BusWorks® NT Series Modular IO Bus System

NT2000 Ethernet IO and Expansion System
10/100MB Industrial Ethernet

USER'S MANUAL

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Table of Contents

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IMPORTANT SAFETY CONSIDERATIONS
You must consider the possible negative effects of power, wiring, component, sensor, or software failure in the design of any type of control or monitoring system. This is very important where property loss or human life is involved. It is important that you perform satisfactory overall system design and it is agreed between you and Acromag, that this is your responsibility.

GETTING STARTED

DESCRIPTION

Symbols on equipment:

⚠ Means "Refer to User's Manual for additional information".

This manual describes the operation of the NT 2000 modular IO system. The various IO boards that can be used with this module are covered in detail in their respective sections. As noted in the table at right, there are fourteen IO model variations. The NTE2000 Ethernet IO module provides Ethernet connectivity plus up to an additional three NTX expansion IO modules. The NTX IO modules receive isolated bus power from their Ethernet Module connection and communicate using an isolated RS485 bus. System IO channels (as a group) are isolated from input power, the Ethernet microcontroller, and both network connections, but the IO channels are not isolated channel-to-channel, or between IO modules.

The BusWorks NT 2000 IO family is designed as an expandable modular network IO system that allows an Ethernet module to be mated with expansion IO modules that address variations/combinations of discrete IO, current/ voltage IO, TC/millivoltage input, and RTD/resistance input signals.

Table 1: Fourteen Compatible NT IO Models for NTE and NTX Modules.

Ethernet IO Modules	IO Expansion Module	SUPPORTED IO CHANNELS/MODULE (An NTE system may have 1-4 IO Modules)
NTE2111	NTX2111	16CH DIO Sinking, Active-Low
NTE2121	NTX2121	16CH DIO Sourcing, Active-High
NTE2131	NTX2131	6CH Mechanical Relay & 6CH DI Active-High
NTE2211	NTX2211	8CH Differential Current & 2 DIO Sinking
NTE2231	NTX2231	8CH Differential Voltage & 2 DIO Sinking
NTE2611	NTX2611	8CH mV/TC & 2 DIO Sinking
NTE2221	NTX2221	16CH Single-Ended Current Input
NTE2241	NTX2241	16CH Single-Ended Voltage Input
Models Coming Soon…		
NTE2621	*NTX2621*	*4CH 2/3/4-Wire RTD & 2 DIO Sinking*
NTE2311	*NTX2311*	*8CH 0-22mA Current Output*
NTE2321	*NTX2321*	*8CH Voltage Output*
NTE2141	*NTX2141*	*6CH 130V/240V AC Input/6CH DIO Sinking*
NTE2511	*NTX2511*	*4CH Diff I+4CH DIO SRC+2CH AO-I*
NTE2531	*NTX2351*	*4CH Diff V+4CH DIO SRC+2CH AO-I*

The NTE IO module is represented as slot 0 of 4 available, which is mated with the system network/CPU inside the NTE model. Optionally, you may connect up to 3 more expansion NTX IO modules by plugging them together with the network/CPU module moving left to right along its DIN rail bus (slots 1-3 in any mix).

Note that a single Ethernet module may support up to 16 channels (internal IO slot 0) and optionally connect 1-3 expansion IO modules (external IO slots 1-3 for up to 48 more channels), providing access for up to 64 channels at a single IP address (total system channels will vary with IO models).

Key Features

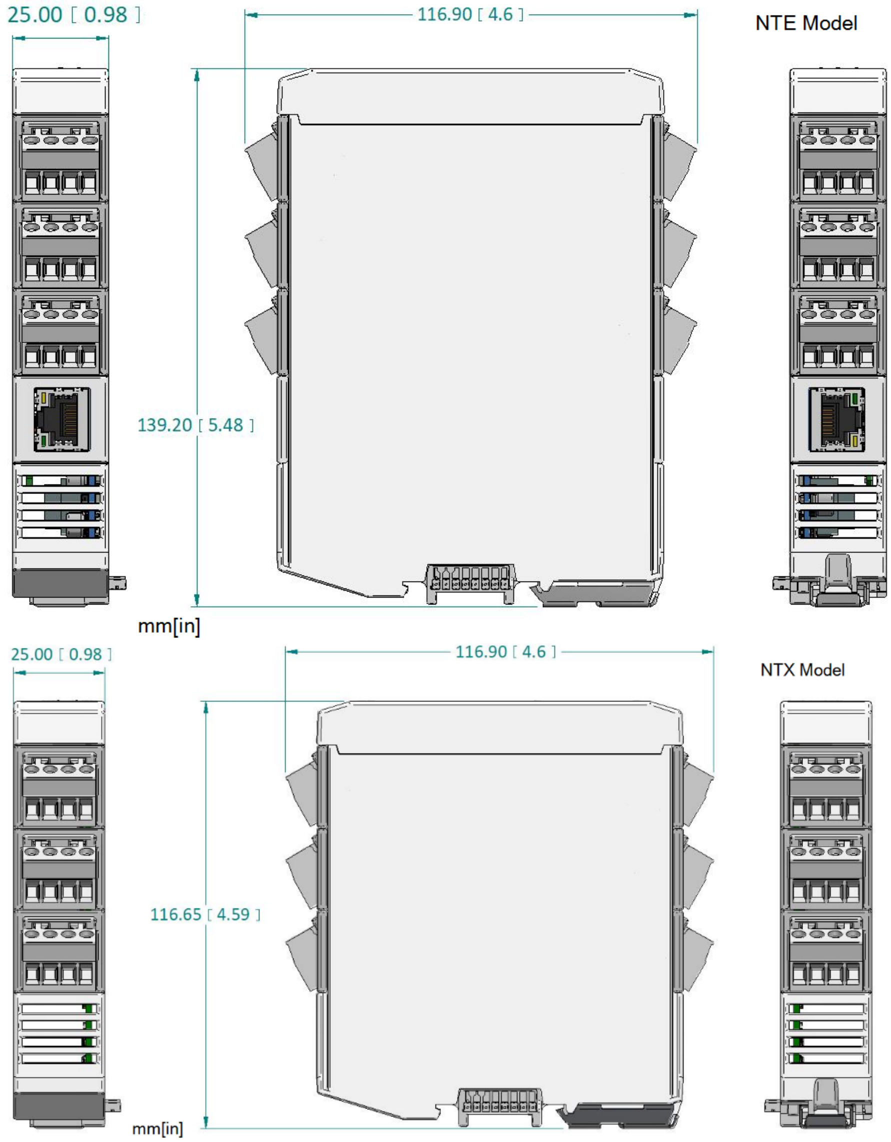
- **Designed and Manufactured with High Quality/High Reliability with AS9100 (Aerospace Quality)/ISO9001.**
- **NT Modules are CE Approved, UL/cUL Class I, Division 2 Approved and are thoroughly Tested and Hardened for Harsh Environments.**
- **High-Density 25mm wide NT modules have pluggable terminal blocks with front-facing terminals that make wiring removal & replacement easy.**
- **Enclosure Has Integrated DIN-Rail Mount for "T" type DIN rail.**
- **Web-Browser Reconfiguration allows a standard web-browser to be used to configure, control, monitor, and calibrate over Ethernet.**
- **Dual Isolated 10/100Mbps Ethernet ports w/ Auto-Negotiation offers convenient "daisy chain" network connection which saves switch ports. Ports are safety-isolated from each other and include transient protected for ESD, EFT, and other transients.**
- **Flexible IP Addressing supports static, or DHCP.**
- **Nonvolatile Reprogrammable Memory allows the functionality of this device to be reliably reprogrammed thousands of times.**
- **The NT system channel IO supports application protocols of Modbus TCP/IP, Profinet, and Ethernet/IP (Modbus models include i2o Messaging Support).**
- **Units can be setup and configured via a web-browser.**
- **An NT system provides high 1500VAC Isolation between IO Channels (as a group), the Ethernet network (including port-to-port), and system power.**
- **NT modules have a wide operating ambient range of -40°C to +70°C.**
- **Wide-range 9-32VDC power drives isolated CPU Power and isolated IO power along their DIN-rail bus connection to the CPU.**
- **IO, power, & network connections are all transient protected.**
- **Convenient "Wink" ID Mode will blink the green RUN LED as a tool to help identify specific remote units.**
- **Operating & Diagnostic LED's Aide Troubleshooting with LED's to indicate power, operating mode, wink status, plus communication LED's for port activity and link status.**
- **Withstands High Shock (25G) and Vibration (4G).**
- **Internal Watchdog timer is built into the microcontroller that causes it to initiate a self-reset if the controller "locks up" or fails to return from an operation in a timely manner.**

Application

In modular fashion, an Ethernet module (NTE model) and additionally up to three expansion IO modules (NTX models) plug together side-by-side, from left to right on 25mm centers along T-type DIN rail. Expansion IO modules receive their power and communication via their bus connection to the leftmost Ethernet module (NTE model). Up to 3 expansion modules link to an Ethernet module. Most NT2000 models also support i2o network messaging, which can allow discrete inputs of one IO module system to link to discrete outputs of another IO system over their Ethernet network connection. A complete NTE system combines an Ethernet module with one to three NT expansion IO boards for support of up to 64 channels at a single IP address (depending on IO models selected).

Mechanical Dimensions

NT IO modules comes in two size variations as shown. NTX2111 models are shorter and only include channel IO. NTX models plug into an NTE model on its right edge for channel expansion. Taller NTE2111 models include RJ45 network jacks as shown. Both model types may be mounted to 35mm “T” type DIN rail (35mm, type EN50022), and may plug together side-by-side on 25mm (1-inch) centers.



WARNING: *IEC Safety Standards may require that this device or system be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.*

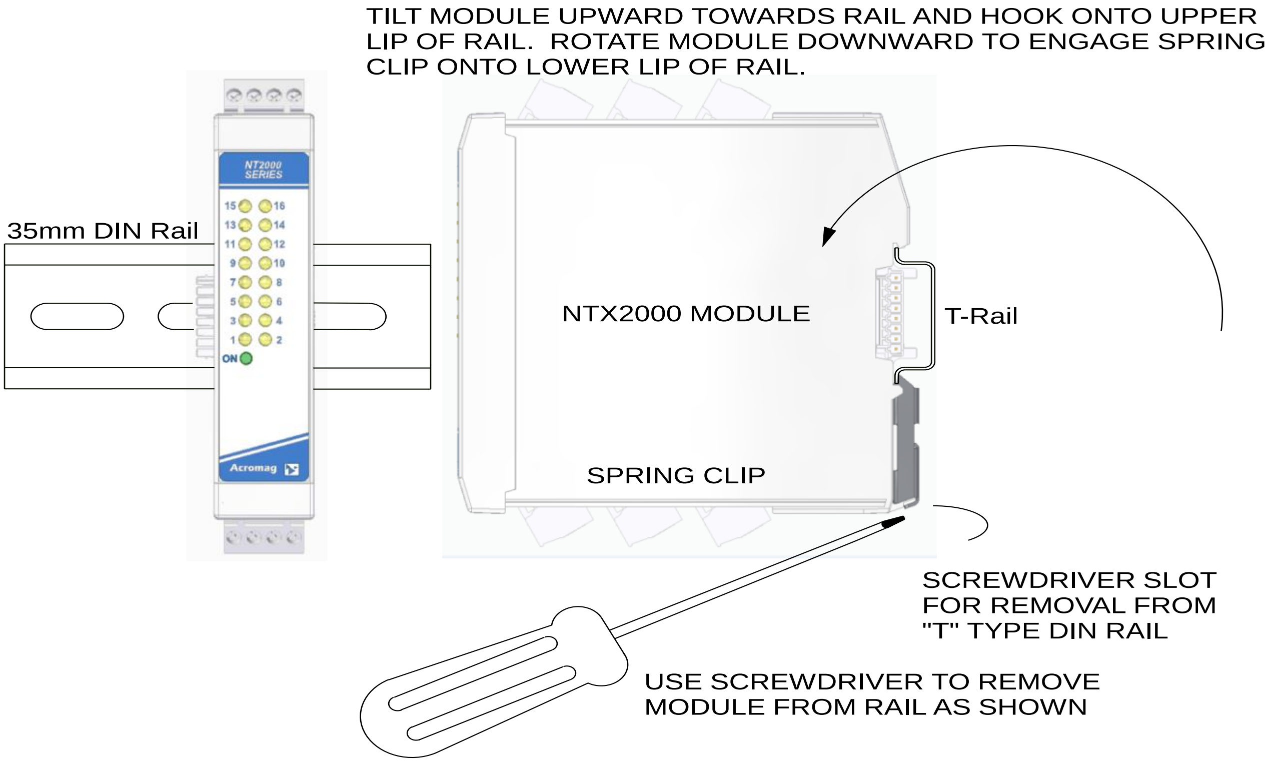
DIN Rail Mounting & Removal

Refer to the following figure for attaching and removing unit(s) from the DIN rail. Note that multi-channel systems are built starting with an NTE Ethernet Model on the left, then adding up to 3 additional NTX IO modules to the right by plugging them together along their base. Each module includes a spring-loaded DIN clip located on its bottom side. The opposite/back edge at the bottom is raised to allow you to tilt the unit upward to lift it from the rail while prying the spring-clip back with a screwdriver. To attach it to T-type DIN rail, angle the top of the unit towards the rail and place the top groove of the module over the upper lip of the DIN rail. Firmly push the unit downward towards the rail until it snaps into place. When connecting multiple modules together, start with an NTE model on the left, then add NTX expansion modules on the right by sliding them together along the DIN rail.

Mounting & Removal…

Up to 3 NTX IO expansion modules may be connected per NTE system module. To remove a unit from the rail, first separate the input terminal blocks from the bottom side of the module to create a clearance to the DIN mounting area. Then you can use a screwdriver to pry the pluggable IO terminals out of their sockets. Modules that are plugged together should be pulled apart along the DIN rail to separate their DIN rail connectors. Then, while holding a module in place from above, insert a screwdriver along the bottom side path of the module to the module's DIN rail clip and use it as a lever to force the DIN rail spring clip down while pulling the bottom of the module outward until it disengages from the rail. Tilt the module upward to lift it from the rail.

SERIES NT MODULE DIN RAIL MOUNTING AND REMOVAL



ELECTRICAL CONNECTIONS

⚠

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.
WARNING – EXPLOSION HAZARD – Substitution of any components may impair suitability for Class I, Division 2.
WARNING – EXPLOSION HAZARD – The area must be known to be non-hazardous before servicing/replacing the unit and before installing.

Wire terminals can accommodate 12–24 AWG (2.5–0.2mm^2) solid or stranded wire with a minimum temperature rating of 85°C. IO wiring may be shielded or unshielded type. The units four position terminals are pluggable and can be removed from their sockets by prying outward from the top with a flat-head screwdriver blade. Strip back wire insulation 0.25-inch on each lead and insert the wire ends into the cage clamp connector of the terminal block. Use a screwdriver to tighten the screw by turning it in a clockwise direction to secure the wire (use 0.5-0.6 Nm torque). Since common mode voltages can exist on IO wiring, use adequate wire insulation and proper wiring practices. IO wires are normally separated from power and network wiring for safety, as well as for low noise pickup.

Power Connections

⚠ System Power is only wired to NTE Models with DC+ at TB6-4 (9), DC- at TB6-3 (10), and Earth Ground at TB6-2 (11).

System input power of 10-32VDC is always direct wired to the NTE Ethernet CPU module at TB6 and all IO expansion modules receive their power from their DIN rail bus connection to the NTE Ethernet CPU module as shown in the following figure. For power earth ground connection, wire earth ground to the EG terminal at TB6 if your input power supply does not already earth ground its DC-.

Some IO models additionally require field excitation and this is normally wired per IO module where required. Refer to your IO model for its excitation requirements. excitation earth ground is generally applied at the EXC- terminal, but note that EXC is not isolated from the IO and you should only earth ground the IO at one point.

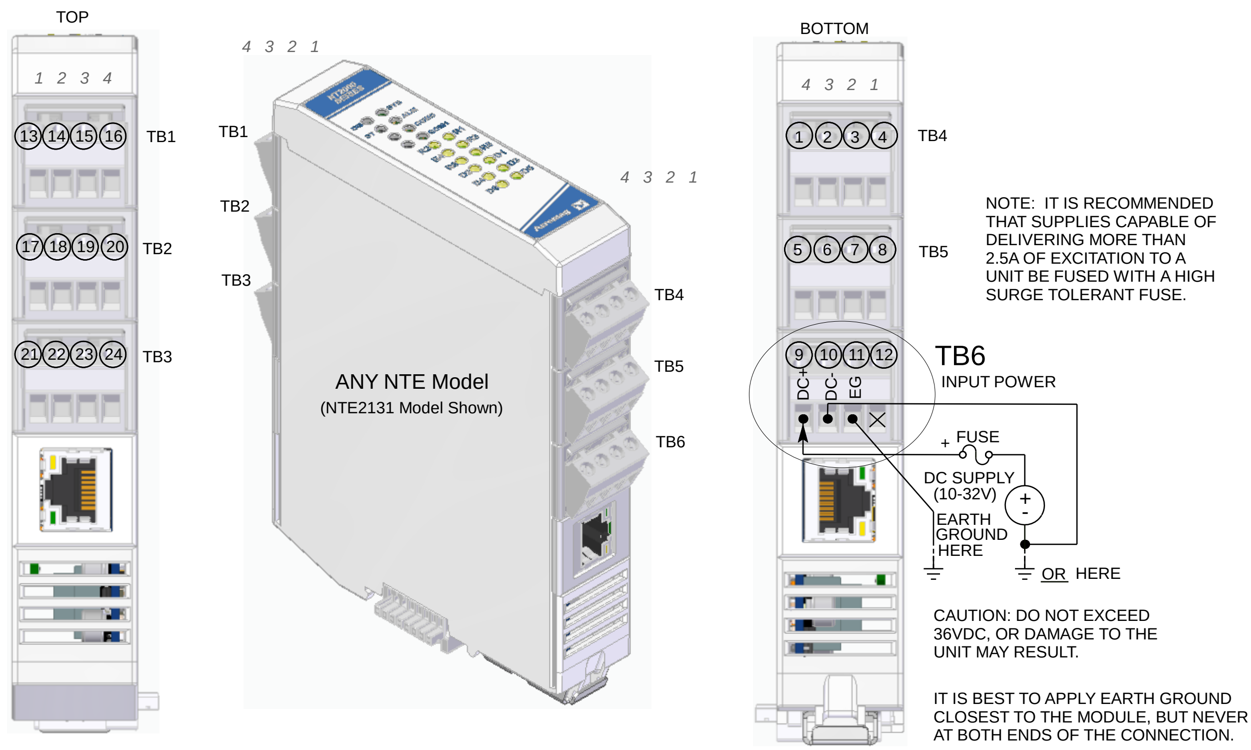
For both input supply and field excitation connections, you should use 14 AWG wire rated for at least 80°C and you must not exceed 36V DC peak. Your supply should be able to drive at least twice the specified current draw of the system.

Important – End Stops (recommended): You should apply end stops to secure system modules along a DIN rail bus. For hazardous location installations (Class I, Division 2 or ATEX Zone 2) you must use two end stops (Acromag 1027-222) to secure the terminal block and module (not shown).

TIP: For NT IO Models that additionally require field excitation (varies by IO model), it is recommended that the excitation supply be separate from unit power. Units that utilize field excitation often switch/source power to inductive loads. If you switch inductive loads from a field excitation supply that is also used to provide unit power, you risk a noisy power connection that may interfere with system operation. Minimally, your power supply should be able to source twice the nominal requirements to account for inrush.

NTE MODEL INPUT POWER CONNECTIONS TO TB6

SYSTEM POWER IS ONLY WIRED TO THE SYSTEM NTE MODEL. NTX EXPANSION MODELS RECEIVE THEIR POWER FROM THEIR BUS CONNECTION TO THE NTE. SOME NTX EXPANSION IO MODELS WILL REQUIRE ADDITIONAL FIELD EXCITATION BE WIRED TO THE NTX MODULE (REFER TO IO MODEL MANUAL FOR IO MODEL CONNECTIONS).



Earth Ground Connections

Earth ground keeps a circuit from floating and provides a safe dissipative body that IO transients are steered to, away from internal circuitry. In general, any isolated circuit should connect to earth ground at one point and the best choice is usually at the point closest to the module (the NTE applies isolation between IO, input power, and the network ports).

