

# Direct I/O-16 Module

## T-IO-16, T-IO-16-USA

### INSTALLATION AND CONFIGURATION GUIDE

This document covers the mounting, wiring, and initial start-up of a T-IO-16 I/O expansion module. It assumes that you are an engineer, technician, or service person who is performing control system installation using the Niagara Framework®. Please read through this entire document before beginning the installation procedures.

These are the main topics included in this document:

- “Product Description,” page 1
- “Preparation,” page 2
- “Precautions,” page 2
- “Installation and Start-up Outline,” page 4
- “Mounting,” page 4
- “T-IO-16 Board Layout and Terminal Locations,” page 6
- “Wiring Details,” page 6
  - “Grounding,” page 6
  - “Inputs,” page 7
  - “Outputs,” page 10
- “NdioBoard (Software) Representation,” page 11
- “Power up and Initial Checkout,” page 12
- “Replacement Parts,” page 13
- “Certifications,” page 15



This document does not discuss software installation or station configuration. For more information on these topics, refer to the documents listed in the “[Related Documentation](#)” on page 2.

## Product Description

The Tridium® T-IO-16 or T-IO-16-USA is a compact direct I/O module for auxiliary monitoring and control when used with a T-200 or T-600 series controller (JACE® 2 or 6). This option expands the controller by an additional sixteen logic-controlled points. Included are eight universal inputs, four form “A” (SPST) relay outputs, and four analog (voltage only) outputs. This greatly expands the controller’s monitoring and control capabilities with fast, reliable, direct inputs and outputs for monitoring power, temperature, humidity, and status.

The on-board I/O can be used to monitor pulse contacts from power/demand meters, analog sensors, or transducers, as well as to control energy-consuming devices such as fans, lights, or pumps with digital relay outputs. Also included are four analog outputs to proportionally control dampers, valves, and other devices.

Up to four T-IO-16 modules may be cascaded to a T-200/T-600 controller, to provide a total of 32 UIs, 16 relays, and 16 analog output points.

## Related Documentation

For more details on configuring and using T-200/T-600 series controllers, refer to the following documents:

- *T-200 (JACE 2) Mounting and Wiring Guide*
- *T-600 (JACE 6) Mounting and Wiring Guide*
- *T-IO-34 Installation and Configuration Guide*
- *NiagaraAX Ndio Guide*
- *NiagaraAX User Guide*
- *JACE NiagaraAX Install & Startup Guide*

## Preparation

Unpack the T-IO-16 and inspect the contents of the packages for damaged or missing components. If damaged, notify the appropriate carrier at once and return any damaged components for immediate repair or replacement. See “[Returning a Defective Unit](#)” on page 14.

- [Included in this Package](#)
- [Material and Tools Required](#)

## Included in this Package

Included in this package you should find the following items:

- One T-IO-16 or T-IO-16-USA module, and grounding wire with quick-disconnect female connector.
- This *Direct I/O-16 Module*, Part Number 11838, Rev. 1.1.
- Four (4) 6-position terminal plugs, for I/O wiring.
- Eight (8) 499-ohm resistors for 4-20 mA inputs.

## Material and Tools Required

The following supplies and tools are required for installation:

- DIN rail, type NS35/7.5 (35mm x 7.5mm) and DIN rail end-clips (stop clips), recommended for mounting with the T-200/T-600 controller. The DIN rail should be sufficient length to accommodate both the controller and all T-IO-16s and other modules. See [Figure 1](#) on page 5.
- Suitable screws and screwdriver for mounting DIN rail, or if DIN rail not used, for mounting bases of T-200/T-600 controller and T-IO-16 module.
- Small flat-blade screwdriver: used for mounting or removing the T-IO-16 from DIN rail, also for screw terminals on I/O connectors.

## Precautions

This document uses the following warning and caution conventions:



### Caution

Cautions remind the reader to be careful. They alert readers to situations where there is a chance that the reader might perform an action that cannot be undone, might receive unexpected results, or might lose data. Cautions contain an explanation of why the action is potentially problematic.



### Warning

Warnings alert the reader to proceed with extreme care. They alert readers to situations where there is a chance that the reader might do something that can result in personal injury or equipment damage. Warnings contain an explanation of why the action is potentially dangerous.

## Safety Precautions

The following items are warnings of a general nature relating to the installation and start-up of the T-200/T-600 series controller. Be sure to heed these warnings to prevent personal injury or equipment damage.



### Warning

- Depending on installation, a 90–263Vac, 24Vac, or 24Vdc circuit powers the attached T-200/T-600 controller. Disconnect power before installation or servicing to prevent electrical shock or equipment damage.
- Make all connections in accordance with national and local electrical codes. Use copper conductors only.
- To reduce the risk of fire or electrical shock, install in a controlled environment relatively free of contaminants.
- Controllers and I/O modules are only intended for use as monitoring and control devices. To prevent data loss or equipment damage, do not use them for any other purposes.

## I/O Module Connection Precautions



### Warning

- Remove power from the unit before plugging or unplugging I/O accessory modules. **If the unit switches to battery operation, wait for all LEDs to go out.**
- Do not connect live voltages to the inputs or outputs of a T-IO-16 or IO-34 while it is in an “un-powered state” before plugging the module into a T-200/T-600 controller. **Otherwise, damage to the I/O module and/or the controller may result!**
- Allow sufficient JACE boot time after attaching I/O accessory modules and applying power. **Otherwise, I/O modules may be rendered inoperable. See [Warning](#) on page 12 for details.**
- Do not plug in more than four (4) T-IO-16 modules into a T-200/T-600 controller. Doing so will have unexpected effects on the software, and may overload the power supply.
- I/O modules are designed to be directly plugged into the T-200/T-600 as directly-attached modules. Do not use a ribbon cable or extend the length of the I/O cable as this will increase radiated signal noise, decreases analog stability, and may introduce communication problems.

## Static Discharge Precautions

The following items are cautionary notes that will help prevent equipment damage or loss of data caused by static discharge.



