr>
</tbody>
</table>

### Processing/Communication

| Total I/O                   | 13 built-in I/O points, software configurable as any combination of up to 13 digital inputs, 4 analog inputs, 6 digital outputs, 2 H-Bridge/speaker outputs and 1 analog output (4-20mA or 0-20mA). See table on next page for I/O configuration. Another 64 digital I/O can be added by using optional 8-point I/O expansion modules (p/n CCIO-8). All configuration of I/O hardware is controlled by software, i.e., no jumpers, DIP switches, trim-pots, etc. need to be manually set. |
| Serial communication        | 2 Multi-functional, individually configurable serial ports that can be used as a UART, SPI, or RS-232 at up to 115.2kBaud. Rates up to 2MBaud are achievable depending on cable length, slave transceiver circuit and grounding. 5V power pins are available on each port. |
| Ethernet                    | 10Base-T/100Base-TX Ethernet                                                |
| USB                         | USB 2.0                                                                     |
Wireless connectivity  Accepts XBee modules for wireless connectivity (Wi-Fi, Bluetooth, Mesh, etc.)

Programming Language  C++

Recommended IDE  Atmel Studio 7 (or higher), or Arduino IDE 1.8.x (or higher) if used with the ClearCore Arduino Wrapper Library.

Memory Capability  512 KB Flash
192 KB RAM
Storage expansion via onboard SD card drive

Supported development environment  Windows 10, Windows 7* (see note)

Processor type and speed  32 bit floating point ARM M4F processor
120 MHz
(p/n SAME53N19A)

Max Step Rate  500kHz

* Win 7 note: USB driver management in Windows 7 causes issues in some installations which affect the uploading of code to ClearCore. Extra manual steps may be required to upload code in these systems.

I/O Function Table

<table>
<thead>
<tr>
<th>Label</th>
<th>Digital Input</th>
<th>Digital Output (^1)</th>
<th>0-10V Analog Input</th>
<th>4-20 mA Output (^2)</th>
<th>Servos or Steppers</th>
<th>Speaker Tones</th>
<th>DC Motor Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O-0</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IO-1</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IO-2</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IO-3</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IO-4</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>IO-5</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>DI-6</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI-7</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-9</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-10</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-11</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-12</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>yes (^3)</td>
</tr>
<tr>
<td>M-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>yes (^3)</td>
</tr>
<tr>
<td>M-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>yes (^3)</td>
</tr>
<tr>
<td>M-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>yes (^3)</td>
</tr>
<tr>
<td>CCIO-8(^4)</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: All digital outputs are PWM capable (except for those on the CCIO-8 expansion board).
Note 2: This output can also provide 0-20mA, which is less commonly used.
Note 3: Each motor connector has 3 digital outputs (step, dir., enable) and 1 digital input.
Note 4: There are 8 of these I/O points on the CCIO-8 expansion module.
## CCIO-8 Specifications

### Mechanical

<table>
<thead>
<tr>
<th>Dimension</th>
<th>3.6” x 3.28” x 1.0” (91.5mm x 83.3mm x 25.4mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>3.18 oz. (90 g)</td>
</tr>
<tr>
<td>Material</td>
<td>Assembled circuit board with aluminum mount frame</td>
</tr>
</tbody>
</table>

### Electrical

<table>
<thead>
<tr>
<th>Voltage Input</th>
<th>12-28 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Current Capability</td>
<td>All I/O points 375 mA RMS (750mA peak)</td>
</tr>
<tr>
<td>Indicator LEDs for each input</td>
<td>Yes</td>
</tr>
<tr>
<td>IP Rating</td>
<td>IP20</td>
</tr>
<tr>
<td>Operating Temperature/Humidity</td>
<td>-20C to 50C, 0-90% non-condensing</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-40C to 85C</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>100mA@24V or 150mA@12V</td>
</tr>
<tr>
<td>Protection Features</td>
<td>Overcurrent protection on all outputs</td>
</tr>
<tr>
<td></td>
<td>Inductive clamping on all outputs</td>
</tr>
<tr>
<td></td>
<td>ESD protection features on all I/O circuits</td>
</tr>
</tbody>
</table>

### Processing / Communication

**Note:** All I/O points on CCIO-8 are electrically identical to ClearCore's I/O-1, I/O-2, and I/O-3.

- Total of 8 built-in I/O points, software configurable as any combination of up to 8 digital inputs and 8 digital outputs.
- A total of 8 CCIO boards can be connected to one ClearCore, for a total of 64 additional digital I/O points.
- All I/O points are software configurable. (There are no jumpers, DIP switches, trim-pots, etc.)

| I/O Update Rate | 0.2mS (1-2 boards), 0.4mS (3-4 boards), 0.6mS (5-6 boards), 0.8mS (7-8 boards) |

### Connectivity

ClearCore connects to "COM IN" of the first CCIO-8. Any additional CCIO-8 boards are connected from COM OUT to COM IN. Use CAT5e cable (non-crossover) or better. Max cable length = 100 feet.

### CCIO-8 I/O Function Table

<table>
<thead>
<tr>
<th>Label</th>
<th>Digital Input</th>
<th>Digital Output</th>
<th>0-10V Analog Input</th>
<th>4-20 mA Output</th>
<th>Servos or Steppers</th>
<th>Speaker Tones</th>
<th>DC Motor Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O-0</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-1</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-2</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-3</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-4</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-5</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-6</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O-7</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I/O-8</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note 1:** Digital outputs on CCIO-8 are not PWM capable.
Appendix E: Processor Signal Routing Schematics