The NTE unit housing is plastic and does not require an earth ground connection to itself. But if the NT system is mounted in a metal housing, an earth ground wire connection to the metal housing's ground terminal (green screw) is usually required using suitable wire per applicable codes.

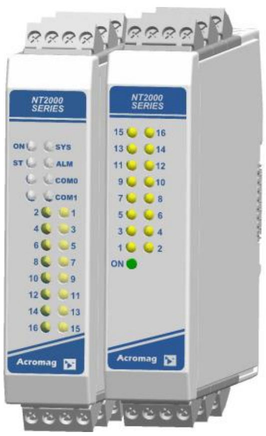
Many NT IO Models include an IO return or common terminal that may also attach to earth ground for grounding its IO. This this return/common terminal is not isolated between IO boards and common to all IO boards present. When connecting earth ground, be sure to make this connection at only one IO board of an NTE system that supports up to four IO boards. Note that all NTE models also include an earth ground terminal (EG) on TB6 terminal 11 which attaches to its isolated input power ground (this is an isolated input and earth grounding point and in addition to applying earth ground at any IO common/return terminal). Circuits wired to power, or IO (as a group), and the network should be earth grounded as reflected in their connection diagrams. It is always best to apply earth ground closest to the module, which allows any destructive transient energy to be safely shunted to earth ground along a short and local low-impedance path, helping to protect the module from damage. See the Electrical Connections Drawings for IO, power, and network ground connections.

NT System Connections

Connecting NTX Expansion Modules

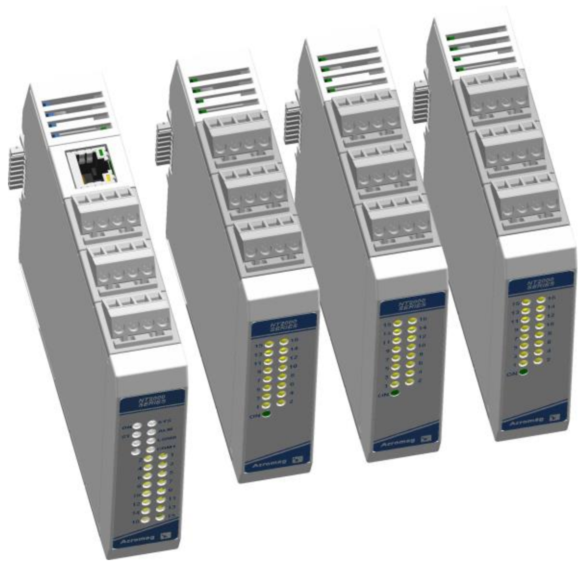
The NT Series is a modular multi-channel IO system that is built starting with a single NTE Ethernet Model on the left, then adding 0-3 additional NTX expansion IO modules on the right by plugging them together along their base on its right as shown below. IO channel expansion models can be added in any mix. System power is always wired to the NTE module (left-most system module) and it drives power to the IO bus to power the expansion modules on the right. Some NTX expansion models may additionally require field excitation and this is wired to the IO modules on a per-module basis where it is required. IO Common/return connections are common to all IO boards of an NTE system.

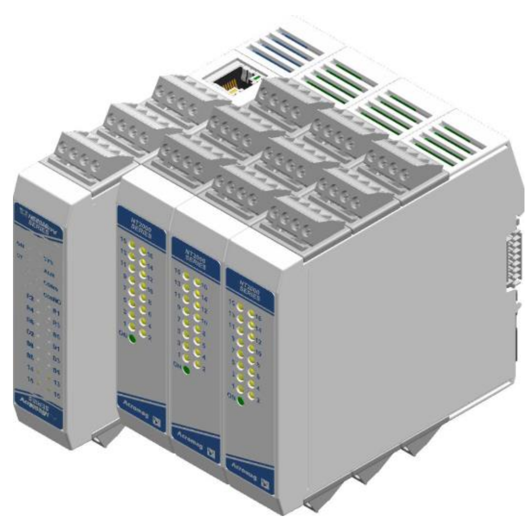
Note: It is recommended that system power be kept separate from field excitation. This is because channel IO is often used to switch inductive loads (relays, solenoids, coils, etc.), which generates noise and the resultant fluctuations in power could interfere with system operation.



Note that modules plug together along their DIN rail bus connectors, starting with the NTE module on the left and adding 1-3 NTX IO modules on the right as shown at left.

IO Modules are not isolated from each other and share common and return connections along their bus. Keep this in mind when mixing IO modules in a system, especially when applying earth ground to an IO return or common terminal, which only needs to be made one-time at one IO module.

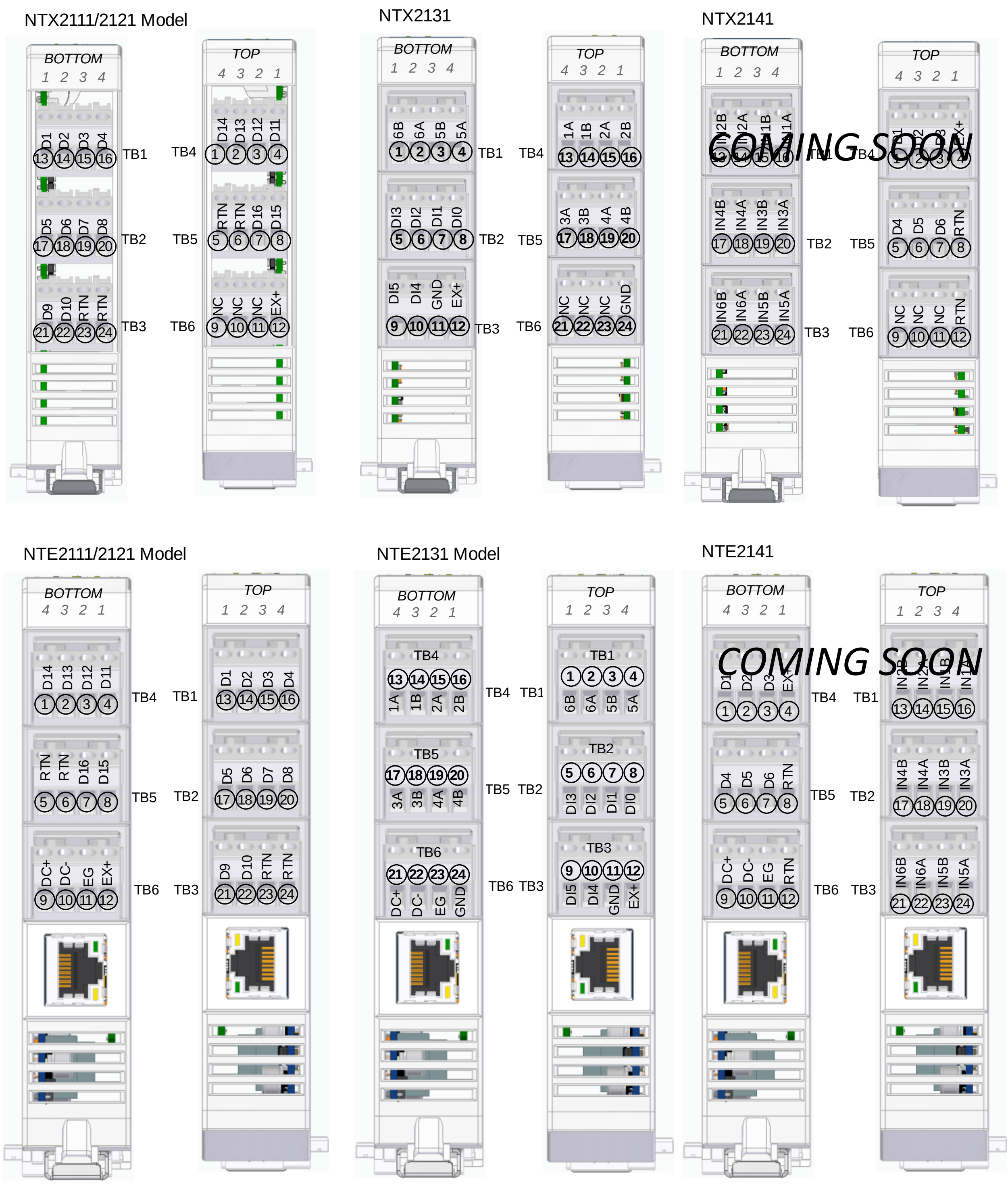




Terminal Reference for NT Modules

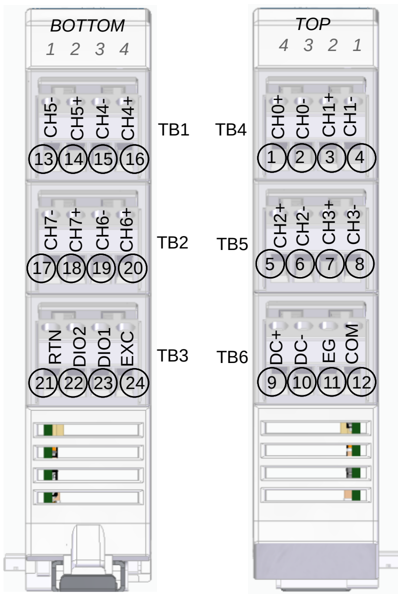
The following figures show the top and bottom terminal assignments of NTE CPU/network and NTX IO expansion modules.

NT DISCRETE IO MODELS

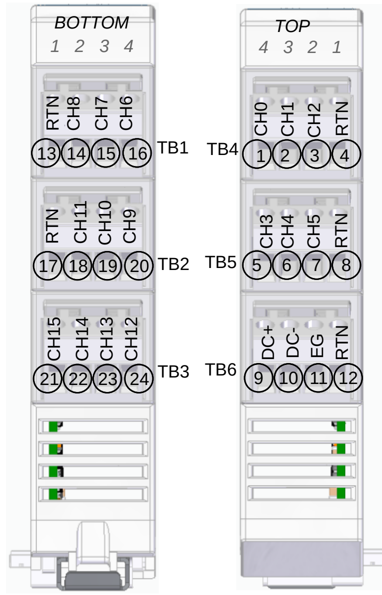


NT ANALOG INPUT MODELS

NTX2211/2231 Model

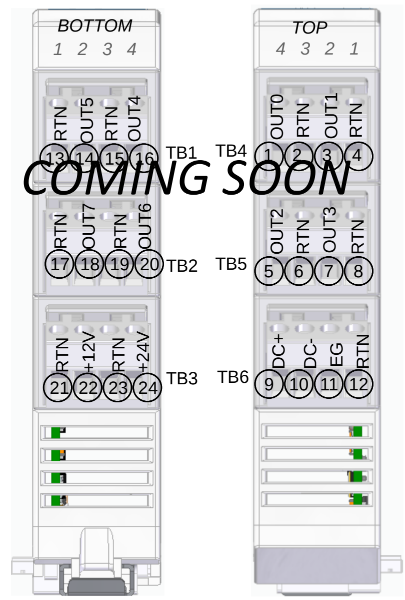


NTX2221/2241 Model

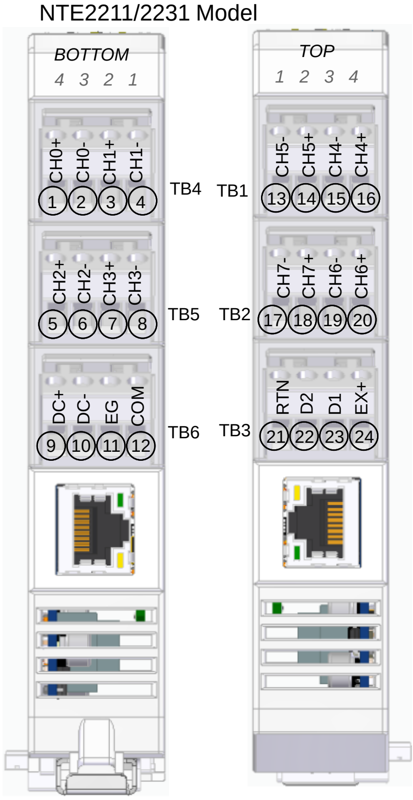


NT ANALOG OUTPUT MODELS

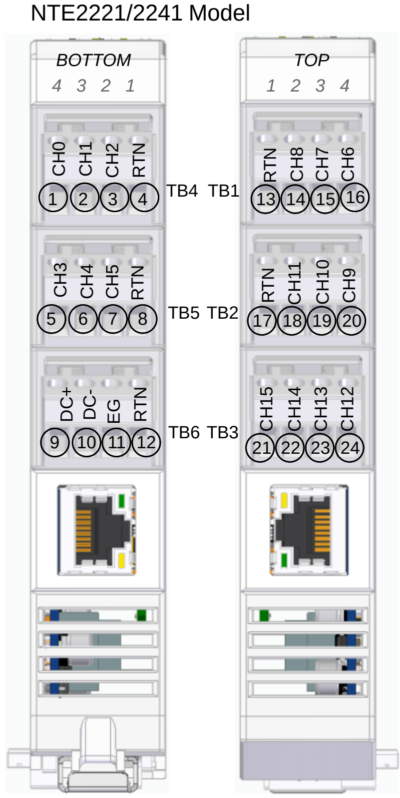
NTX2311/2321 Model



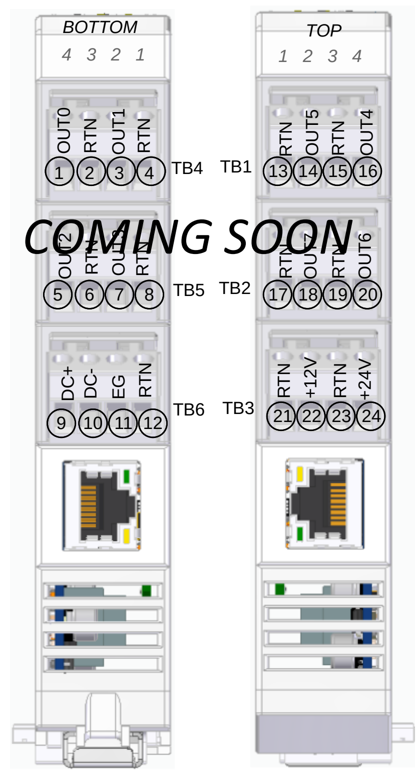
NTE2211/2231 Model



NTE2221/2241 Model



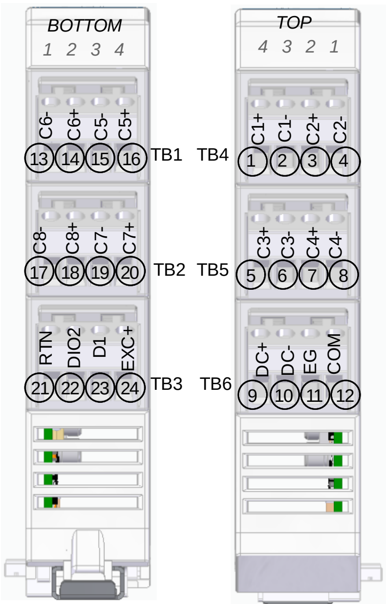
NTE2311/2321 Model



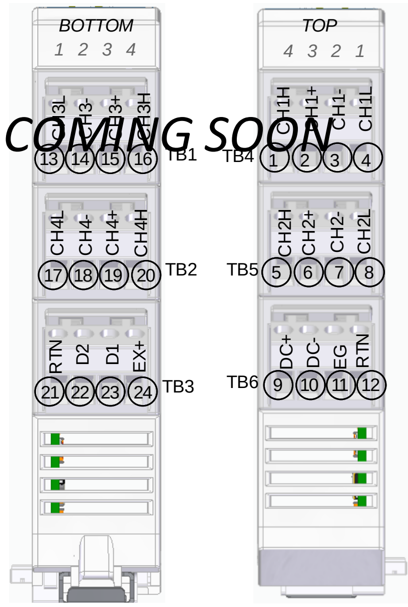
NT TEMPERATURE MODELS

NT COMBO IO MODELS

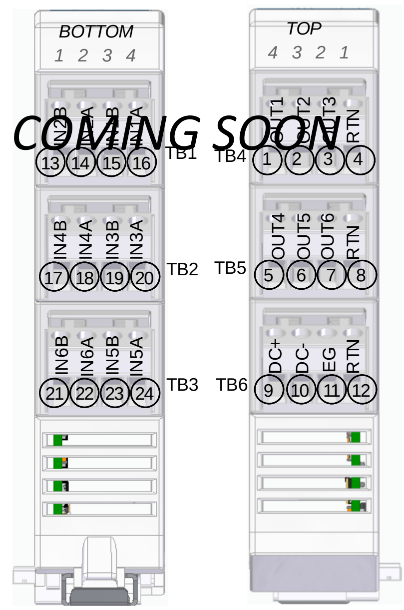
NTX2611 Model



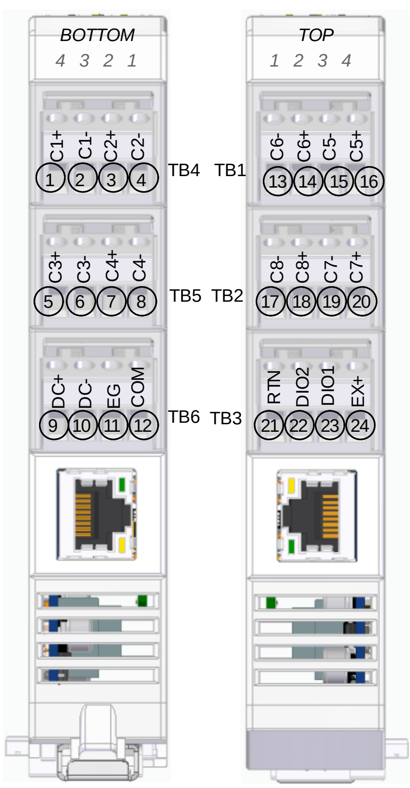
NTX2621 Model



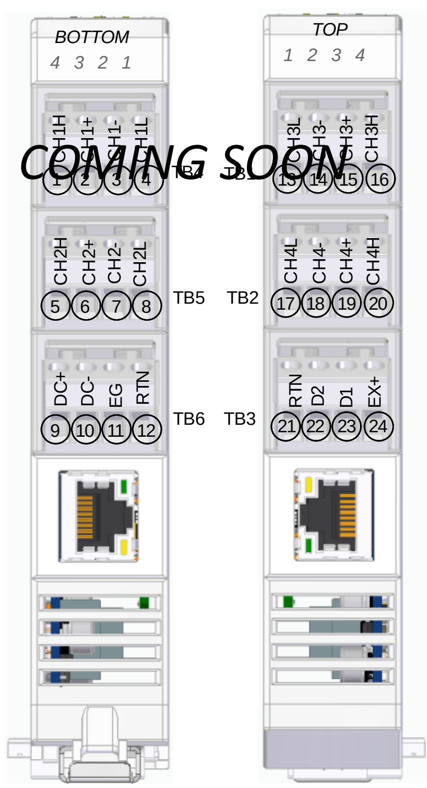
NTX2511/2531 Model



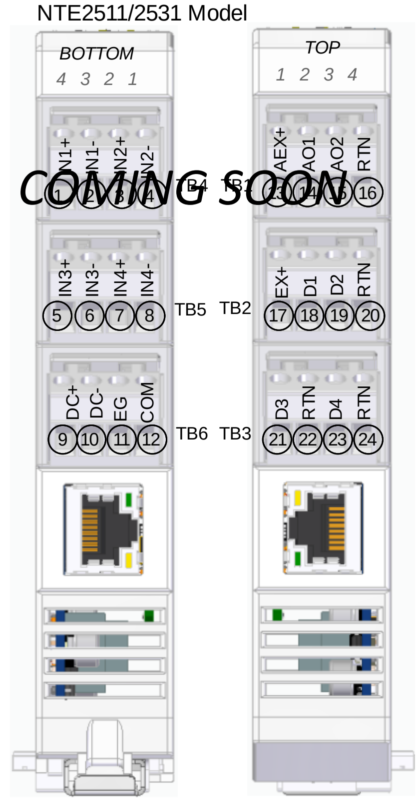
NTE2611 Model



NTE2621 Model



NTE2511/2531 Model



IO Wiring Connections

Digital Input/Output Connections

Digital Inputs - Active Low

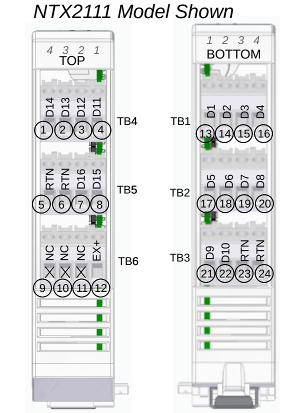
Applicable NT Models – 2111, 2211, 2231, 2611, 2621.