### Caution

- Static charges produce voltages high enough to damage electronic components. The microprocessors and associated circuitry within a T-IO-16 are sensitive to static discharge. Follow these precautions when installing, servicing, or operating the system:
  - **Work in a static-free area.**
  - **Discharge any static electricity you may have accumulated. Discharge static electricity by touching a known, securely grounded object.**
  - **Do not handle the printed circuit board (PCB) without proper protection against static discharge. Use a wrist strap when handling PCBs, with the wrist strap clamp secured to earth ground.**

## Installation and Start-up Outline



**Note** If installing the T-200/T-600 controller and T-IO-16 at the same time, please refer to the appropriate controller installation document. Note that a maximum of four T-IO-16 modules are supported (or two if a T-IO-34 is installed)—see [Figure 1](#) on page 5.

The major steps to installing and starting the T-IO-16, are outlined as follows:

1. Physically mount the T-IO-16 module with the T-200/T-600 controller. See [“Mounting.”](#) Make sure that the T-IO-16 input connector is properly seated into the IO connector on the JACE (or if used, another IO-16 module). Note the previous [“I/O Module Connection Precautions”](#) on page 3.
2. Make wiring connections for earth ground and I/O wiring. See [“Wiring Details,”](#) page 6.
3. Apply power and perform an initial checkout. See [“Power up and Initial Checkout”](#) on page 12.

## Mounting

The following applies to mounting a T-IO-16 module with a T-200/T-600 series controller:

- You can mount the units in any orientation. It is not necessary to remove the covers before mounting.
- Mounting on a 35mm wide DIN rail is recommended. Both the T-200/T-600 controller base and T-IO-16 module base have a molded DIN rail slot and locking clip, as do power supply modules (NPB-PWR, NPB-PWR-UN). Mounting on a DIN rail ensures accurate alignment of connectors between all modules.
- If DIN rail mounting is impractical, you can use screws in mounting tabs on the T-200/T-600, then in the T-IO-16 module. Mounting tab dimensions are on the [last page](#) of this document.

[Procedure 1](#) provides step-by-step mounting instructions for the T-IO-16 on an existing installed DIN rail.



**Note** If the T-200/T-600 controller is already in use:

- a. Back up its configuration to your PC using NiagaraAX Workbench 3.n.nn. You can do this with a platform connection to it, using the **Backup** command in the **Platform Administration** view.
- b. Turn off power to the controller and disconnect the power cord. Be sure that all of the LEDs are off. Make sure that the controller is not running off of battery power.

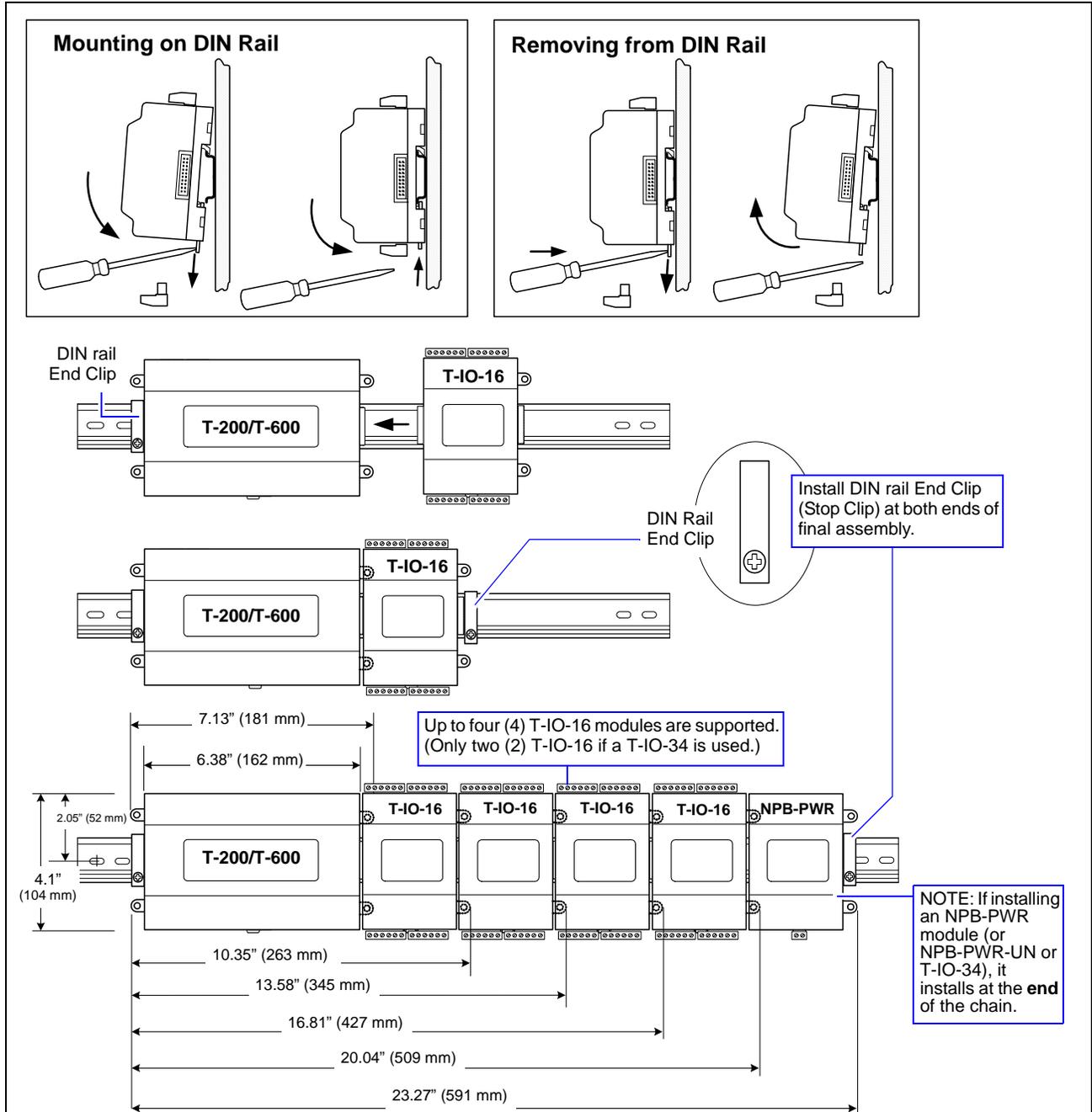
If the controller is using an NPB-PWR, NPB-PWR-UN, or T-IO-34 module for power, remove it before mounting T-IO-16 modules.

### Procedure 1 To mount the T-IO-16 on DIN rail.

- Step 1** Remove the bottom I/O connector plug(s) that cover the plastic DIN locking clip.
- Step 2** Position the T-IO-16 on the rail, tilting to hook DIN rail tabs over one edge of the DIN rail ([Figure 1](#)).
- Step 3** Use a screwdriver to pry down the plastic locking clip, and push down and in on the unit, to force the clip to snap over the other edge of the DIN rail.
- Step 4** Slide the unit on the DIN rail to connect its 20-position plug into the T-200/T-600 (or if used, another T-IO-16). If an NPB-PWR, NPB-PWR-UN, or T-IO-34 module is used, it mounts last. Make sure that all modules are firmly seated.
- Step 5** Continue to mount all T-IO-16 modules, and if used, then the power supply module (NPB-PWR, etc.).

**Step 6** To keep the final assembly together, secure at both ends with DIN rail end-clips provided by the DIN rail vendor. This also prevents the assembly from sliding on the DIN rail. See [Figure 1](#).

**Figure 1** T-IO-16 module mounting details.

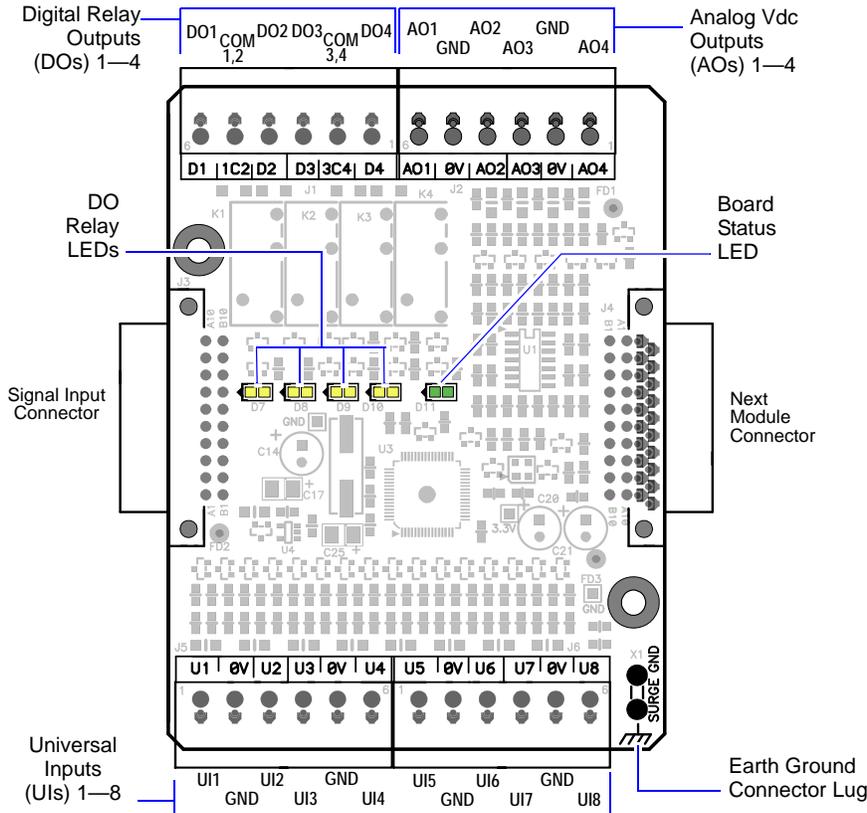


**Note** To remove a T-IO-16 module from DIN rail, slide it away from other modules. Insert a screwdriver in the center plastic locking tab and pull downwards, then lift the unit outwards. You may need to first remove an I/O connector plug, as shown at the top of [Figure 1](#).

## T-IO-16 Board Layout and Terminal Locations

The T-IO-16 provides 8 universal **inputs** supporting analog inputs (temperature, resistance, voltage, and current) and digital inputs (contact closure, pulse count), and 8 **outputs**: 4 relay (24Vac/dc, 0.5A max.) outputs and 4 analog outputs (0–10 Vdc). Wiring terminal positions are shown below (Figure 2), along with LED locations.

**Figure 2 T-IO-16 Wiring Terminal Locations.**



## Wiring Details

See Figure 2 above to locate connectors and other components on the T-IO-16 controller.

Make connections to the T-IO-16 in the following order.

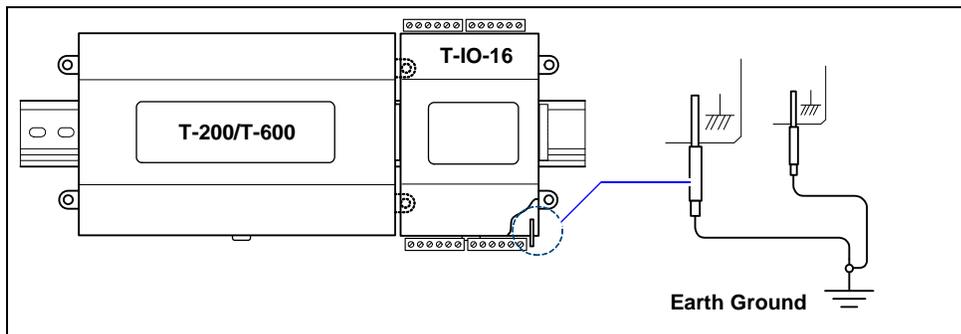
1. Connect the earth grounding wire (with spade connector) from the earth ground lug on the T-IO-16 to a nearby earth grounding point. See “Grounding” for details.
2. Connect I/O wiring. See sections “Inputs” on page 7, and “Outputs” on page 10.
3. Apply power to the unit. See “Power up and Initial Checkout,” page 12.