IMPORTANT: When driving an input from the field, be sure to turn off that channel's tandem output to prevent signal contention between the module's open-drain output and the field input signal.

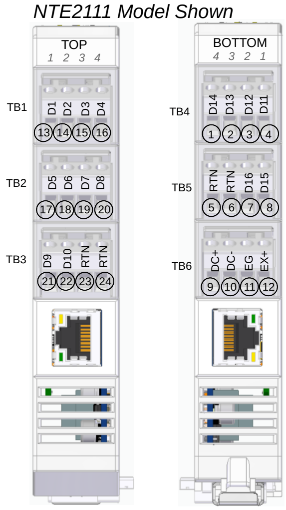
Several models include active-low digital inputs and accept voltage signals up to 32V. The logic-transfer occurs using TTL thresholds (low is <=0.8V, high >=2V). These inputs are additionally pulled up to excitation via 10K pull-up resistors installed in sockets on-board. These model's inputs are already wired to accomplish loopback monitoring of their tandem open-drain outputs, and they may be alternately used to monitor field input levels when the tandem output is switched OFF. Always observe proper polarity when making IO and excitation connections. Refer to the following figures to wire the active-low inputs of this model.

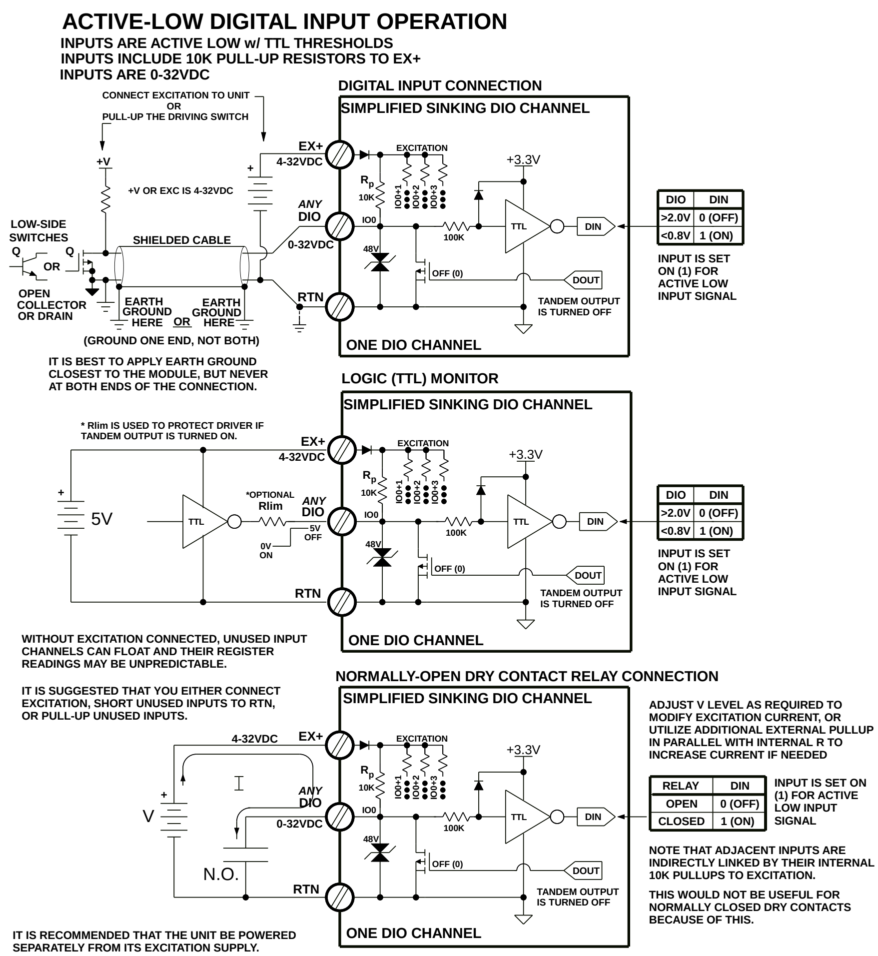
IMPORTANT: Do not allow unused active-low IO channels or their excitation to float. These inputs normally include pull-ups to excitation and will float if you fail to also connect excitation. Likewise, operating one output while failing to connect excitation will allow that output to pull on adjacent channels. For example, on the 2111, every four channels have a 10KΩ pull-up element of a 4-element SIP that connects to a common excitation rail).

NTX2111 Model Shown



NTE2111 Model Shown





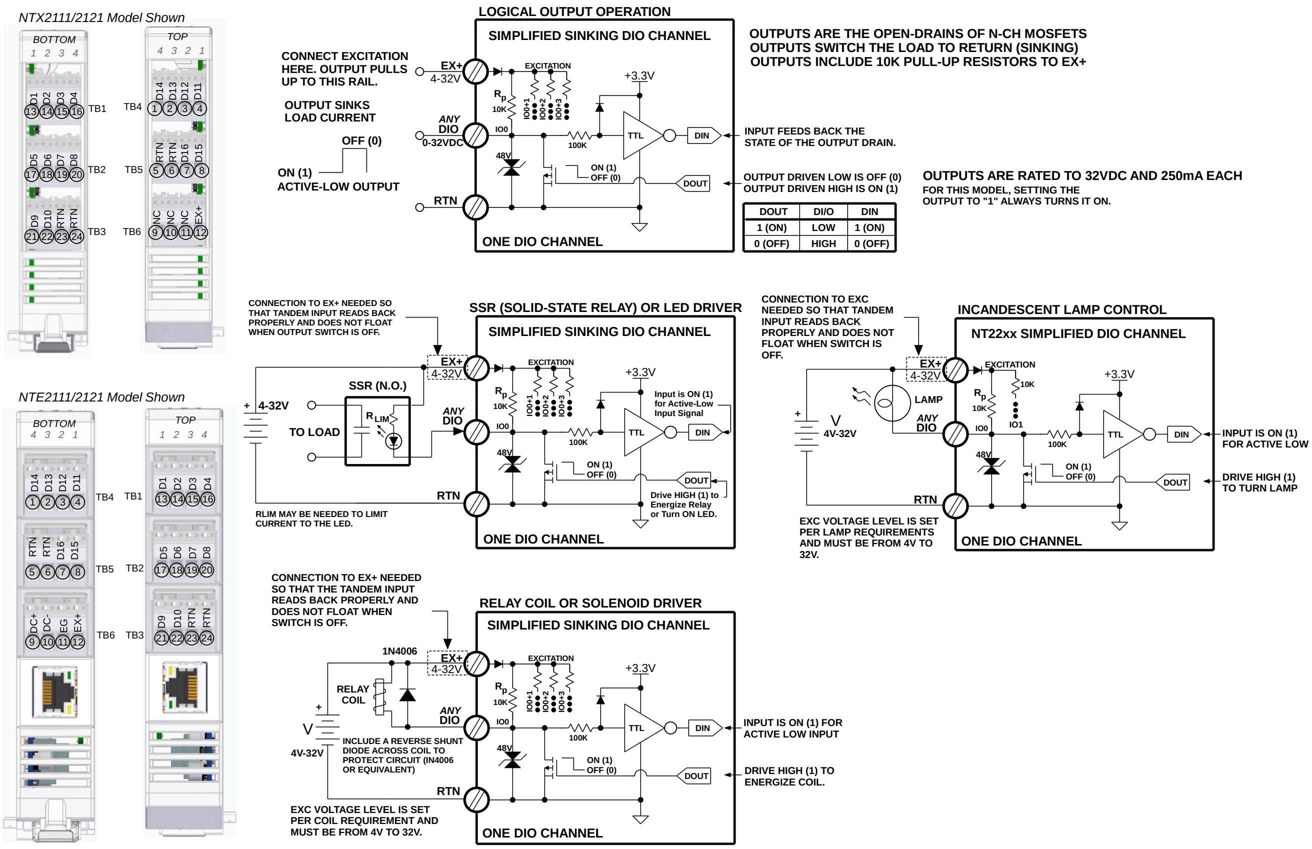
Digital Outputs - Sinking

Applicable NT Models – 2111, 2211, 2231, 2611, 2621.

Outputs are smart open-drain (low-side) N-channel mosfets that switch the load to ground (return) and include 10K pull-up resistors to EX+.

Several models include digital outputs that sink loads to return (active-low). Most sinking output models are paired with active-low inputs. Refer to the following figures to wire the digital outputs of these models. You must connect 4-32V Field excitation to operate the outputs and to keep its tandem inputs from floating. These outputs may each switch loads up to 32V and 250mA. Observe proper polarity when making IO connections. Since each output drain lead is pulled to excitation via a 10K pull-up resistor SIP to a common EX+ rail, an adjacent channel can pull on another channel if excitation is left floating.

SINKING DIGITAL OUTPUT OPERATION



Add Load Protection

IMPORTANT – Add Protection with Inductive Loads: Sinking outputs do include integrated reverse-bias shunt diodes to help protect the output switch from damage due to high reverse-bias voltages generated when switching inductive loads. But you should add external protection near the inductive load being controlled to prevent these transients from being sent along the connection wires. Place a diode (1N4006 or equivalent) across an inductive load with the cathode to (+) and the anode to (-).

For greater drive capability or for switching AC loads, it is common to use an appropriately rated interposing relay. Add protection local to the relay as noted above when driving inductive relay coils.

Per UL, when the outputs are used to drive interposing relays for switching AC or DC devices of higher voltage/current, the coil ratings for the interposing relay shall not exceed 24VDC, 100mA.

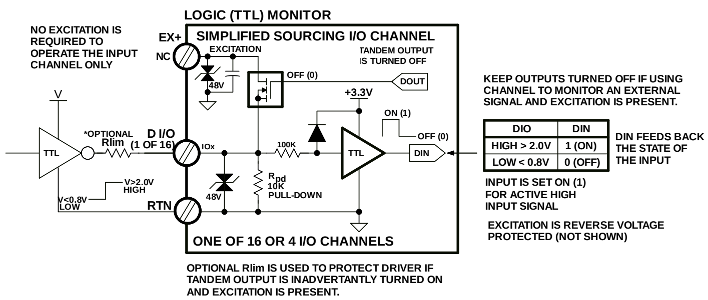
Digital Inputs – Active High

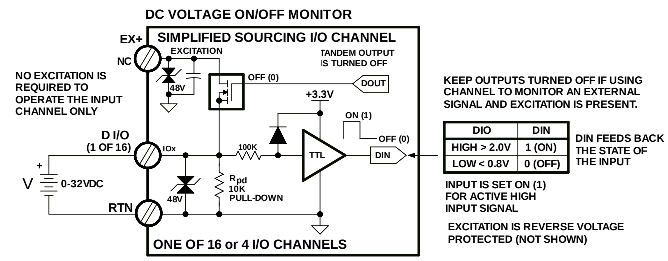
Applicable NT Models – 2121, 2131, and 2511/2531.

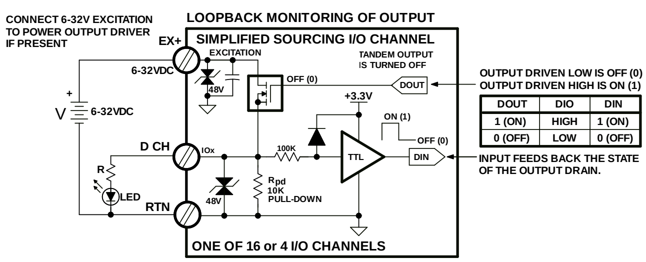
Active-high inputs are pulled down to Return (RTN), use TTL thresholds, and can be wired to monitor their tandem high-side mosfet switch, or field input levels with the tandem output turned OFF.

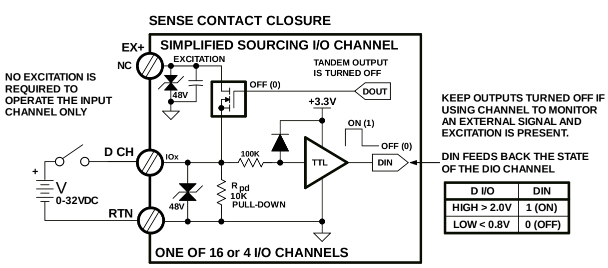
Some NT models include active-high digital inputs which accept voltage levels up to 32V and use TTL thresholds for logic transfer. These inputs are usually paired with sourcing digital outputs (except NT2131). Refer to the following figures to wire discrete inputs to these models. If only using inputs to monitor active-low field signals, you do not need to connect excitation, as excitation is only required to operate the tandem outputs if present. These inputs are always pulled down to Return via 10K pull-down resistors installed on board and never float. Observe proper polarity when making IO connections.

IMPORTANT: You must keep the tandem output turned off when using the input to sense voltage levels from the field to prevent contention between the field signal and the output channel, which may be turned ON.

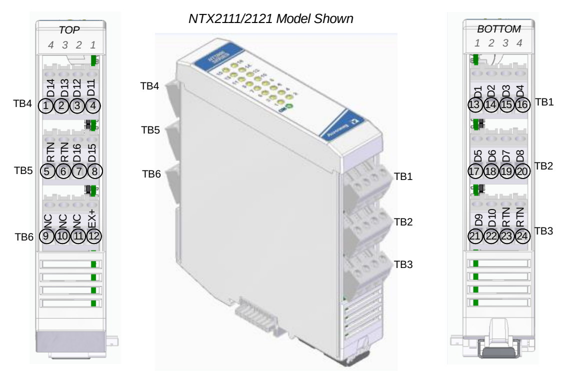


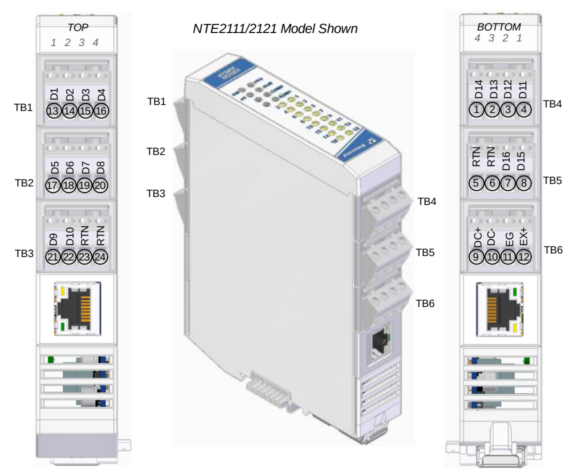






NT2121 & NT2511/2531 DIGITAL INPUT OPERATION
INPUTS ARE ACTIVE HIGH w/ TTL THRESHOLDS
THESE INPUTS ARE USUALLY PAIRED WITH SOURCING OUTPUTS (EXCEPT NT2131)
INPUTS INCLUDE 10K PULL-DOWN RESISTORS
INPUTS ARE 0-32VDC



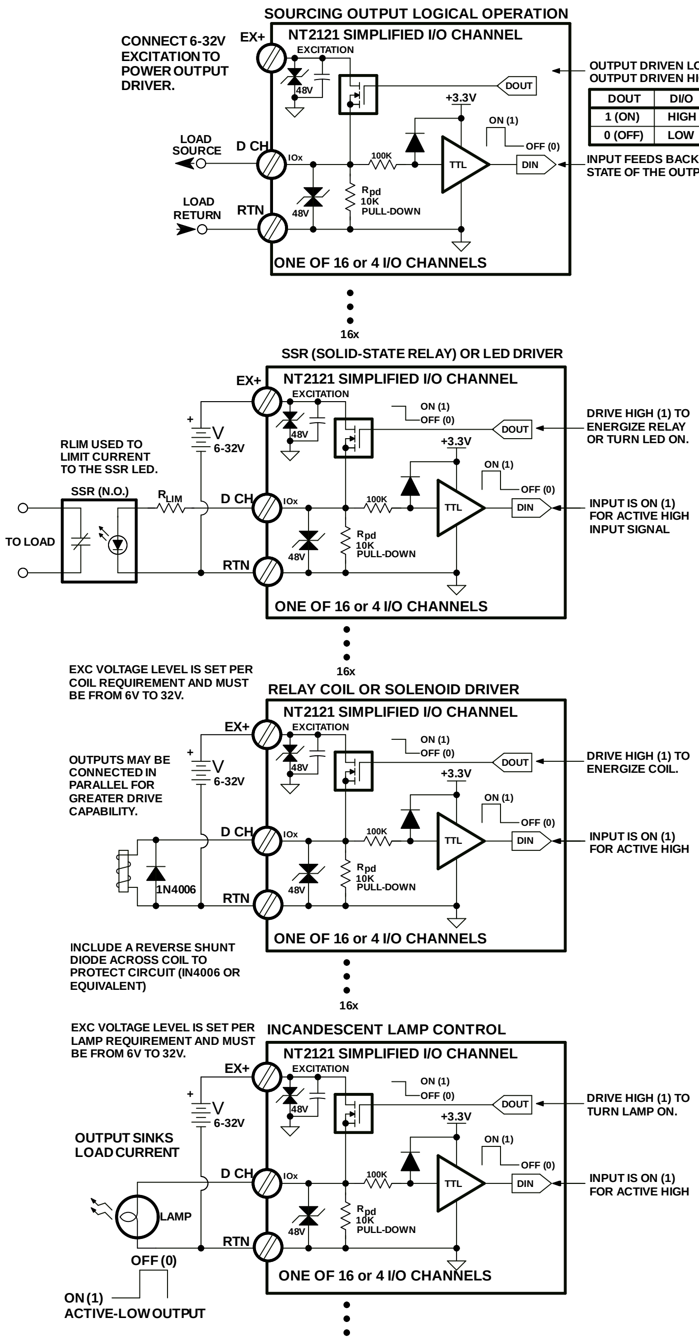


Digital Outputs - Sourcing

Applicable NT Models – 2121 (16x), and 2511/2531 (4x).

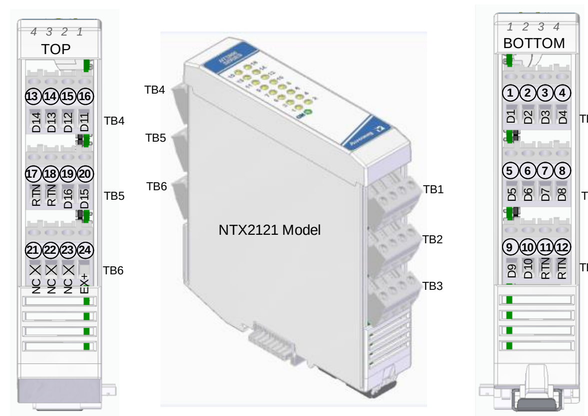
Open-source outputs operate as high-side switches between EX+ and your load and include 10K pull-downs to Return (RTN).

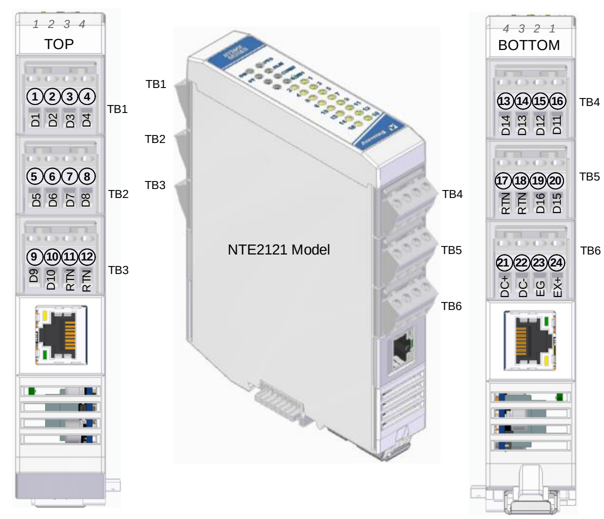
Three NT models include sourcing digital outputs which are open-source leads of mosfet switches connected on the high-side of their loads (their drain leads connect to excitation rail). These outputs will source up to 250mA from 6-32V excitation to each load. You must connect 6-32V excitation to operate these outputs, as the output drivers are powered from the excitation supply. Observe proper polarity when making IO connections. Refer to the following figures to wire the outputs of these models.