## Grounding

An earth ground spade lug (0.187”) is provided on the base of the T-IO-16 (as well as the T-200/T-600 controller, NPB-PWR and other modules) for connection to earth ground. For maximum protection from electrostatic discharge or other forms of EMI, connect each earth ground using a #16 AWG or larger wire. Keep these wires as short as possible.

See [Figure 3](#) for the location of the earth grounding wire for the T-IO-16.

**Figure 3** T-IO-16 earth ground connection.



**Note** Do not apply 24V power (reapply power to the NPB-PWR or WPM-XXX) until all other wiring is completed, including T-IO-16 [inputs](#) and [outputs](#). See [“Power up and Initial Checkout,”](#) page 12.

## Inputs

Each of the 8 universal inputs (UI) can support any one of the following:

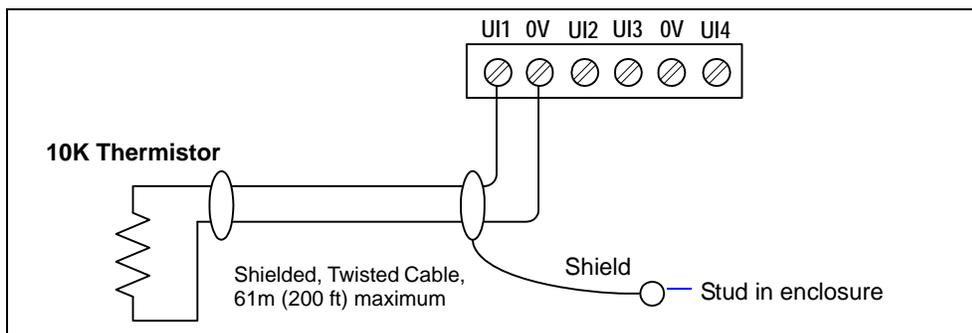
- Type-3 10K ohm [Thermistor](#) (also see [Caution](#) on page 8)
- [Resistive 0—100K ohms](#)
- [0–10 Vdc](#)
- [4–20 mA](#)
- [Binary Input](#)

### Thermistor

The inputs support 10K Thermistor temperature sensors using a **ThermistorInputPoint**. Input accuracy is in the range of  $\pm 1\%$  of span. By default, conversion is for a standard Type 3 thermistor sensor, with a sensor range of  $-10^{\circ}$  to  $135^{\circ}\text{F}$  ( $23.3^{\circ}$  to  $57.2^{\circ}\text{C}$ ). Using a conversion type of “Tabular Thermistor,” you can specify a different thermistor response curve, by importing a thermistor curve .xml file. Currently, the ndio module contains an xml folder with thermistor curves for a Radio Shack sensor model 271-0110 and TE-6300 10K type sensor. You can also edit and export (for reuse) *customized* thermistor xml files. See the *NiagaraAX Ndio Guide* for more details.

[Figure 4](#) shows the wiring diagram.

**Figure 4** Thermistor wiring.



## Resistive 0—100K ohms

The inputs can read a resistive signal within a range from 0 to 100,000 ohms. Wiring is the same as shown for a Thermistor temperature sensor (Figure 4 on page 7).

Resistive signals require a **ResistiveInputPoint**.



### Caution

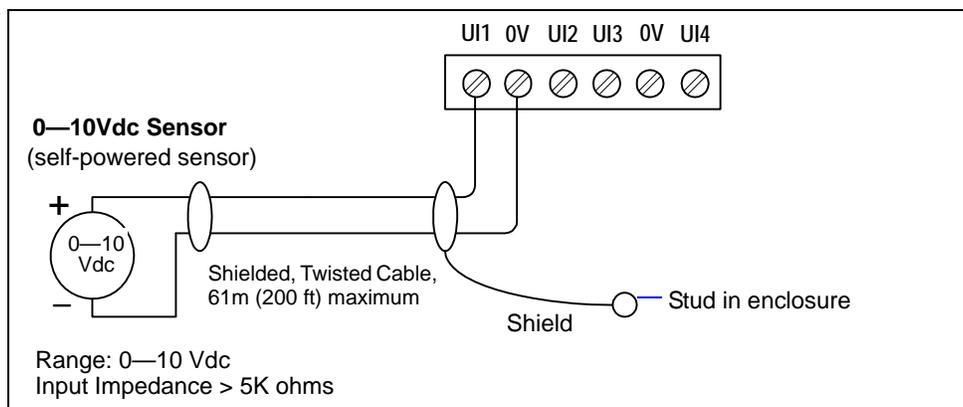
UI inputs provide optimum resistive-to-temperature resolution in the 10K ohm range. For a sensor with a range far from 10K ohms (such as a **100-ohm** or **1000-ohm sensor**), resolution is **so poor as to be unusable!** To successfully use such a sensor, install a *transmitter* that produces a Vdc or mA signal, and then wire the transmitter to the UI according to the **0–10 Vdc** or **4–20 mA** instructions.

## 0–10 Vdc

The inputs support self-powered 0–10 Vdc sensors. Input impedance is greater than 5K ohms. 0–10 volt accuracy is  $\pm 2\%$  of span, without user calibration. Figure 5 shows the wiring diagram.

0–10 Vdc sensors require a **VoltageInputPoint**.

Figure 5 0–10 Vdc wiring.