NT2121 & NT2511/2531 OUTPUT OPERATION

OUTPUTS ARE THE OPEN-SOURCES OF P-CH MOSFETS
OUTPUTS SWITCH EXCITATION TO THE LOAD
OUTPUTS INCLUDE 10K PULL-DOWN RESISTORS
OUTPUTS ARE RATED TO 32VDC AND 250mA EACH





Add Load Protection

IMPORTANT – Add Protection with Inductive Loads: Outputs do include internal reverse-bias shunt diodes to help protect the output switch from damage due to high reverse-bias voltages generated when switching inductive loads. But you should add external protection near the inductive load to prevent these transients from being sent along the connection wires. Place a diode (1N4006 or equivalent) across an inductive load with the cathode to (+) and the anode to (-).

To raise drive capability or for switching AC loads, it is common practice to use a load rated interposing relay. But add protection local to the relay as shown below when driving inductive relay coils. Per UL, if the outputs are used to drive interposing relays for switching AC or DC devices of a higher voltage/ current, the coil ratings for the interposing relay shall not exceed 24VDC, 100mA.

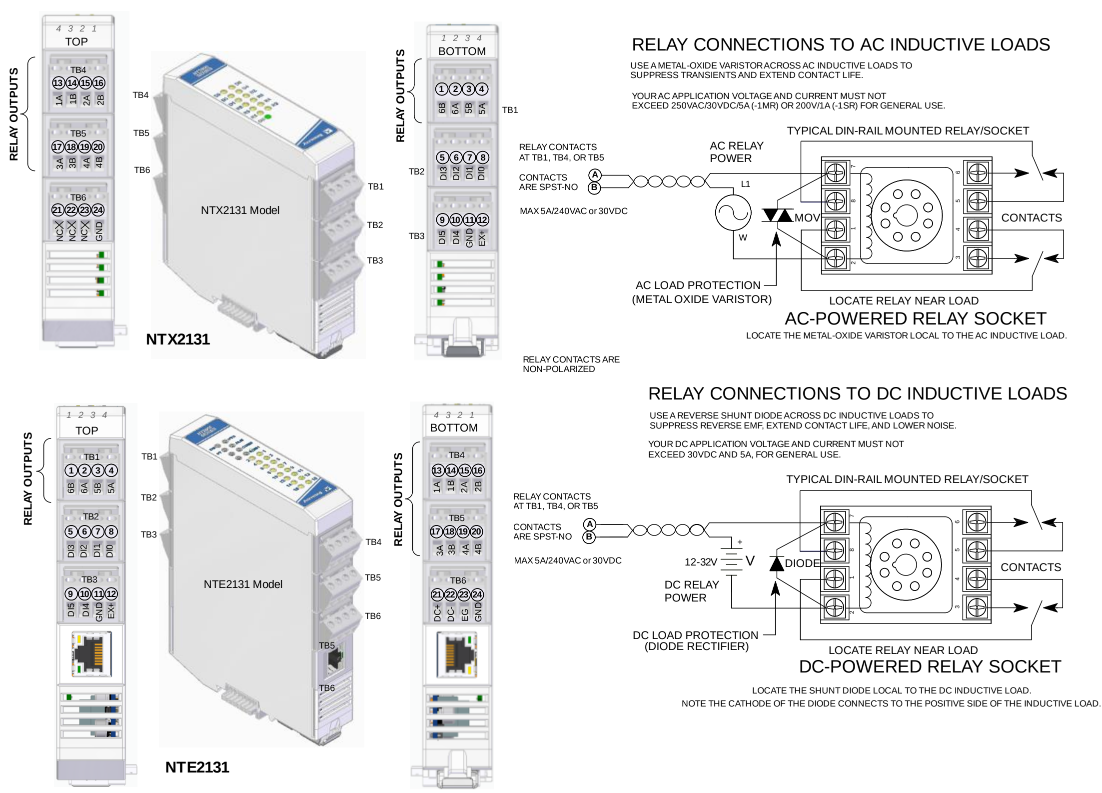
Output Mechanical Relay Connections

Applicable NT Model – 2131.

Six 1 FORM A (SPST-NO) mechanical relays rated to 30VDC/240VAC, 5A.

The NT Model 2131 includes six mechanical relay outputs (1 FORM A, SPST-NO). Refer to the following figures to wire the mechanical relay outputs of this model. Note that protection shown is generally recommended when switching inductive loads like electric motors, relay coils (shown), or solenoids.

NT2131 INTERPOSING RELAY OUTPUT CONNECTIONS FOR INCREASING DRIVE CAPABILITY
OUTPUTS ARE 1 FORM A (SPST-NO)
OUTPUTS ARE RATED TO 5A, 30VDC OR 240VAC
INPUTS ARE 0-32VDC



IMPORTANT – Add Protection with Inductive Loads: Switching inductive loads will generate momentary high reverse-bias voltages between the switch and load. But you should add external protection near the inductive load to prevent these transients from being sent along the connection wires. Place a diode (1N4006 or equivalent) across an inductive load with the cathode to (+) and the anode to (-).

Differential Analog Input Connections

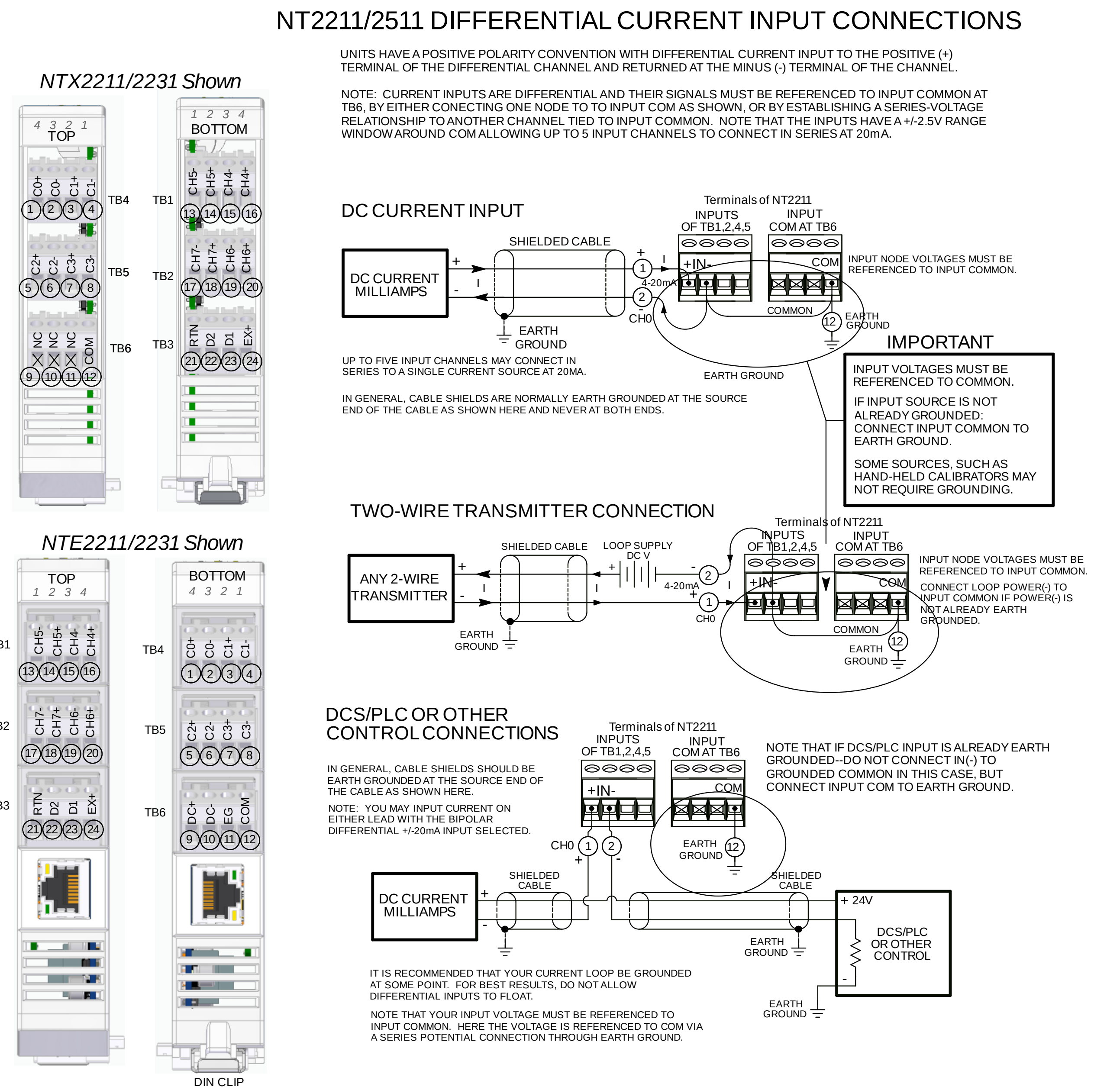
Analog Input – Diff Current

Applicable NT Model – 2211 and 2511.

Eight Differential Current input channels at TB4, TB5, TB1, and TB2.

The input channels of the NT 2211 and 2511 models are ***differential node pairs.*** *Input node potentials must not float and must be referenced to input common (COM), either by directly connecting one node to input common, or by establishing a series-voltage relationship to input common. Input common is available at TB6 terminal 12 and the input ADC ground connects to common internally.*

NT2211 Models utilize precision 24.9Ω shunt resistors at their inputs to convert differential current to voltage. Input node potentials must be within a ±2.5V ADC range window around common for conversion and must be referenced to common.



Analog Input – Diff Voltage

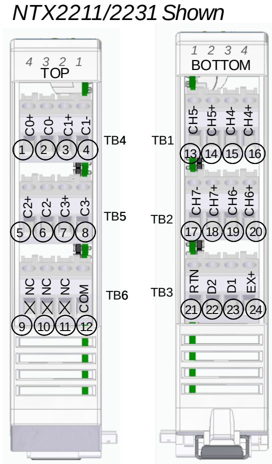
Applicable NT Models – 2231 and 2531.

Eight Differential Voltage input channels at TB4, TB5, TB1, and TB2 (2231), or 4 differential voltage channels at TB4 and TB5 (2531).

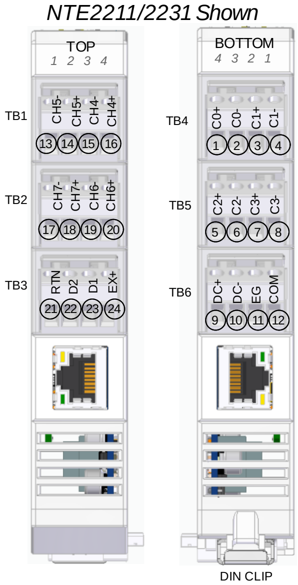
The voltage input channels of these models are ***differential node pairs that reference to COM.*** *The input node voltage potentials do not float relative to the ADC and input is referenced to input common (COM) using a resistive divider at each input node. If your input signal is not already earth grounded, you can also connect earth ground to IO COM at TB6 terminal 12 (the input ADC ground connects to common internally).*

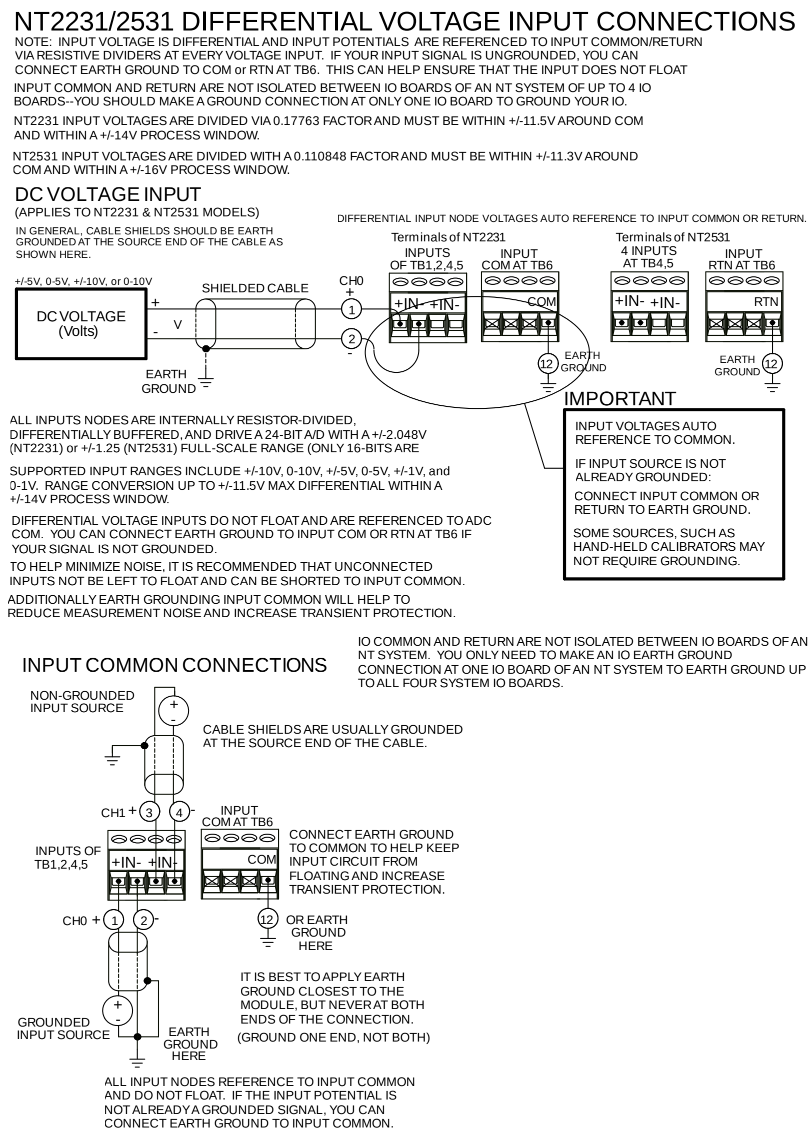
These models utilize precision voltage dividers to COM at each input. For the NT2231, this reduces ±11.50 of voltage difference around COM using a 0.1776x divider factor. Its input buffer/ADC uses ±2.5V rails such that input node potentials must be within a +/-14V range window around COM (i.e. ±2.5/0.178=±14V). Likewise, for the NT2531, it reduces ±11.3V of voltage difference around COM with an input divider factor of 0.1108x, ±1.8V buffer/ADC rails, requiring its node potentials be within ±16V around COM.

NTX2211/2231 Shown



NTE2211/2231 Shown





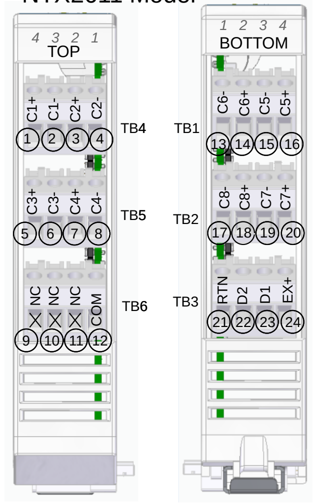
Analog Input – Diff TC/mV

Applicable NT Model - 2611.

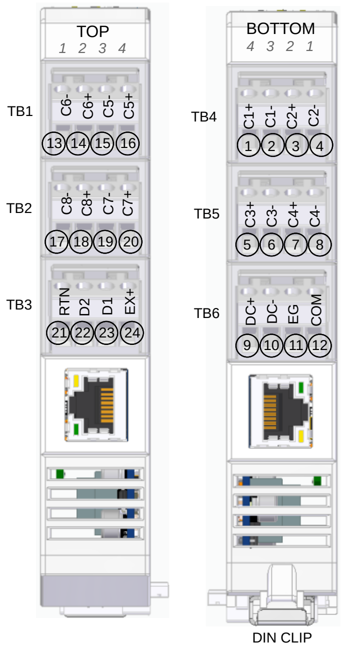
Eight Differential mV/TC channels at TB4, TB5, TB1, and TB2.

*<u>The input channels of these models are **differential node pairs** for the small thermoelectric voltages of thermocouples. Input node potentials should not float and be referenced to input common (COM), either by directly connecting one node to input common, or by establishing a series-voltage relationship to input common. Input common is available at TB6 terminal 12 and the input ADC ground connects to this common internally.</u>*

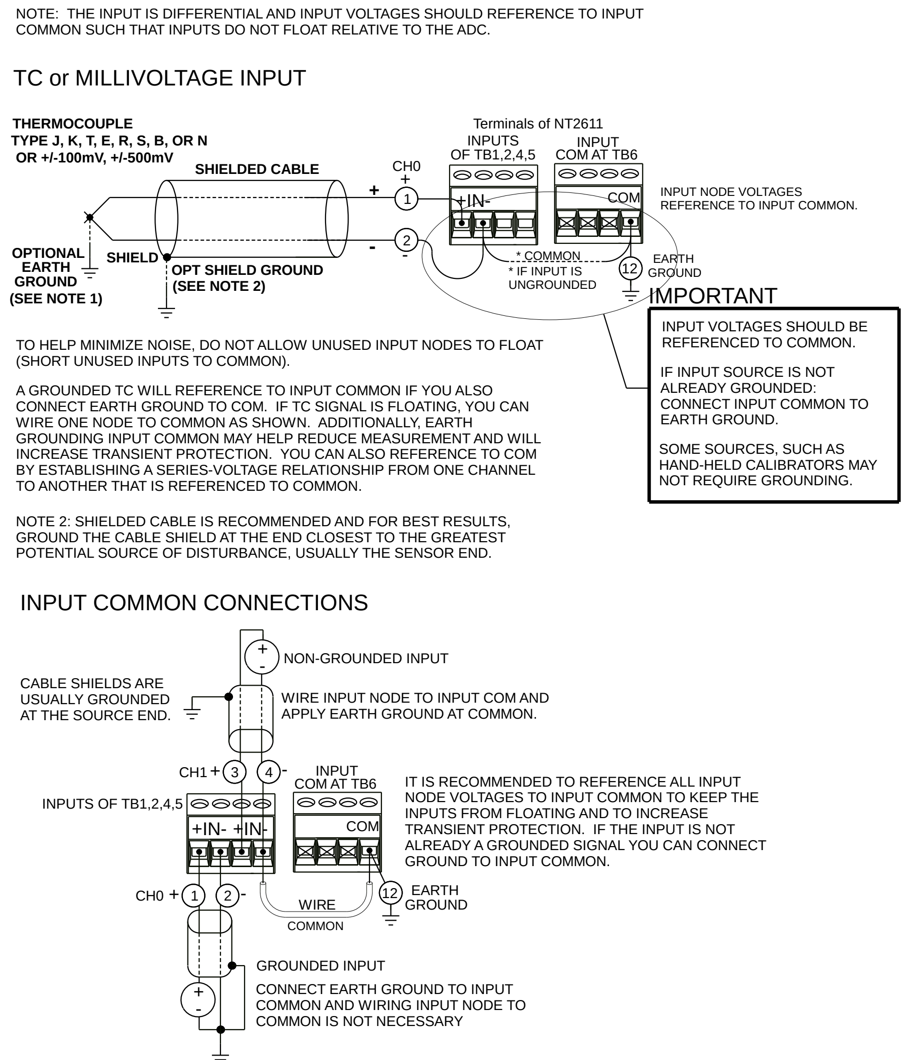
NTX2611 Model



NTE2611 Model



MODEL NT2611 INPUT SENSOR WIRING
THERMOCOUPLE AND DC MILLIVOLTAGE WIRING



Analog Input Single-Ended Current Connections

Analog Input – SE Current

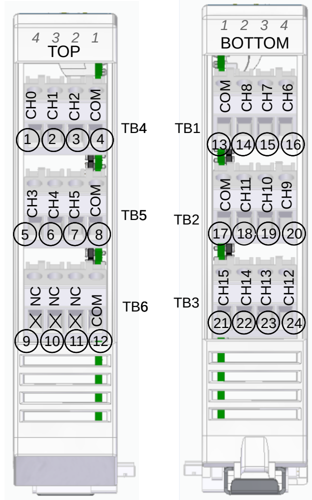
Applicable NT Model - 2221.

Sixteen Single-Ended Current input channels at TB1, TB2, TB3, TB4, and TB5.

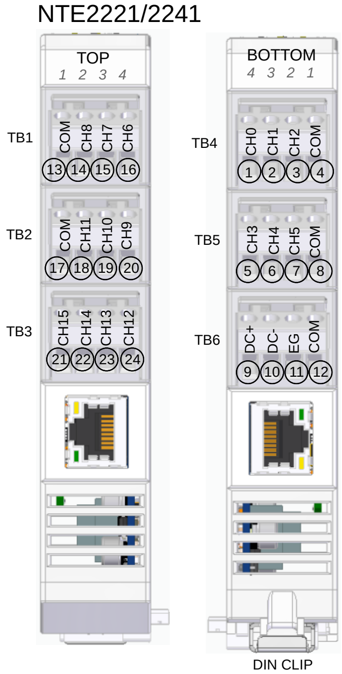
A single-ended input signal refers to a signal pair where one connection is grounded. The input channels of these models are single-ended inputs that share a common return connection. Input returns are available at terminals 4, 8, 12, 13, and 17. Do not share more than 4 channels per return screw.

NT2221 Models utilize precision 49.9Ω shunt resistors at their inputs to convert current to voltage. The ADC converts this current with ±25mA = ±1.25V = ±32768.

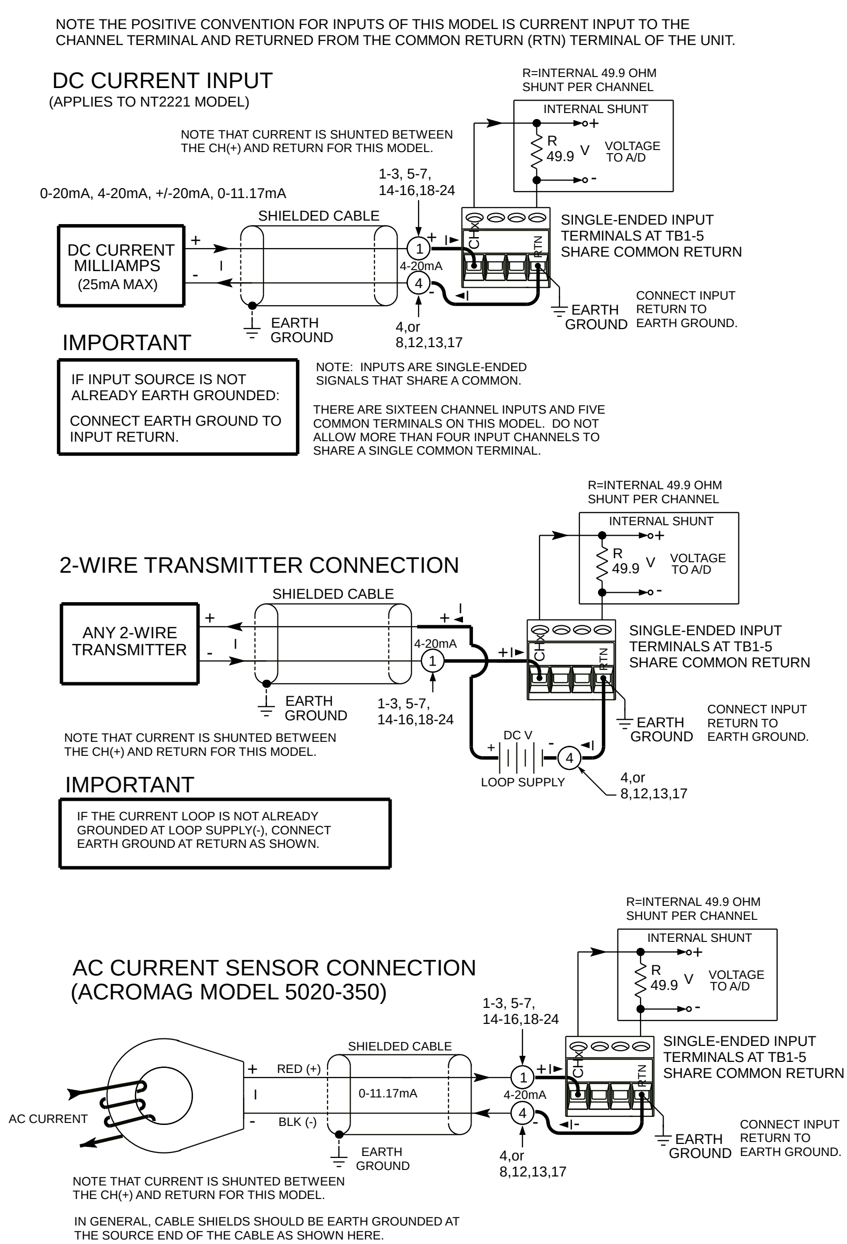
NTX2221/2241



NTE2221/2241



MODEL NT2221 CURRENT INPUT CONNECTIONS



Analog Input – SE Voltage

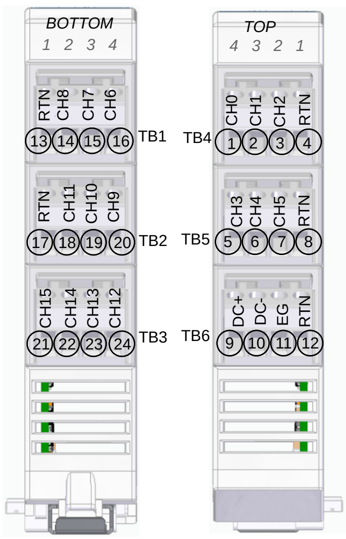
Applicable NT Model - 2241.

Sixteen Single-Ended Voltage input channels at TB1, TB2, TB3, TB4, and TB5.

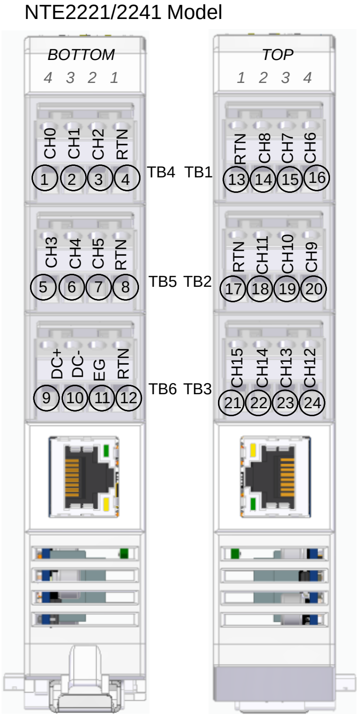
<u>The input channels of this model are single-ended voltage inputs that share a common return connection. Input return is available at terminals 4, 8, 12, 13, and 17. Do not share more than 4 channels per return screw</u>.

NT2241 Models utilize a precision voltage divider at each input to reduce up to ±11.56 of input voltage difference around RTN (0.1081x divider factor). The voltage signal is digitally converted using a 16-bit bipolar conversion scheme with ±11.56 = ±1.25V = ±32768. ADC = (Vin*GAIN/1.25)*32768 + 32767.

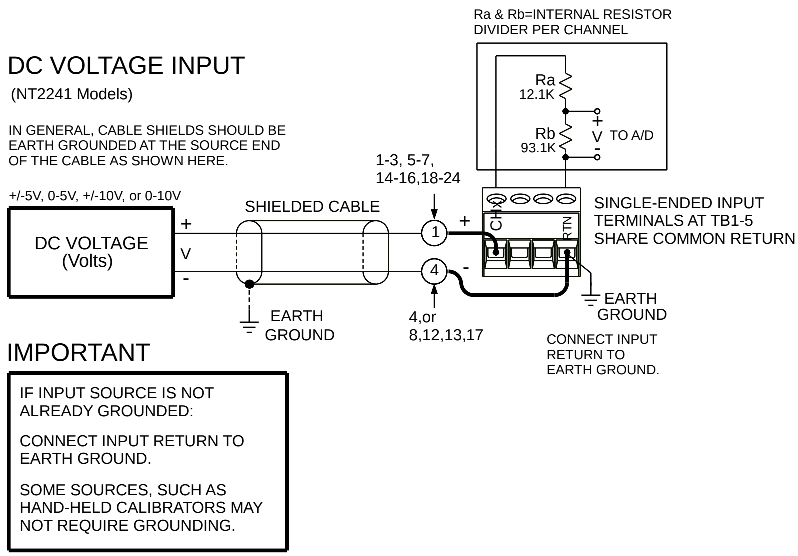
NTX2221/2241 Model



NTE2221/2241 Model



NT MODEL 2241 VOLTAGE INPUT CONNECTIONS



ALL INPUTS ARE INTERNALLY RESISTOR-DIVIDED WITH 10.5K/97.1K AND DRIVE A 24-BIT A/D WITH A +/-1.25V FULL-SCALE RANGE.

SUPPORTED INPUT RANGES INCLUDE +/-10V, 0-10V, +/-5V, 0-5V. +/-1V, AND 0-1V.

GROUNDING INPUT RETURN AS SHOWN WILL KEEP INPUTS FROM FLOATING AND REDUCE MEASUREMENT NOISE.

Field-Excitation Connections

Excitation for 16CH DIO

Applicable NT Models – 2111 and 2121.

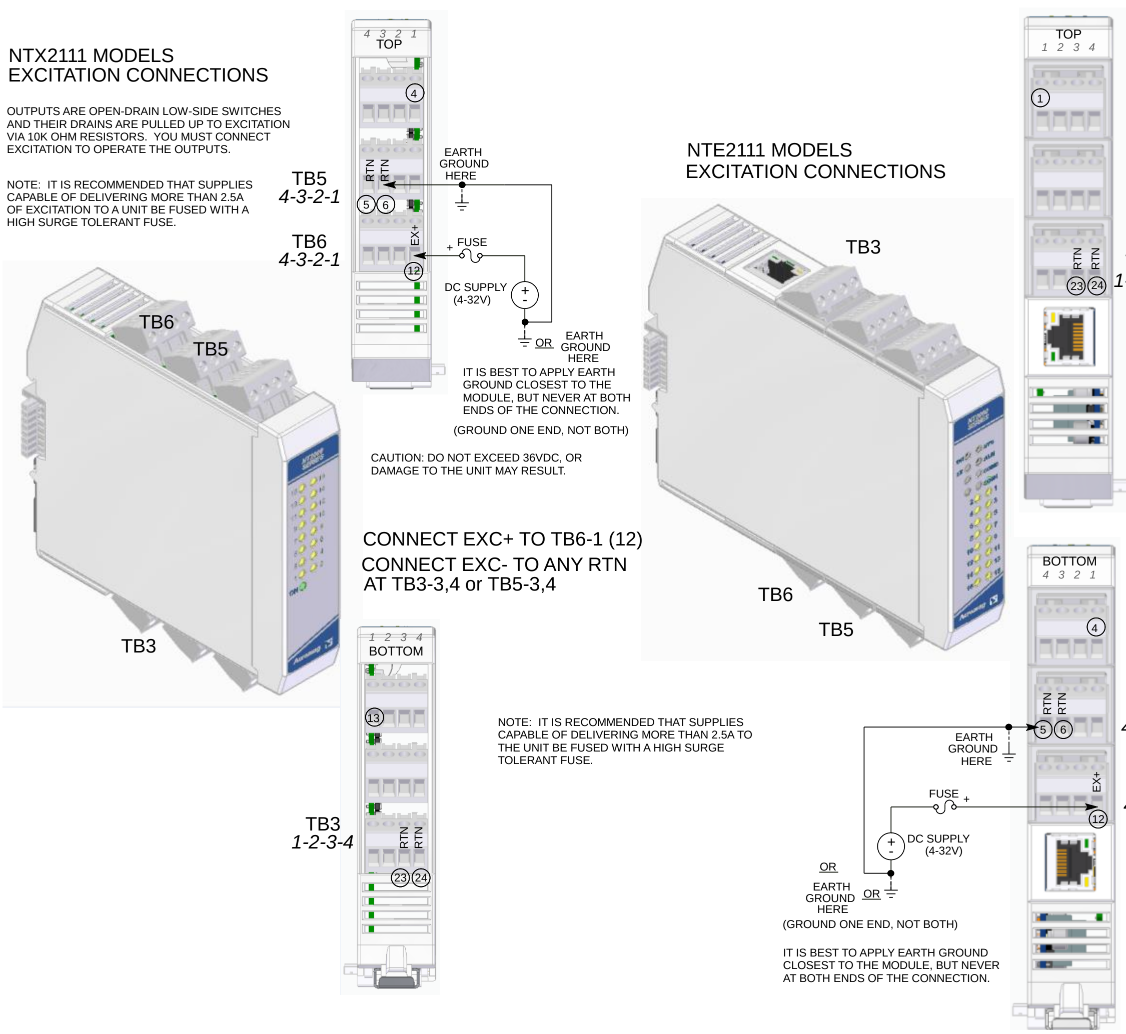
EX+ connects at TB6-1 (24), EXC- at any RTN at TB3-3,4 (11,12) or TB5-3,4 (19,20).

***IMPORTANT:** An NT system will have 1-4 separate IO cards. Remember that unlike system power, field excitation is always wired per IO card that requires it.*

***The NT 2111 sinking DIO model requires 4-32V of excitation to pull its active-low inputs to their OFF/high state. The NT 2121 sourcing DIO model requires that you connect 6-32V of Excitation to operate its digital outputs (not required for input-only operation)*.**

Field excitation for both 16 channel DIO models is connected between terminal TB6-1 (+) and Return (RTN at TB3-3,4 and at TB5-3,4). Outputs are driven by the leads of n-channel mosfets with their opposite leads connected either to return (2111) or Excitation (2121). Channels are pulled to their OFF state via 10KΩ SIP resistors installed in sockets on the board. Connect DC excitation from 4-32V as shown (use 6-32V for NT2121) in the drawing below and observe proper polarity (excitation is reverse-polarity protected). For excitation connections, use 14 AWG wire rated for at least 80°C. Do not exceed 36V DC peak.

NOTE: Because outputs of this model may switch inductive loads at high current, it is recommended that your field excitation supply be kept separate from the supply voltage used to power this system, as switching these loads may produce supply noise that could interfere with operation.



Excitation for 2/4 CH DIO

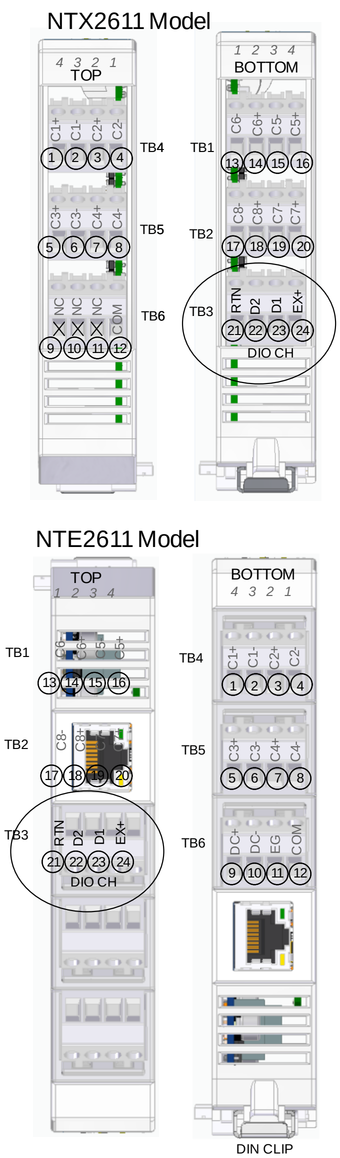
Applicable NT Models – 2211, 2231, 2611, 2621, 2511, 2531.

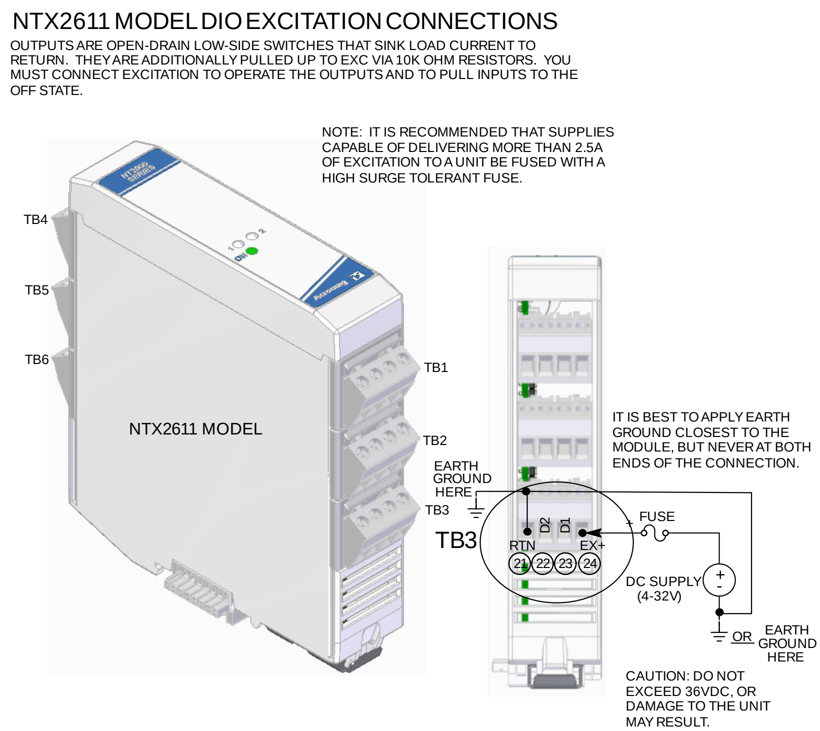
EX+ connected at TB3-4 (24) and RTN at TB3-1 (21).

IMPORTANT: An NT system will have 1-4 separate IO cards. Remember that unlike system power, field excitation is always wired per IO card that requires it.

These NT models include 2 or 4 channels of DIO and excitation is required to operate the digital outputs and to pull the digital inputs to their OFF state (sinking models). Sinking digital outputs are open-drain n-channel mosfets with their source leads sinking to return and they switch the low-side of the output load to return and are pulled-up to their OFF state or excitation via 10KΩ SIP resistors on the board. Sourcing digital outputs are the open-drain leads of n-channel mosfets with their source leads connected to EX+ and they source excitation voltage to the load and are pulled-down to their OFF state with 10KΩ SIP resistors on the board. Connect 4-32V DC excitation as shown in the example below and observe proper polarity (excitation is reverse-polarity protected). Use 14 AWG wire rated for at least 80°C. Do not exceed 36V DC peak.

NOTE: Because outputs of this model may switch inductive loads at high current, it is recommended that your field excitation supply be kept separate from the supply voltage used to power this system, as switching these loads may produce supply noise that could interfere with operation.





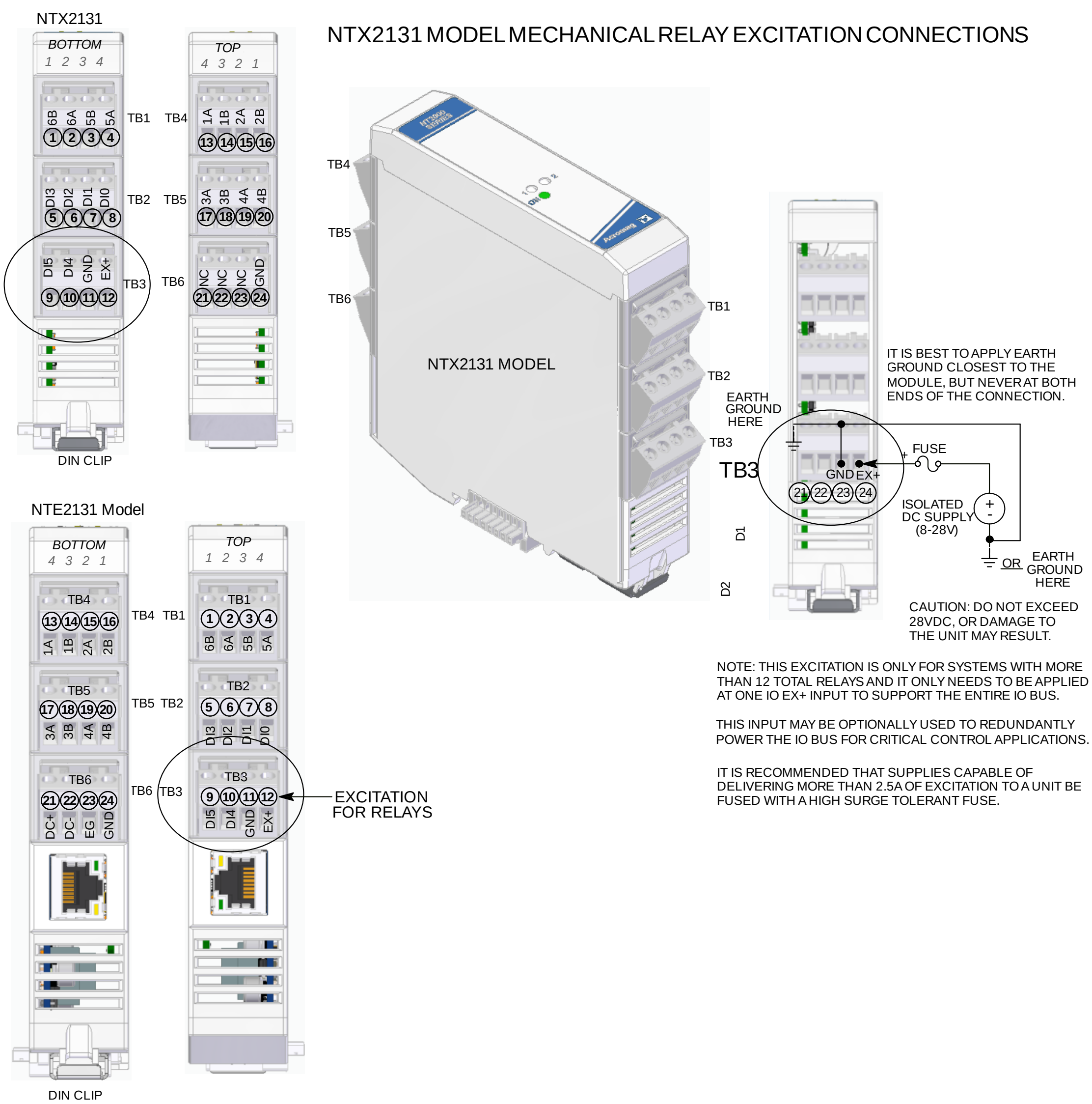
Excitation for Mechanical Relay Model (Optional)

Applicable NT Model – 2131, only required for second and third added NTX2131 Module. Connect EX+ at TB3-4 & EX- at GND (TB3-3 or TB6-4).