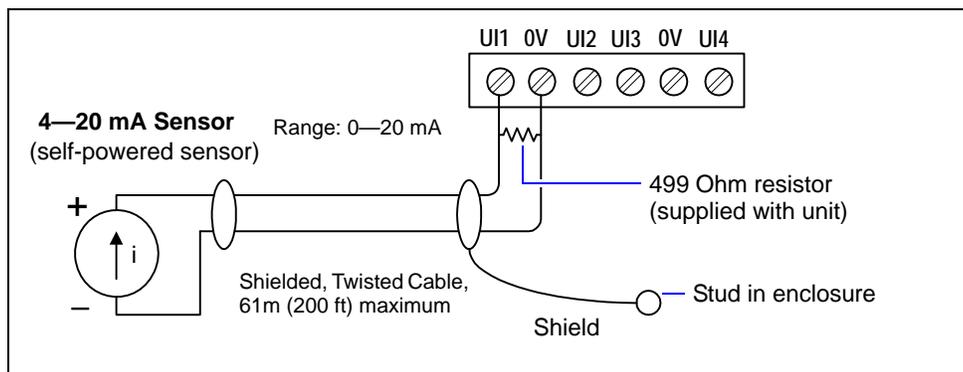


## 4–20 mA

The inputs support self-powered 4–20 mA sensors. Input accuracy is  $\pm 2\%$  of span, without user calibration. Figure 6 shows the wiring diagram, which requires a 499 ohm resistor wired across the input terminals.

4–20 mA sensors also require the **VoltageInputPoint**.

Figure 6 4 to 20 mA wiring.



## Binary Input

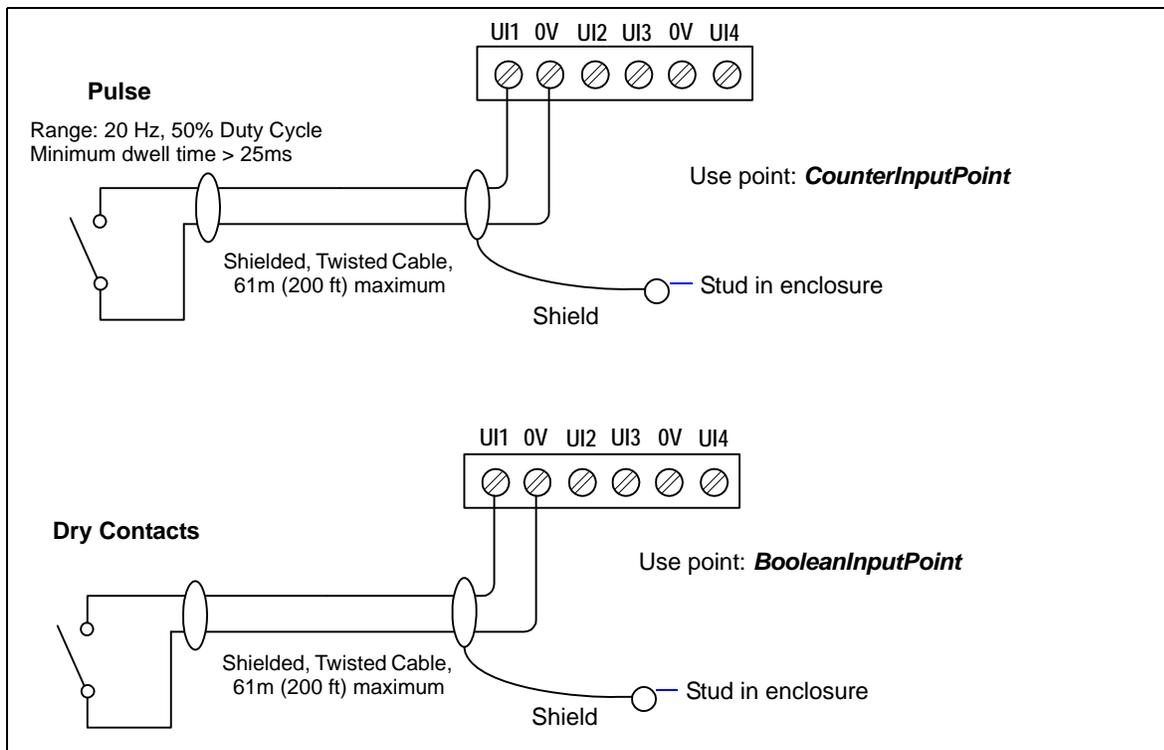
The universal inputs support both pulse contacts and normal dry (equipment status) contacts.

- Pulse contacts may have a change-of-state (COS) frequency of up to 20 Hz with a 50% duty cycle.  
*Note:* Minimum dwell time must be > 25ms.  
(Contacts must remain open at least 25ms and be closed at least 25ms.)
- Standard dry contacts must have a 1 Hz. (or less) COS frequency, with minimum dwell time > 500ms.  
(Contacts must remain open at least 500ms and be closed at least 500ms.)

Both types of dry contacts support 3.3 Vdc open circuits or 330  $\mu$ A short-circuit current.

Figure 7 shows the wiring diagram. For a pulse contact, use the **CounterInputPoint** in the station database. For other dry contacts, use the **BooleanInputPoint**.

**Figure 7** Binary input wiring.



## Outputs

The T-IO-16 has four (4) digital **relay outputs** and four (4) 0–10 volt **analog outputs**.

### Relay Outputs

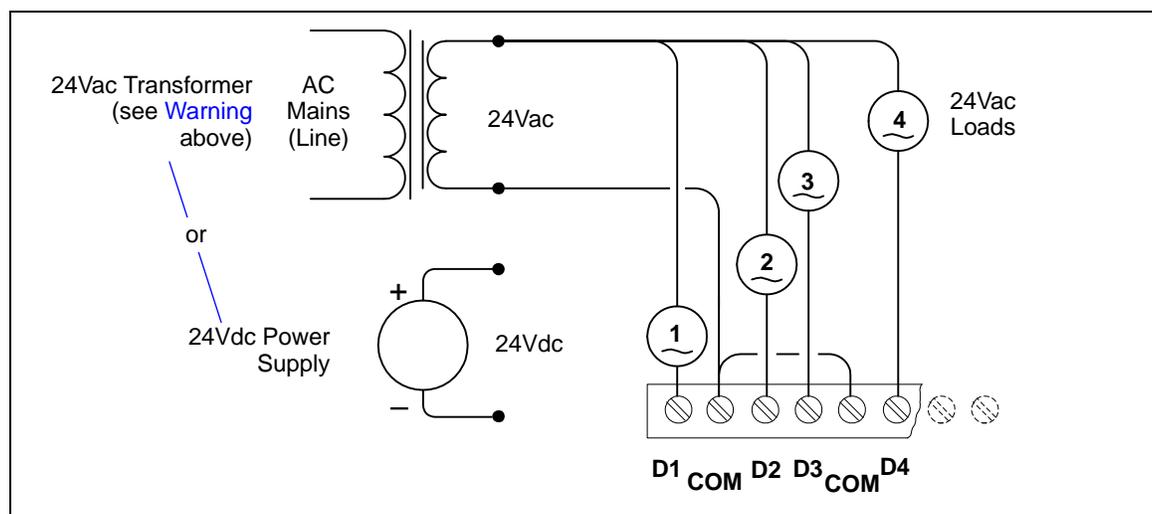
Each relay output is rated at 24 Vac or Vdc at 0.5A. Relay outputs have MOV (metal oxide varistor) suppressors to support inductive-type loads such as heavy-duty relay coils.