IMPORTANT: An NT system will have 1-4 separate IO cards (one NTE model plus up to 3 NTX models). Unlike other excitation sources, this one is only wired to one IO card to support all 4.

This NT model utilizes 6 high-power mechanical relays that draw high current and will exceed internal power capacity if an NTE2131 is mated with more than one NTX2131 expansion board. Extra excitation is required between EX+ and ground to support more than 12 relays in a system. This supply input is diode-coupled to the internal IO bus and will provide the extra power needed to support 24 NT2131 relays in a bussed system (4 Relay IO Cards). Connect 8-28V DC excitation to TB3-4 (EX+) and ground (GND at TB3-3 or TB6-1) of one of the system 2131 IO boards to power more than an NTE2131 and one NTX2131 as shown below. Observe proper polarity (excitation is reverse-polarity protected). Use 14 AWG wire rated for at least 80°C. Do not exceed 28VDC. Use an isolated excitation source to add power.

Note: This input source is diode-coupled to the internal IO bus and may be used to redundantly power the IO bus as needed to support an NTE model and up to 3 NTX expansion modules (some NTX models draw more power than others).



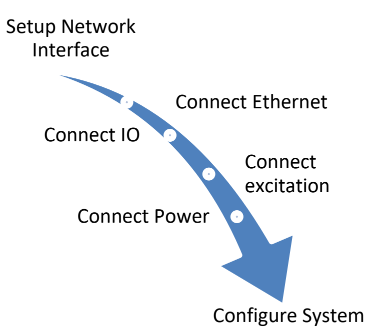
TECHNICAL REFERENCE

WEB SYSTEM CONFIGURATION

For any NT system, its channel IO can be alternately monitored and controlled via its application protocol (Modbus TCP/IP, Ethernet/IP, or Profinet). But the NT is first setup and configured for Ethernet operation using a common web-browser and an Ethernet connection to a PC or laptop and reconfiguration is accomplished via built-in web pages. There are built-in web pages that allow you to configure IO, calibrate channels, poll channel data, write outputs, plus read unit status and diagnostic information via your web-browser. But just as for any Ethernet device, you must first change the address setting of your PC network interface to a compatible IP address within the domain of the NTE system before you can communicate with it. Once able to communicate with the NTE on Ethernet, then you can use its internal web pages to set its IP address to another address suitable to your own application network (do not forget to also set your network adapter back to a compatible address if you wish to talk to the unit at a new IP address setting).

Getting Started

The next section will walk you through configuration of the NT system step-by-step. But before you attempt to reconfigure, please make the following electrical connections.



Every NT system begins with a single NTE IO Model (there are 13 unique IO models to choose from that serve a variety of signal interface needs, refer to Table 1 of page 3). Then you choose up to 3 additional IO expansion models to add additional channels as required by your application. Start with your NTE model on the left and snap additional NTX expansion models on its right along the DIN rail, as required by your application. You can expand your NTE IO module with up to 3 additional NTX IO modules in any mix (the NTE model always includes one IO model internally).

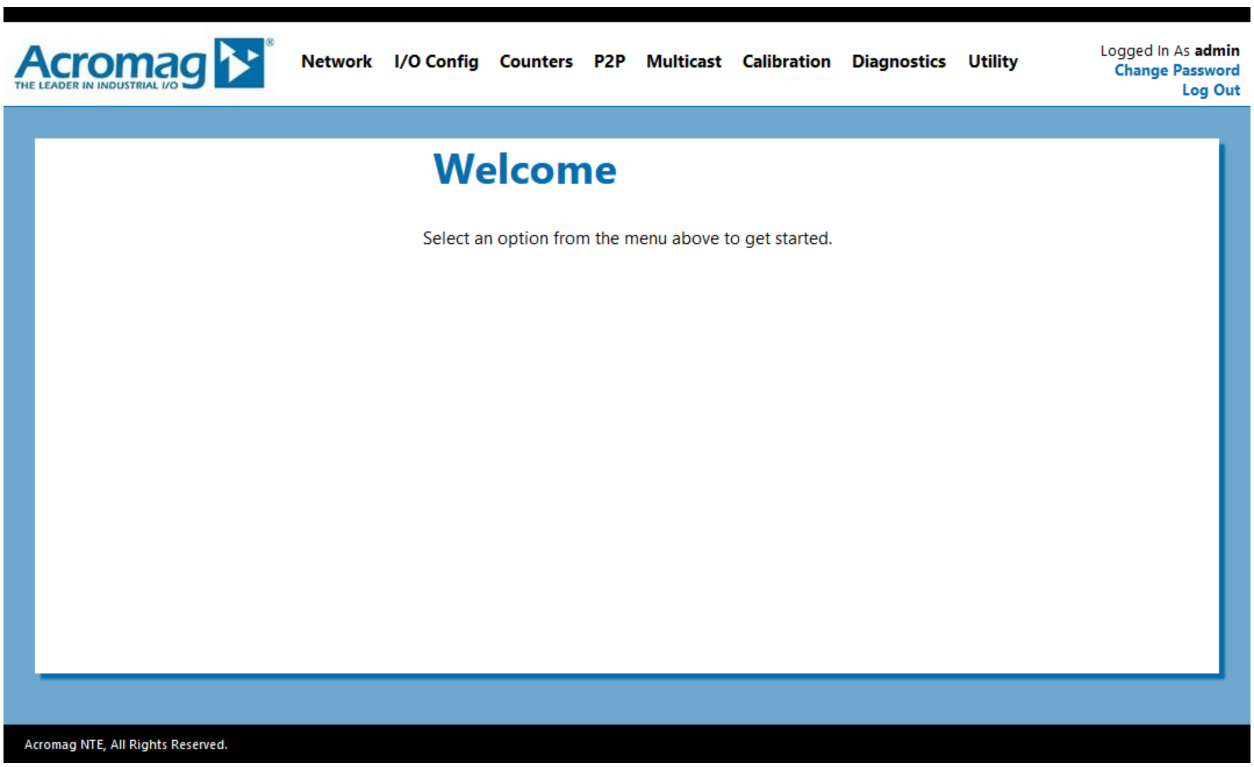
1. **Set your PC/laptop Network Interface Address:** The NTE module is preset from the factory to a default IP address of 192.168.0.10 with subnet mask 255.255.255.0. To communicate with it over Ethernet, the network adapter of your PC/laptop must be set to a compatible address in its domain (i.e. another IP address with its 4th octet set to another/unique number from 1-255 except 10). You could set your interface adapter to use IP address 192.168.0.11 for example. You can consult with your IT department for help doing this or refer to Application Note 8500-734.
2. **Connect Ethernet Cable:** Use an Ethernet cable to connect your PC/laptop to the NTE module at either of its RJ45 network ports (but not both).
3. **Connect IO:** Refer to your IO model(s) User Manual(s) and make your Input and Output Connections as required for your system application.
4. **Connect IO Excitation (if required):** Some IO models require field excitation to operate outputs and you should consult the IO User's Manuals to make these connections. The required current will depend on your models, loads, and voltage level. Unlike power, excitation is connected per IO module where applicable (excitation is not bussed between modules).
5. **Connect Input Power:** Wire power from 10-32V DC to the TB6 power terminals of the left-most NTE module of your system (consult the IO Model User Manuals for power requirements to compute the total power required of your NTE IO Module and each additional NTX IO Module connected). Current required will vary with voltage level (refer to Specifications). Your supply must be capable of providing at least twice the maximum rated current for your voltage level. Supplies capable of driving more than 3A to any unit should fuse their connections to the unit.

Getting Started…

Note that the Ethernet port of your connected PC or laptop must be preset to a compatible IP address in the same subnet as the default IP address of the NTE module (the default NTE system address is 192.168.0.10 of sub-net 192.168.0.xxx). You may refer to Acromag application note 8500-734 for more information on how to set your network adapter to a valid default domain address.

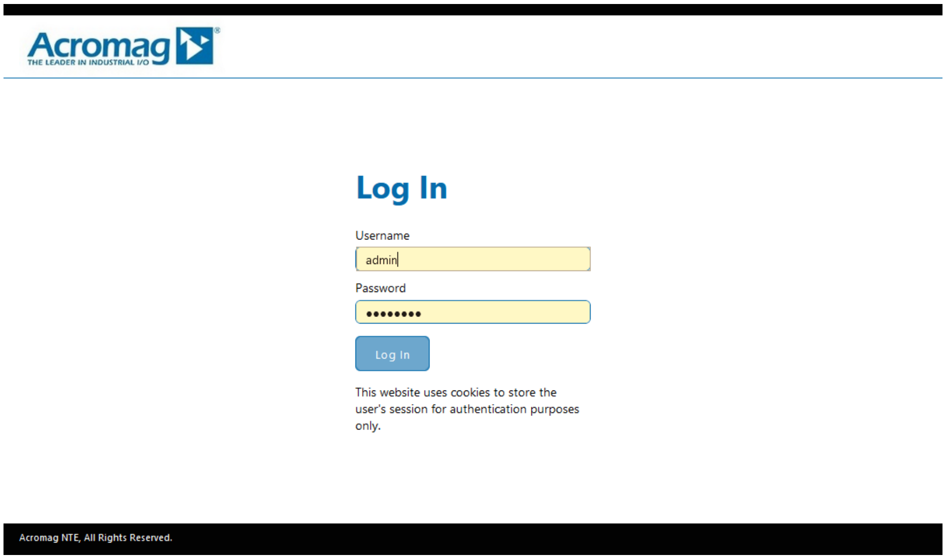
Once you have set your PC or laptop Ethernet port IP address to access the default NTE domain and you have made your hardware connections and applied power, you can boot your browser and type 192.168.0.10 into the browser URL window (Google Chrome or Firefox browsers are preferred) and you will navigate to the NTE main Index screen shown below. Be sure to give the unit a moment to allow it to fully power-up and establish its Ethernet connection. You can choose a tab of interest along the top to navigate to other web-pages of the unit.

Main Index Page



Before you can utilize any area of the program, you must login to the unit. Applicable areas will vary with IO model(s) in your system and are listed across the top of this screen. If you click to select any of seven tabs shown here, Network, IO Configuration, Counters, multicast, Calibration, Diagnostics, or Utility, you will be initially directed to a login page as shown below:

Log-In Page

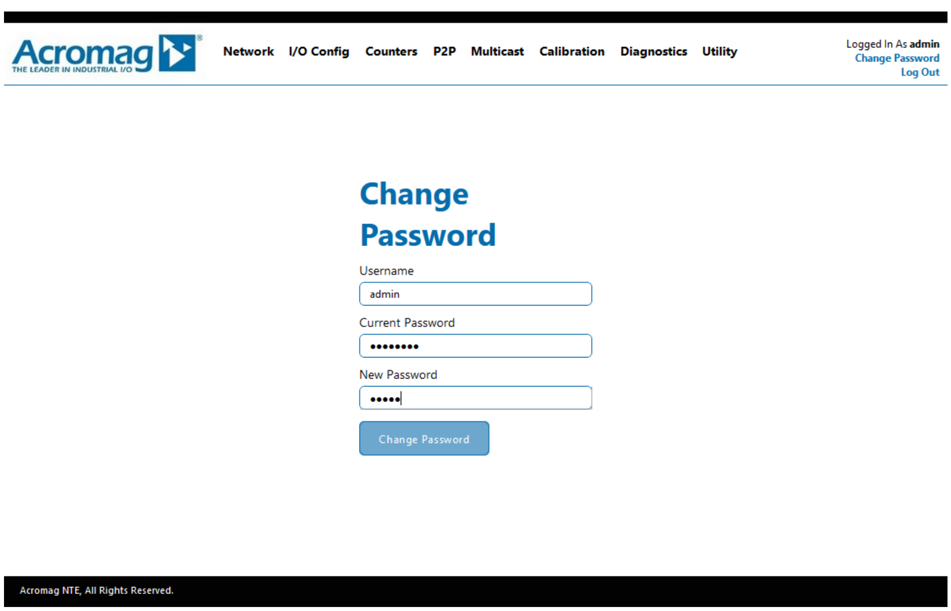


If you have not already set a unique password, you can use “admin” for Username and the default password as “password”. Then click the [Login] button to login. Once you successfully login, you will be returned to the Index page where you can then select what part of the program you want to navigate to.

You can refer to the upper right-hand corner of the index page (or another web-page) and it should display “Logged in As admin”. You could elect to “Change Password” using the link below that message or select “Log Out” to log out of the system.

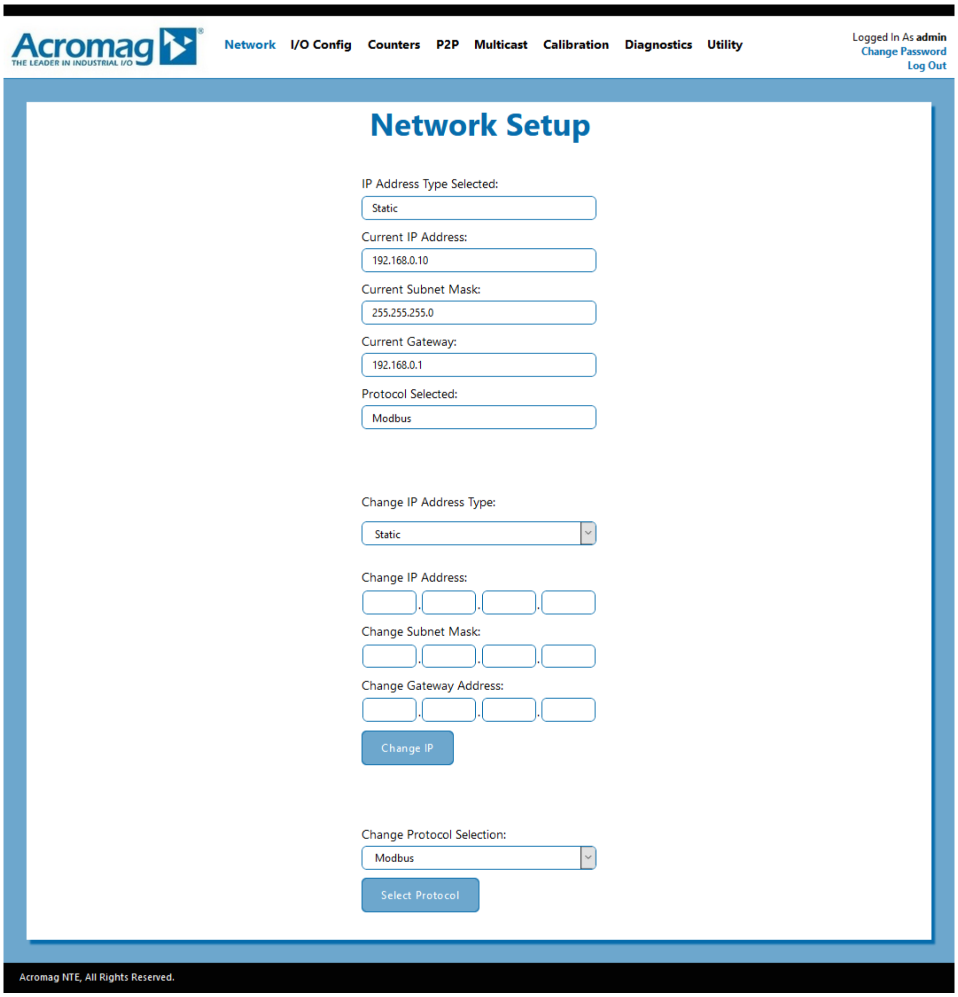
If you choose “Change Password”, you will be presented with the Change Password page shown below. You can use this screen to set a unique password from 8-16 alphanumeric characters. The Username cannot change and you should continue to use “admin”.

Change Password Page



Network Setup Page

Once logged in, the first page you are likely to visit is the Network Page shown below (at least initially). This is where you can give your system its own IP address different from the default of 192.168.0.10 and select the intended application protocol for use by this system: Modbus TCP/IP, Ethernet/IP, or Profinet. You are communicating with the unit at the Current IP Address shown across the top with its Class C subnet mask setting indicated along with the gateway IP address shown and utilizing the Protocol indicated.



Your NT system's particular IO model(s) will have additional model-specific IO screens for configuring/monitoring and controlling its channel IO--you should refer to the IO Manual for your model(s) to explore these tools as applicable. The various IO models include web pages for IO Configuration, Diagnostic Polling, an IO Utility page, i2o configuration and multicast messaging, and special pages for functions like configuring counters. Most items can be configured using your web-browser and/or its specified application protocol. For example, you may use your own application software to issue Modbus commands to this module via Modbus Registers for some IO parameters instead of a web-browser.

If you choose to change the default NTE system address 192.168.0.10 of sub-net 192.168.0.xxx, you will not be able to communicate with the system until you also change the IP address of the Ethernet port of your connected PC or laptop. That is, the Ethernet port of your PC or laptop must be preset to a compatible IP address in the same subnet as the IP address of the NTE module you wish to communicate with. Refer to Acromag application note 8500-734 for more information on how to set your network adapter to a valid default domain address.

Network Setup Page…

The fields display the current (default) Ethernet settings of the connected module for IP address, its subnet mask, its gateway if present, and the applicable protocol (Modbus TCP/IP, Ethernet/IP, or Profinet). You can use the Change IP address and Change Subnet Mask fields to set addresses other than the defaults above by entering your required values and clicking the [Change IP] button. You may have to consult with your network administrator to complete the contents of this page. A brief description of the communication parameters follows:

Your **IP Address** is a unique identification number for any host (this system) on any TCP/IP network (including the internet). The IP address is made up of four octets (8 bits), each octet having a decimal value between 0-255 (00H-FFH) and expressed here with a period placed between octets.

The **Subnet Mask** is used along with the IP address to subdivide the host portion of the IP address into two or more subnets. The subnet mask will flag the bits of the IP address that belong to the network address, and the remaining bits that correspond to the host portion of the address. The unique subnet to which an IP address refers to is recovered by performing a bitwise AND operation between the IP address and the mask itself, with the result being the sub-network address.

The Current Gateway refers to the IP Address of the gateway device this module is to crossover if your local area network happens to be isolated or segmented by a gateway. Typically, the gateway is assigned the first host address in the subnet address space. If a gateway is not present, then this field should contain an unused address within the host subnet address range.

NOTE: In order to network your PC with an Acromag module, you may have to consult with your network administrator and either temporarily change your TCP/IP configuration (see TCP/IP Properties of Network Configuration in Windows), or create a separate private network using a second network adapter installed in your PC (recommended). The necessary steps to take will vary with your operating system. You may refer to Acromag Application Note 8500-734 to help accomplish this (this can be downloaded from our web site at https://www.acromag.com).

The **Addressing Method** refers to how this network module will obtain its IP address when connected to its network.

Static addressing is exactly as the name implies—*static* and represents a unique fixed IP Address that is generally assigned by your service provider or system administrator. The Default static IP address assigned to this module is 192.168.0.10 (refer to product side label).