**Warning** Relays are not rated for AC mains (line level) powered loads (instead, 24V maximum). Never use the T-200/T-600 controllers's power transformer to power I/O loads. Using the controller's transformer introduces potentially damaging switching transients into the unit.

Use a **BooleanOutputWritable** in the station for each output. [Figure 8](#) shows an example wiring diagram.

**Figure 8** Relay output wiring diagram.



Note that the two common DO terminals are isolated from each other. This is useful if controlled loads are powered from different circuits.

An LED status indicator for each relay (D1—D4) is located on the board ([Figure 2](#) on page 6), and also visible through the cover. Under normal operation, each digital status LED indicates activity as follows:

- **Off**—relay open / no current flows.
- **On**—relay closed / load current flows.

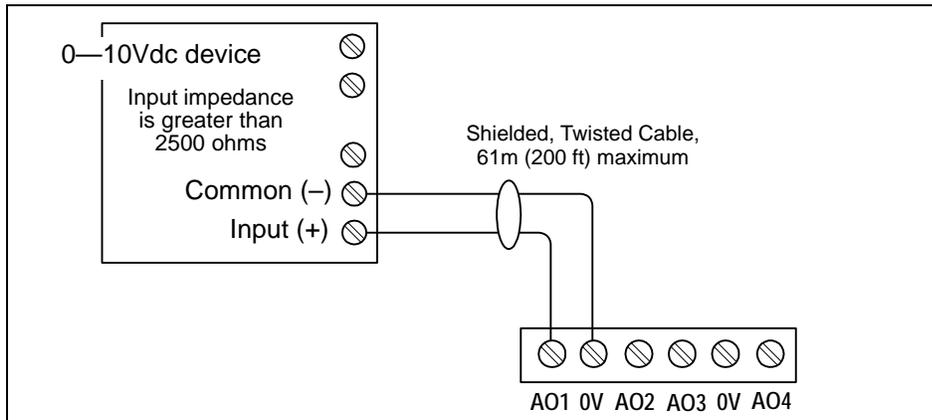
Therefore, an **On** status indicates that the load is powered.

### Analog Outputs

Analog outputs (AO) are referenced by the terminals labeled  $A_n$  and 0V (ground). Each AO can supply a maximum of 4 mA over the entire 0 to 10Vdc range. The minimum input impedance of a device controlled by an AO must be greater than 2500 ohms. Typical wiring for an AO is shown in Figure 9.

For each AO, use a **VoltageOutputWritable** in the station database.

Figure 9 Analog output wiring diagram.

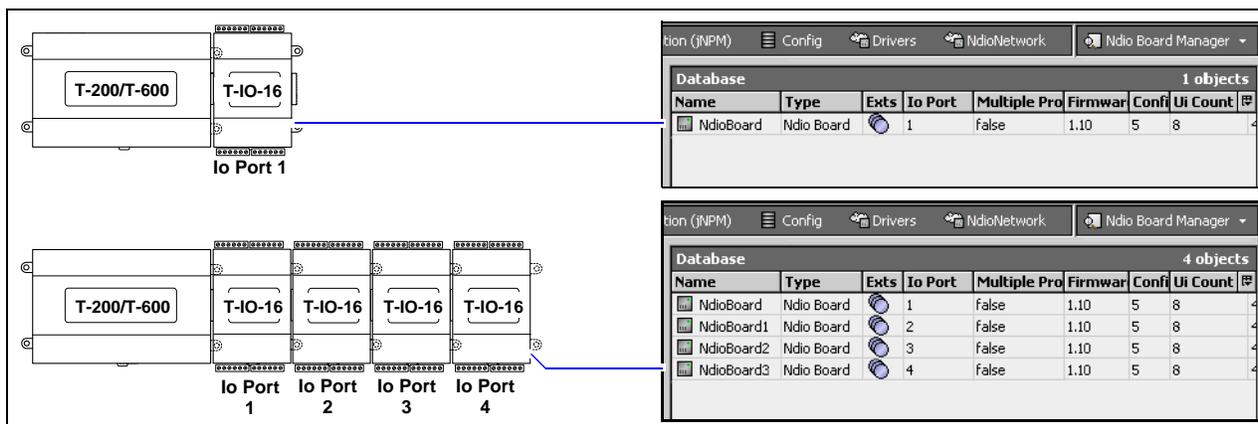


## NdioBoard (Software) Representation

In the Niagara station interface to the T-200/T-600 controller, each IO module appears as one **NdioBoard** under the station’s **NdioNetwork**. If the controller has only *one* T-IO-16 module, the NdioNetwork has a single NdioBoard component, where the “Io Port” property of the NdioBoard is 1. See Figure 10, top.

Upon discovery, if the controller has *multiple* T-IO-16 modules, the module closest to the T-200/T-600 controller is the *first* NdioBoard (property Io Port 1), the next chained module is NdioBoard1 (property Io Port 2), and the third module is NdioBoard2 (property Io Port 3). See Figure 10, bottom.

Figure 10 NdioBoard assignment (Io Port) is determined by proximity order to JACE.