DHCP (Dynamic Host Configuration Protocol) refers to a protocol for assigning dynamic IP addresses to devices on a network. With dynamic addressing, a device can have a different IP address every time it connects to the network. In some systems, it can even change while it is still connected.

This module can support three different network protocols simply by switching its loaded firmware (Modbus TCP/IP, Ethernet IP, or ProfiNet). The Protocol addressing method refers to allowing the application protocol specific to this model to set the IP address (Profinet generally requires this).

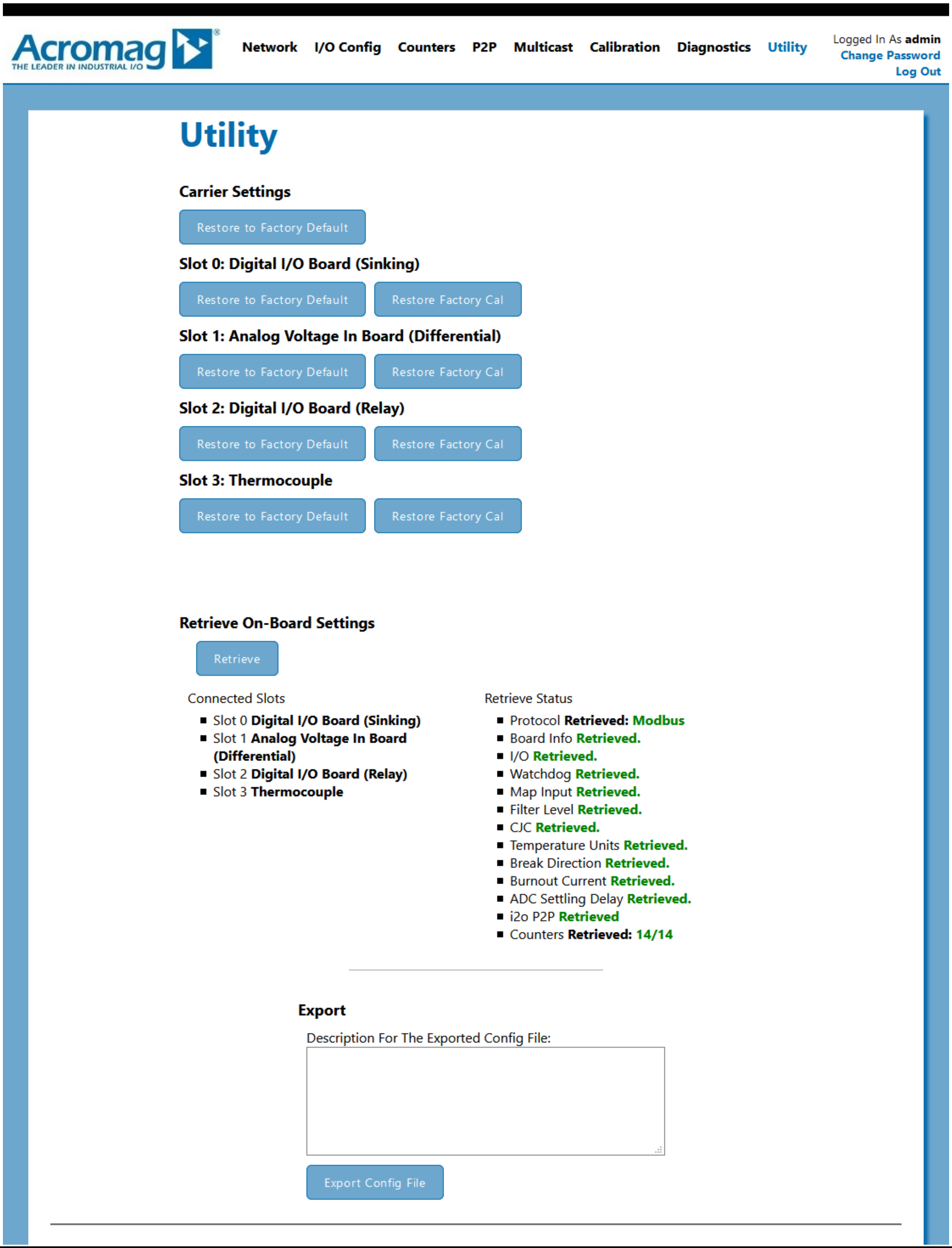
By default, the module is setup to use **Static IP Addressing and a default Static IP Address of 192.168.0.10**. You can optionally choose to have the IP address assigned dynamically via DHCP, but this will additionally require that you specify a valid Host Name to retrieve the address from. Choosing Protocol gives the application protocol permission to assign the address.

You can click [Change IP] button to send the IP address, subnet mask, and gateway address required and this completes any changes made on this page.

You can click another tab along the top of this screen to exit Network Setup to access another page, but if you changed the IP address, you must make sure that the connected network adapter of your PC/laptop is subsequently set to a compatible address in the address domain of your new IP address.

Utility Page

Your NTE system will also include a Utility Page that allows you to retrieve the current system settings and import or export its configuration to a file that you can use to document or to replicate to another system.



Utility Page…

Click [Retrieve] to load all config options of the connected NTE system and its IO board, plus any NTX IO expansion modules connected (Retrieve status indicates progress). You can choose a single IO board configuration or an entire system. Once all system NTE and NTX board setting are retrieved, the configuration can be exported to a file that you can use to document a unit or to import to a replicant system. A description field is provided if you wish to attach a description of the exported file—once you enter a description, click the [Export Config File] button to save an electronic file copy of your connected system configuration.

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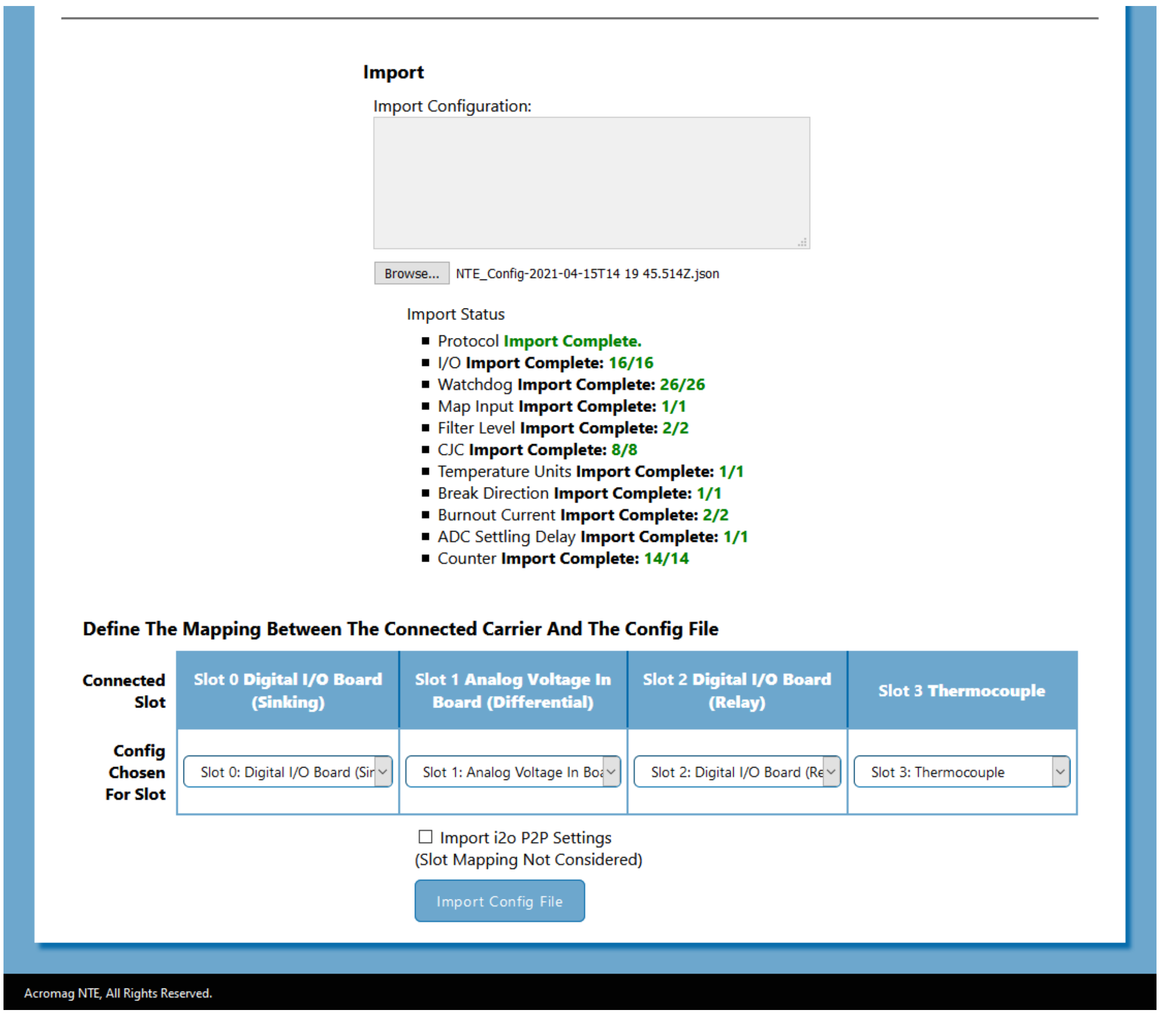


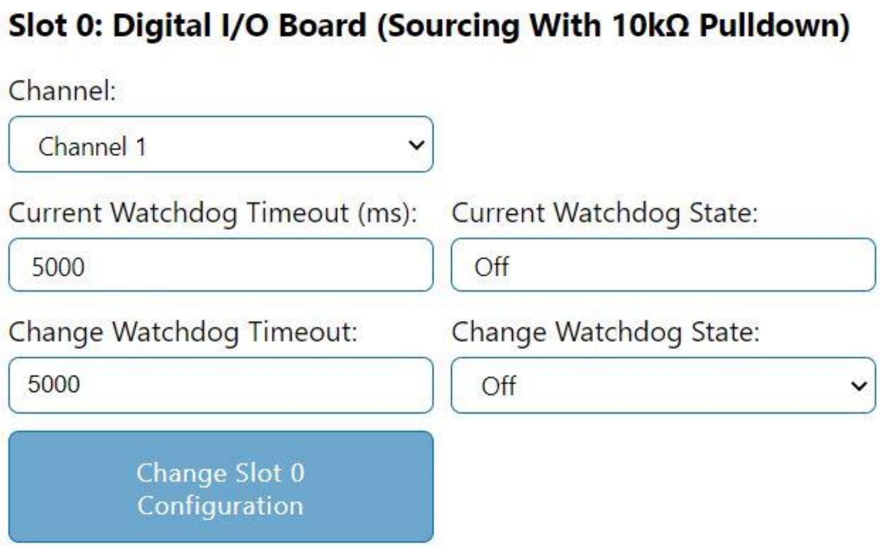
The second part of the Utility Page allows you to import a saved configuration file to the current connected system or another IO board of the current system. Click the [Browse] button to select the previously saved configuration file (with file extension **.json*) that you wish to import. The import status will be displayed.

With the file chosen, you can selectively map the file contents to the connected carrier slot(s). For example, if you imported settings from an NTE2131 IO module, you could map it to any/all slots of the connected device that use NT2131 IO. Simply select the file, set the mapping, then click the [Import Config File] button to begin importing the file to the specified system slots (the exported and imported IO models must match).

Config Page

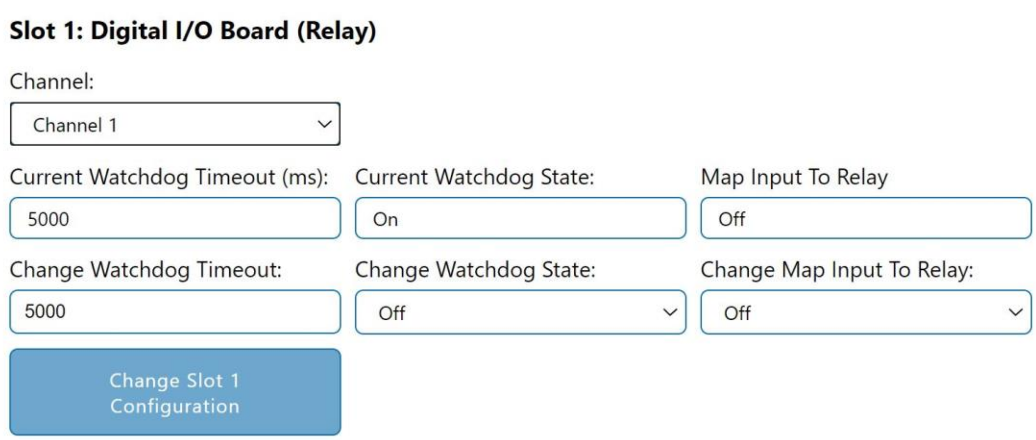
The NT Config page will automatically populate the configuration of up to four IO slots. Each unique IO module is documented below:

NT2111/2121



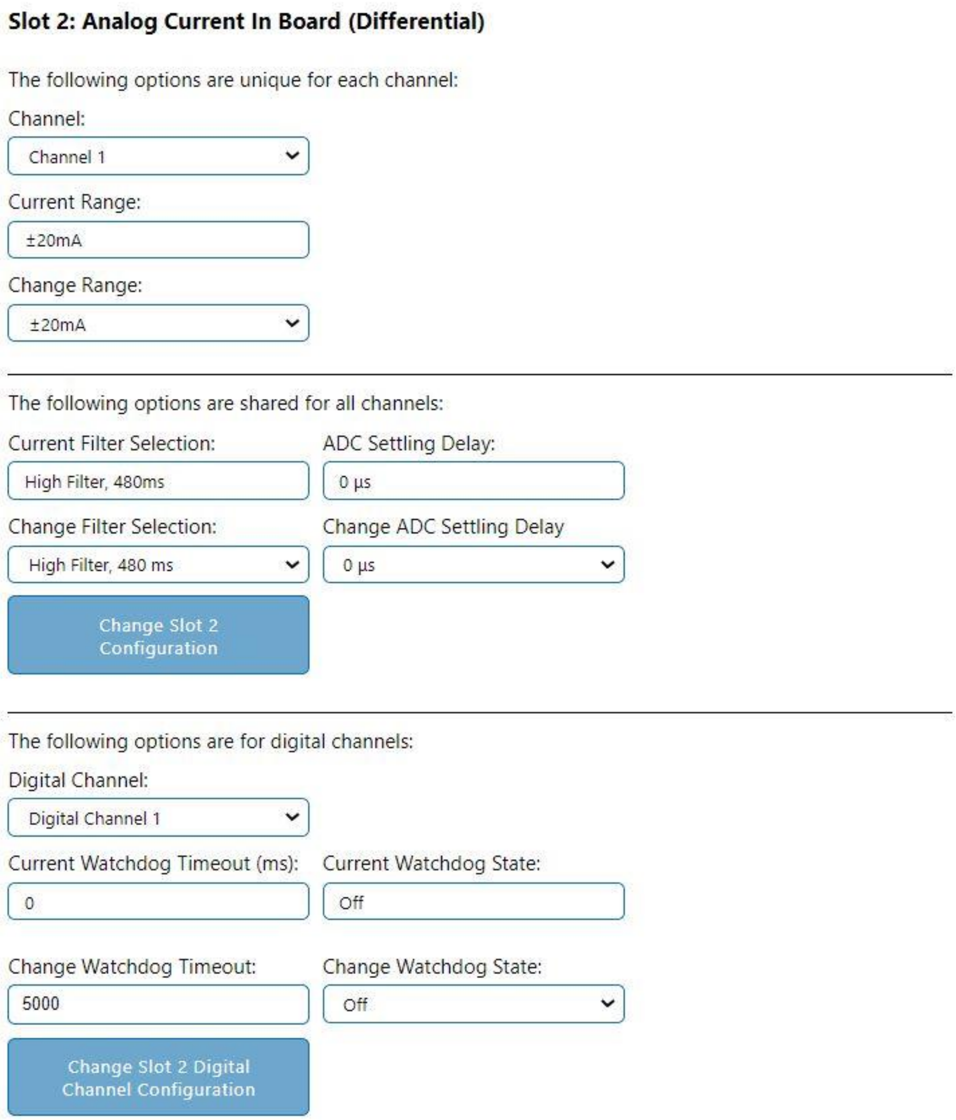
Channel: Use the channel pull down bar to select the DIO channel you wish to configure. This model has 16 discrete DIO channels that you can configure individually.
Watchdog Timeout: Specify a time from 1 to 65535 seconds. A time of 0 will disable the channel's watchdog timer. If no channel write activity occurs during this period, a watchdog timeout will trigger and the channel will be written to the watchdog state (On or Off) you specify in the next field.
Watchdog State: This is the state that you want the output to go to following a watchdog timeout.

NT2131



Channel: Use the channel pull down bar to select the DIO channel you wish to configure. This model has 16 discrete DIO channels that you can configure individually.
Watchdog Timeout: Specify a time from 1 to 65535 seconds. A time of 0 will disable the channel's watchdog timer. If no channel write activity occurs during this period, a watchdog timeout will be triggered and the channel will be written to the watchdog state (On or Off) you specify in the next field.
Watchdog State: This is the state that you want the output to go to following a watchdog timeout.
Map Input to Relay: This feature automatically maps the state of the input to the corresponding relay output.

NT2211/2221/2231/2241



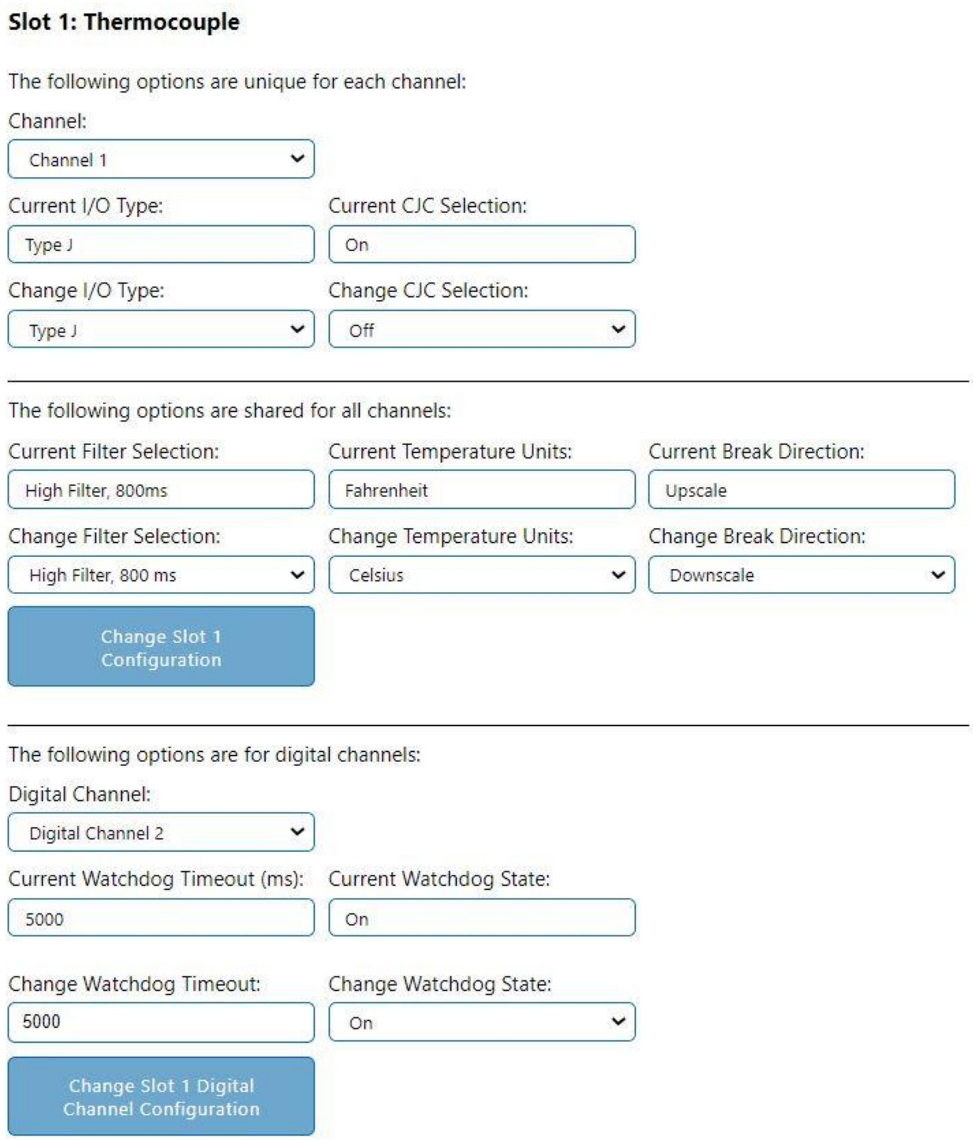
Analog Inputs:

Channel: Use the channel pull down bar to select the analog input channel you wish to configure. This model has 16 discrete DIO channels that you can configure individually.
Range: Use the range field to select your input range. For the NT2211/2221, you can select DC current ranges of ±20mA, 0-20mA, 4-20mA, 0-11.17mA, 0-50mA (NT2111 only), and 10-50mA (NT2211 only). For the NT2231/2241 model, you can select DC voltage ranges of ±10V, ±5V, ±1V (NT2231 only), 0-10V, 0-5V, and 0-1V (NT2231 only).
Filter Selection: You may select the level of digital filtering to apply to the input channel as Low (80mS), Medium (293mS), High (480mS), or None (8mS). The respective IO response times are indicated in parenthesis next to your filter selection. Note that higher filter levels result in lower average noise, but with slower IO response times (See Specifications). Medium and high filter include enhanced 50/60 Hz rejection filtering. Always set the input filter as desired before calibrating an input.
ADC Settling Delay: Use the pull-down bar to select the settling time between ADC reads. You can select 0uS, 32uS, 128uS, 320uS, 800uS, 1.6mS, 4mS, and 8mS.