Once the operating system identifies the NDIO processors, the I/O board status LED on each IO module turns green. The green status LED means that the controller is able to communicate with the I/O. It does not indicate anything about the status of the Niagara station or its Ndio components. See Figure 2 on page 6 for location of the T-IO-16 board Status LED.



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- Notes**
- If the I/O board Status LED is blinking with a long duty cycle (mostly On, quick blink Off), the controller is downloading an IO firmware upgrade—do not power off! See the [Warning](#) below.
  - Any time a powered IO module’s board Status LED is not lit, all outputs are in “failsafe” state (all relay outputs OFF, and all AOs are at a 0-volt level).
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Each type of input or output used requires a special Niagara Direct Input/Output (Ndio) point to be added in the station database. These components act as the station interface to the physical I/O points. The Ndio points you need for each input or output type are noted in previous wiring sections in **boldface**. For Ndio component details, see the *Ndio Guide* in Workbench online Help, or the same document in PDF.

## Power up and Initial Checkout



**Warning** After applying power, allow the T-200/T-600 sufficient time to boot (as long as 4 minutes) **without disconnecting power** following attachment of IO modules, or after upgrading its core software. At power up, the controller scans attached IO modules and *automatically installs IO firmware in modules*, if older firmware was detected. Each IO processor is downloaded in turn, starting with the lowest logical address. During a download, an IO module’s Status LED has a *long duty cycle blink*, i.e. *mostly On, blinking Off*. Power interruption during this IO module upgrade can *render IO modules unusable!* Note this IO firmware upgrade occurs *before* the platform daemon starts in the JACE. Therefore, it is safe to interrupt power anytime *after* you can open a platform connection to the JACE.

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- Step 1** Apply power to the T-200/T-600 (e.g., NPB-PWR or WPM-XXX). Note [Warning](#) above. The T-IO-16 board status LED ([Figure 2](#) on page 6) will initially be Off.
- Step 2** Upgrade the controller’s firmware if necessary (if it has a Niagara build earlier than your Workbench). Using Workbench, open a platform connection to it and use the **Commissioning Wizard** to do this. For more details, see the *JACE Niagara<sup>AX</sup> Install and Startup Guide*, also available in Workbench online Help (doc Jace Startup). Make sure to install the **ndio** software module. Note [Warning](#) above.
- Step 3** Verify that the T-IO-16 board Status LED is now lit solid green.
- Step 4** Using Workbench, open the station (if running), or open a platform connection and start the station with using the **Station Director**.
- Step 5** If not already present, add an **NdioNetwork** component to the station’s Drivers Container, and use “Manager” views and “Learn Mode” to discover and add Ndio components to the station database. See “[NdioBoard \(Software\) Representation](#),” page 11. For more details about Ndio components, refer to the *Ndio Guide*, also available in Workbench online Help (doc Ndio).
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## Replacement Parts

Servicing the T-IO-16 may call for replacement parts. There are two categories of parts:

- [Standard Replacement Parts](#)
- [New Replacement Units](#)

### Standard Replacement Parts

Standard replacement parts are listed in [Table 1](#) and can be ordered from stock without restriction. Standard replacement parts cannot be returned for credit and should be disposed of in an appropriate manner.

**Table 1** Standard replacement parts.

Part Number	Description
10149	Resistor, 499 ohm, 1%, 0.6w
10429	Connector plug, 6-position screw terminal, 180 deg. (4 used for I/O)
10370	Grounding wire with quick-disconnect 0.187" female connector

### New Replacement Units

To replace a faulty unit, order and install a *new* T-IO-16 accessory module. If the faulty T-IO-16 is *still in warranty*, you can receive credit by returning it. Be sure to contact the vendor for a return material authorization (RMA) number before shipping an item for return credit. See [“Returning a Defective Unit,”](#) page 14, for details.



**Note** Before ordering a new T-IO-16, it is strongly recommended that you contact your normal technical support resource to eliminate the possibility of a software issue or mis-configuration problem.

### Replacing a T-IO-16



**Caution** Before handling circuit boards, discharge any accumulated static by touching the nearby earth grounding point. For details, see the [“Static Discharge Precautions”](#) section on page 3.

To replace the T-IO-16 accessory module in the field, proceed as follows:

#### Procedure 2 Replacing a T-IO-16 accessory module.

**Step 1** Using the appropriate NiagaraAX software tool, back up the JACE’s configuration to your PC.

**Step 2** Remove power to the T-200/T-600 controller. The unit should power down automatically. Wait for all LEDs on the controller to remain off.



**Note** If any I/O points have voltage, turn the devices off or disconnect power to them.

**Step 3** Note positions of all I/O wiring going to the T-IO-16 to be replaced, as well as for any other installed modules. If necessary, label connectors and accessory modules to avoid mis-connection later (after T-IO-16 is replaced). The software that runs on the controller expects the terminal positions to be the same in the replacement T-IO-16, in order to collect data from or to control the attached devices.

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Returning a Defective Unit

- Step 4** Unplug all connectors from the T-IO-16, including all I/O connectors and earth ground wire.
- Step 5** Remove any screws or DIN rail clips securing the module, removing it from its mounting. See [Figure 1](#) on page 5 for details on removal from (and mounting onto) DIN rail.
- Step 6** Mount the replacement T-IO-16 as it was previously, using the same DIN rail location and/or screws.
- Step 7** Reconnect the earth ground wire to the module's grounding lug.
- Step 8** Reconnect all I/O connectors to the T-IO-16.
- Step 9** If any of your I/O points have voltage, turn the devices back on, or reconnect power to them.
- Step 10** Restore power to the T-200/T-600 controller, *allowing at least 4 minutes before possibility of power interruption*.  
For related details, see [“Power up and Initial Checkout”](#), including the [Warning](#) on page 12.
- Step 11** For more details, see the *Niagara<sup>AX</sup> Ndio Guide* and *JACE Niagara<sup>AX</sup> Install and Startup Guide*.
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## Returning a Defective Unit



- Note** If the defective unit is under warranty, please follow return instructions provided in this section. If the unit is *out of warranty*, please discard it, observing all national and local recycling regulations.
- Do not return an out-of-warranty T-IO-16.
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Prior to returning the unit, contact your vendor to obtain a return materials authorization (RMA) number and other instructions.

Please provide:

- Product model
- Nature of the defect
- PO number to secure the RMA

## Certifications

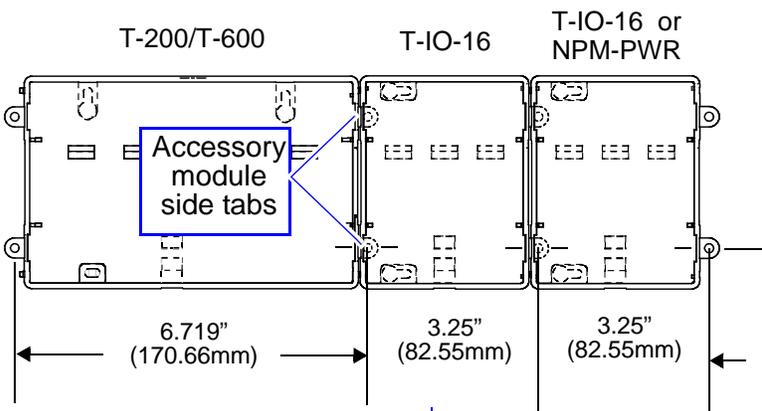
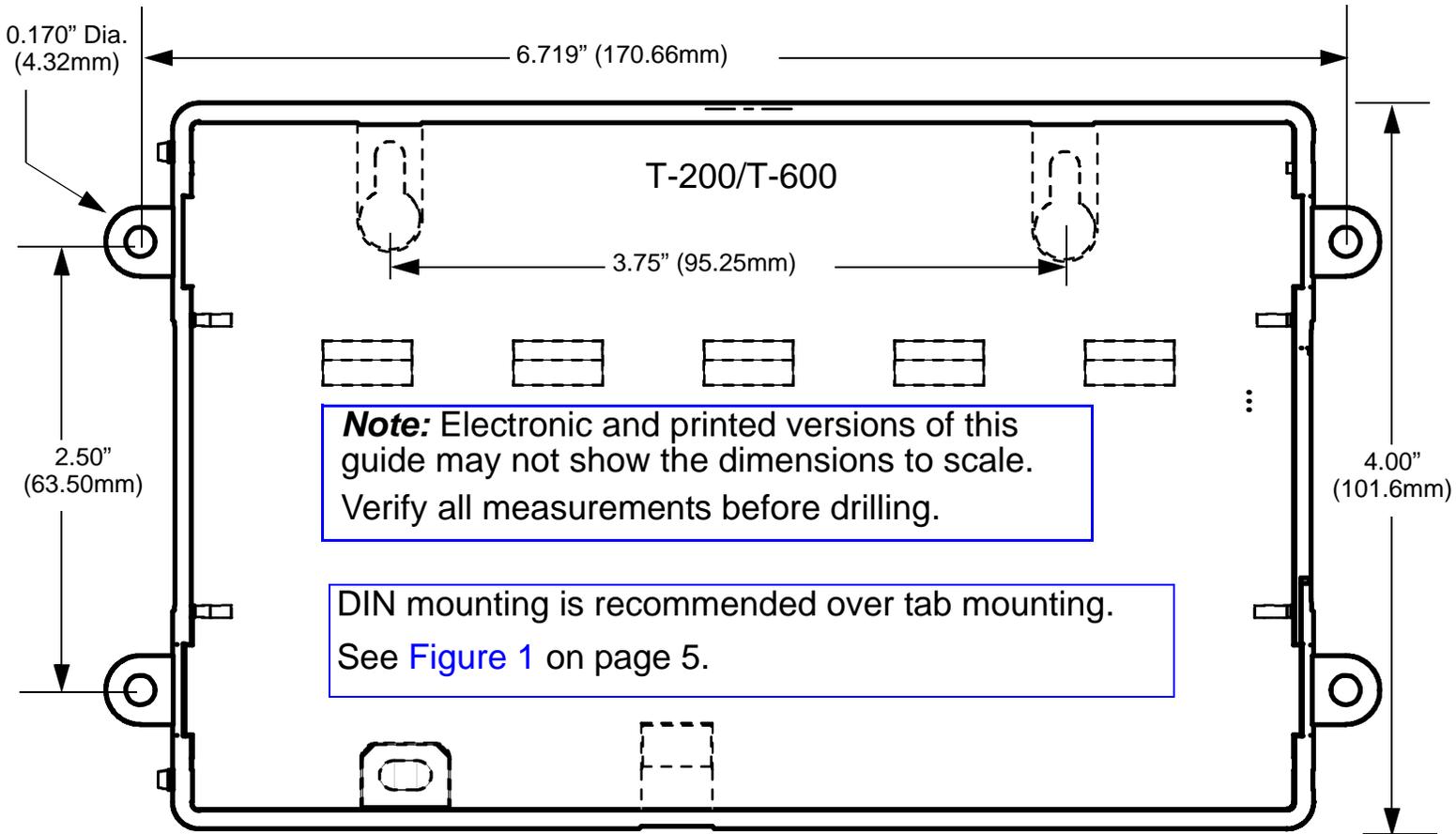
The T-IO-16 meets certifications of the Federal Communications Commission (FCC), Canadian Department of Communications (DOC), and is included in an EC “Declaration of Conformity” for the T-200 and T-600 series controllers.

In addition, this product meets all requirements of RoHS Directive (EU 202/95/EC). All components used in this product are RoHS compliant, and there have been no leaded solders used in manufacture.

For further details, please see these sections in the *T-200 (JACE 2) Mounting and Wiring Guide*, part number 11842, and the *T-600 (JACE 6) Mounting and Wiring Guide*, part number 11843.

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# Tab Mounting Dimensions



Distance between center of tabs from one unit to another unit.

**Tip:** When mounting the controller, you can simplify any future removal or replacement of it by **not** installing screws in its "accessory module side" tabs (see above).