Digital IO (NT2211/2231 Only):

Channel: Use the channel pull down bar to select the DIO channel you wish to configure. This model has 2 discrete DIO channels that you can configure individually.
Watchdog Timeout: Specify a time from 1 to 65535 seconds. A time of 0 will disable the channel’s watchdog timer. If no channel write activity occurs during this period, a watchdog timeout will be triggered and the channel will be written to its watchdog state (On or Off) that you specify in the next field.
Watchdog State: This is the state that you want the output to go to following a watchdog timeout.

NT2611



Analog Inputs:

Channel: Use the channel pull down bar to select the analog input channel you wish to configure. This model has 8 thermocouple/millivolt channels that you can configure individually.
IO Type: Use the IO type field to select your input range. You can select DC voltage ranges of ±500mV, ±100mV, or thermocouple ranges Type J, K, T, R, S, E, B, or N.
CJC Selection: You can turn CJC sensors on or off. Note that to read thermocouples accurately, CJC sensors must be turned On.
Filter Selection: You may select the level of digital filtering to apply to the input channel as Low (25mS), Low (100mS), Medium (160mS), Medium (133.3mS), High (800mS), or None (1.67mS). The respective IO response times are indicated in parenthesis next to your filter selection. Note that higher filter levels result in lower average noise, but with slower I/O response times (See Specifications). Medium and high filter include enhanced 50/60 Hz rejection filtering. Always set the input filter as desired before calibrating an input.
Temperature Units: You can select temperature units of Fahrenheit or Celsius.

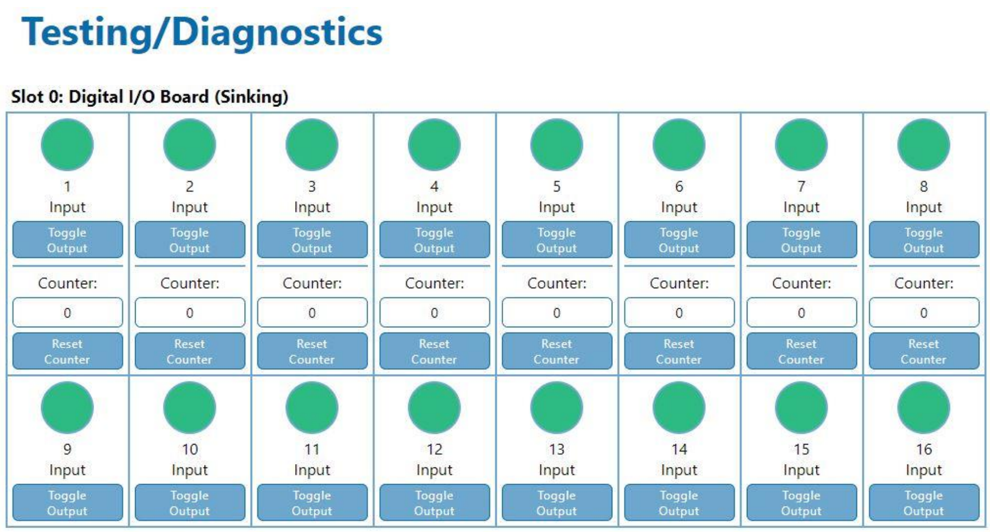
Break Direction: Can be set for Upscale or Downscale open sensor or lead break detection. Module checks for breaks every 10 seconds.

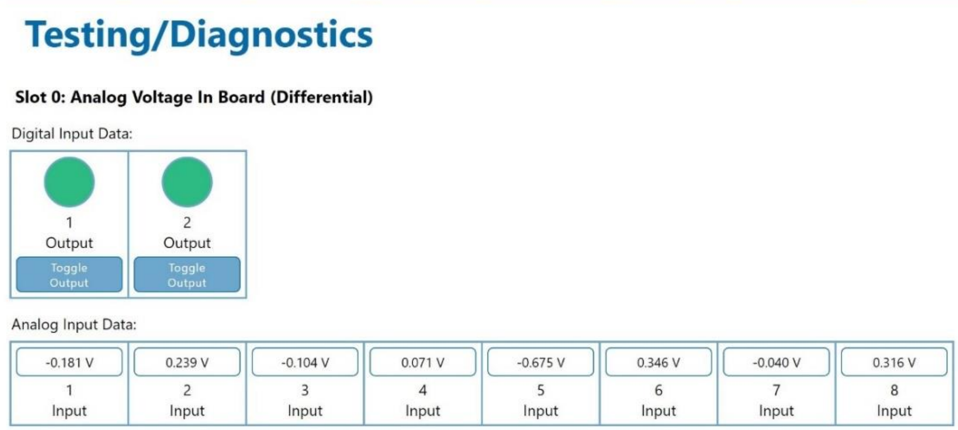
Digital IO:

Channel: Use the channel pull down bar to select the DIO channel you wish to configure. This model has 2 discrete DIO channels that you can configure individually.
Watchdog Timeout: Specify a time from 1 to 65535 seconds. A time of 0 will disable the channel's watchdog timer. If no channel write activity occurs during this period, a watchdog timeout will occur and the channel will be written to the watchdog state (On or Off) you specify in the next field.
Watchdog State: This is the state that you want the output to go to following a watchdog timeout.

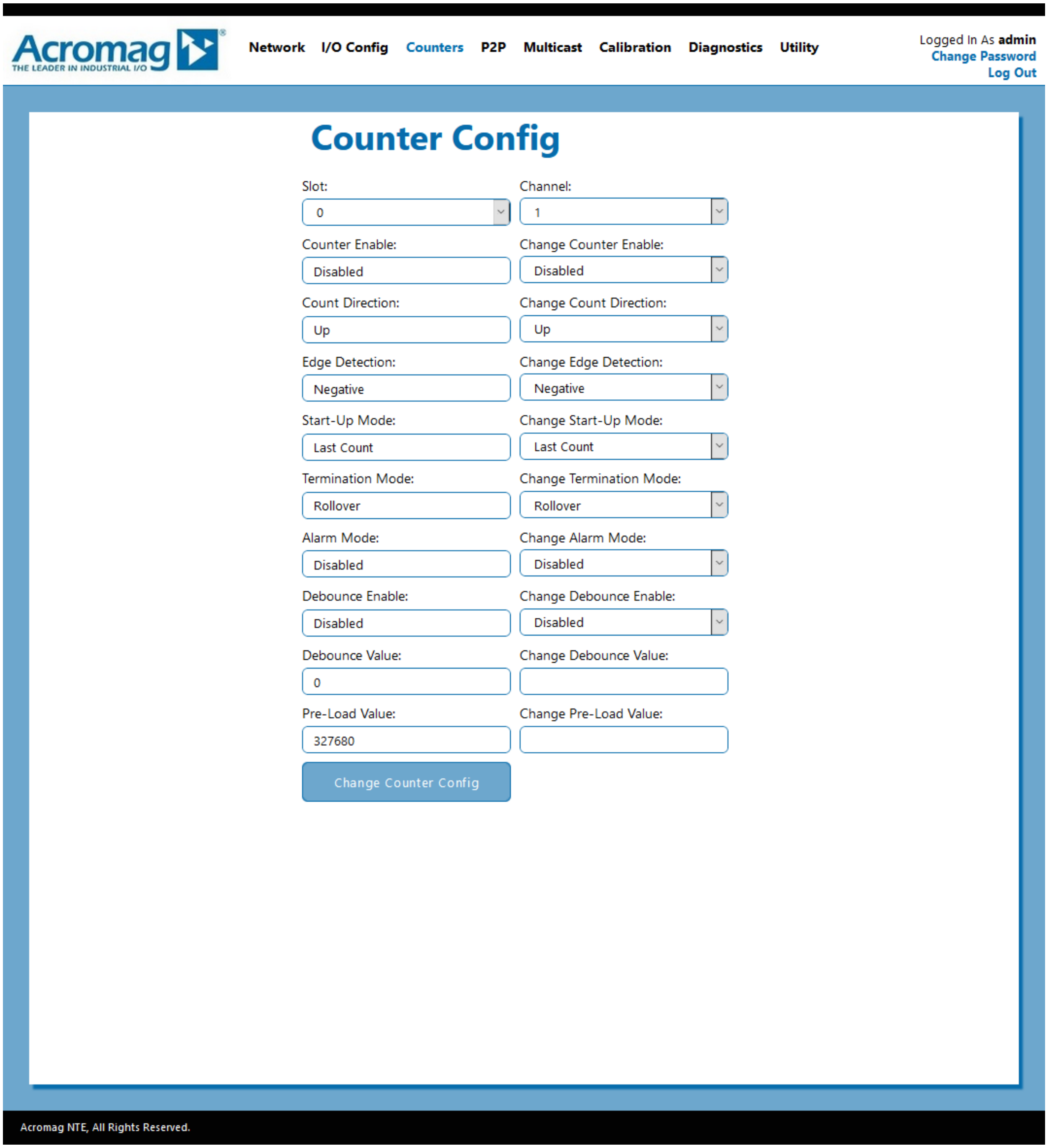
Diagnostic Page

After completing the username/password assignments, plus the network and input configuration parameters, click the Diagnostic Page to access the web-server Diagnostic Page and operate your unit. Here you may read or write input/output values, counter values, and reset counters. Click on Toggle IO Polling at the bottom of the page to begin reading the inputs and outputs.





Counter Config Page



Counter Config Page…

Input Counter (Default=OFF): Certain inputs may be used as 32-bit event counters for signals up to 85 Hz (channels 1-8). excitation must be connected to function properly. Once a counter is enabled, the output function is disabled until the counter is disabled.
Count Direction (Default=Up): Input signal pulses can be either counted-up or counted-down from a pre-loaded value.
Count Edge Direction (Default=Negative): Input signal pulses can be detected on either a rising edge or falling edge.
Start-Up Count Mode (Default=Last Count): Input event counts can be configured to be stored in non-volatile memory, allowing the event count on a given input channel to be restored after a power-loss. Event counts can also be enabled to start-up with its preload value after power-loss.
Counter Debounce (Default=Disabled): Event Counters are equipped with a programmable debounce for noisy input signals such as electro-mechanical relay contact bounce.
Counter Debounce Time: Debounce Time can be set from 0 to 65535ms.
Counter Pre-Load Value: Each channel can be pre-loaded with a start value for the counter from 0 – 4,294,967,295.
Counter Alarm Enable (Default=Disabled): Event counters are equipped with alarms that can toggle the alarm output state upon reaching the termination value of 0 or 4,294,967,295.
Count Termination Mode (Default=Rollover): The outputs can be programmed to either reset the alarm after the next count (Auto) or hold the alarm state until reset (Latch). **Note:** Once the count rolls over, it returns to the pre-load value.

i2o Peer-to-Peer Page

Click the "i2o Mapping Page" tab of the Configuration Software and the screen below will be displayed:

i2o Peer-to-Peer Config

Slot	Starting I/O Channel	# of Channels	Target IP Address	Starting Target Register	Update Time	Change of State	Percent Change	
Slot 0: Analog Current In Board (Single-Ended)	Channel 1	1	192.168.0.3	0000	2000 ms	N/A	0%	Update
Slot 0: Analog Current In Board (Single-Ended)	Channel 1	1	192.168.0.4	0000	2000 ms	N/A	0%	Update
Slot 0: Analog Current In Board (Single-Ended)	Channel 1	1	192.168.0.5	0000	2000 ms	N/A	0%	Update
Slot 0: Analog Current In Board (Single-Ended)	Channel 1	1	192.168.0.7	0006	2000 ms	N/A	0%	Update
Slot 0: Analog Current In Board (Single-Ended)	Channel 1	1	192.168.0.6	0000	2000 ms	N/A	0%	Update
Slot 0: Analog Current In Board (Single-Ended)	Channel 1	4	192.168.0.8	0000	2000 ms	N/A	0%	Update
Slot 0: Analog Current In Board (Single-Ended)	Channel 1	10	192.168.0.9	0000	2000 ms	N/A	0%	Update
Slot 0: Analog Current In Board (Single-Ended)	Channel 1	10	192.168.0.11	0000	2000 ms	N/A	0%	Update

This model includes a special remote messaging function called i2o, for input-to-output communication. This capability allows it to send its digital or analog input information over the network to digital or analog outputs on an identical unit, or another compatible unit (like the XT1121-000). The i2o Page shown above is used to setup i2o by specifying the IP address of the target module (output) to send input channel data to, either upon change-of-state, or cyclically at the update time specified.

With i2o, a client-server network connection is established between a sending-module (client) and a target output module (server). This connection refers to an established data path, or socket, between the client input device and server output—it does not refer to just the physical network connection between devices. It operates like other client-server network connections that are created for the exchange of data between devices, such as that between a Modbus Master and slave, or that between a networked PLC, HMI, or other client device and its target server module.

The NT System allows inputs to be mapped to up to 8 IP addresses. Inputs to map are selected as a group, either digital or analog from each slot. You can select up to sixteen digital inputs or sixteen analog inputs. The digital input data may be sent cyclically according to an update time, and/or upon change of state.

Model	Digital Channels	Analog Channels
NT2111	16	0
NT2121	16	0
NT2131	6	0
NT2211	2	8
NT2221	0	16
NT2231	2	8
NT2241	0	16
NT2611	2	8

The i2o messaging function works best if the target module(s) are already online and ready to receive messages. However, it will still work if the target output module comes online after the input module. It may take several minutes to "discover" the network targets and begin transmitting to them. If this input module or the target module(s) go offline, remote i2o messaging will resume on its own when the connection is re-established, but this "healing" function may take several minutes depending on which device(s) went offline, why, and for how long.

It is not recommended to set an i2o update rate greater than 60 seconds, as increasing bandwidth and shortening response times is not a concern when cyclical messages are spaced farther than 60 seconds apart. But be conservative when setting an update time—shorter intervals than needed may unnecessarily increase network traffic and longer intervals will conserve network bandwidth. Note that digital inputs only map externally to digital outputs of other target modules at different IP addresses, and inputs are mapped in groups of four, to output channels of the target device in groups of four, in the same order. Each i2o message will write a single channel and up to 16 at a time.

To summarize, the behavior of i2o is controlled by the configuration of Update Time, and Change-of-State as illustrated in the following example combinations:

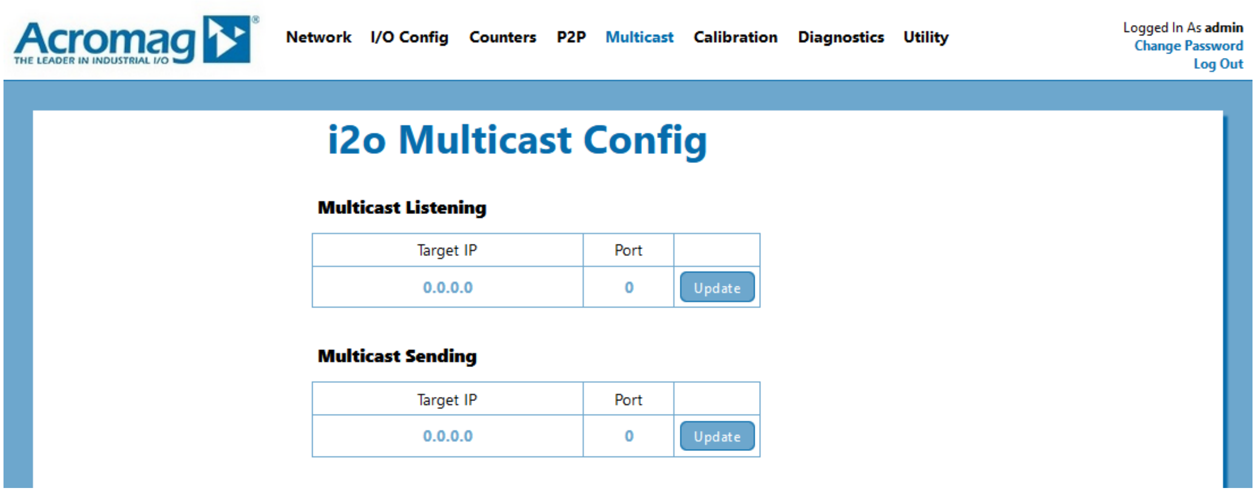
Update Time	Change-of-State	Behavior
0	Disabled	i2o is OFF and no i2o messages are sent
0	Enabled	Inputs sent every Change-Of-State (COS)
5-60sec	Enabled	Inputs sent every COS AND at every interval of time
5-60sec	Disabled	Inputs sent every interval of Update Time
T > 60sec	Disabled	Invalid Configuration w/ a long time over an open socket. This will work but it is not recommended to keep the socket open for infrequent i2o updates.

Each input group of this device may be mapped to a channel group of another Acromag NTE digital IO channel at one or two different IP addresses. Subsequent messages will be sent at a periodic rate specified by the update time. Note that the target output port channels may still be controlled independently via the network, but their state will be overwritten by subsequent mapped messages when enabled. It is recommended that you do not control the i2o mapped output ports (target channels) directly, as this could create contention with the i2o control.

Select Slot #: Select the desired slot to map the input data to.
Select Starting Input Channel: Select the desired starting input channel to map. Digital and Analog channels are treated as separate groups.
Target IP Address: This is the IP Address of the target output devices (another Acromag output module on the network). Each digital input group can only be mapped to a digital output group at the target IP address. Each analog input group can only be mapped to an analog output group at the target IP address.
Number of Channels to map: Select the number of contiguous channels to map.
Holding Register Address: This is the Starting Memory Map address of the output channel group of your i2o target to send this unit's input data to.
Update Time Field: Specify a time of 0, or from 500-65535 seconds between messages. Specify 0 to turn i2o messaging OFF (cyclical). If change-of-state is enabled and a time greater than or equal to 500 is specified, your message will be sent both upon change of state and at the update time specified.
Change-of-State Checkbox (Digital Inputs Only): Set ON to enable output updates on change of input state, and OFF to update cyclically according to the update time.
Percent-of-State (Analog Inputs Only): Set a percent of change value from 0.1-99.9% to enable output updates when a percent of change of input state occurs, and OFF to update cyclically according to the update time.

i2o Multicast Page

Click the "Multicast" tab of the Configuration Software and the screen below will be displayed:



The NT can be configured to send multicast messages or receive them. When enabled, a multicast message will send when a change of state occurs on any enabled channel.

Multicast Listening: Specify a Target IP address to receive multicast messages from. The IP address must be in the range of 244.0.0.0 to 239.255.255.255. If the module is configured to listen and send multicast message, it cannot have the same IP. Select the port number to send to. Default for Modbus is 502.
Multicast Sending: Specify a Target IP address to send multicast messages to. The IP address must be in the range of 244.0.0.0 to 239.255.255.255. If the module is configured to listen and send multicast message, it cannot have the same IP. Select the port number to send to. Default for Modbus is 502.

After updating your settings for the channels you want to modify, click on "Update Flash".

Update Flash

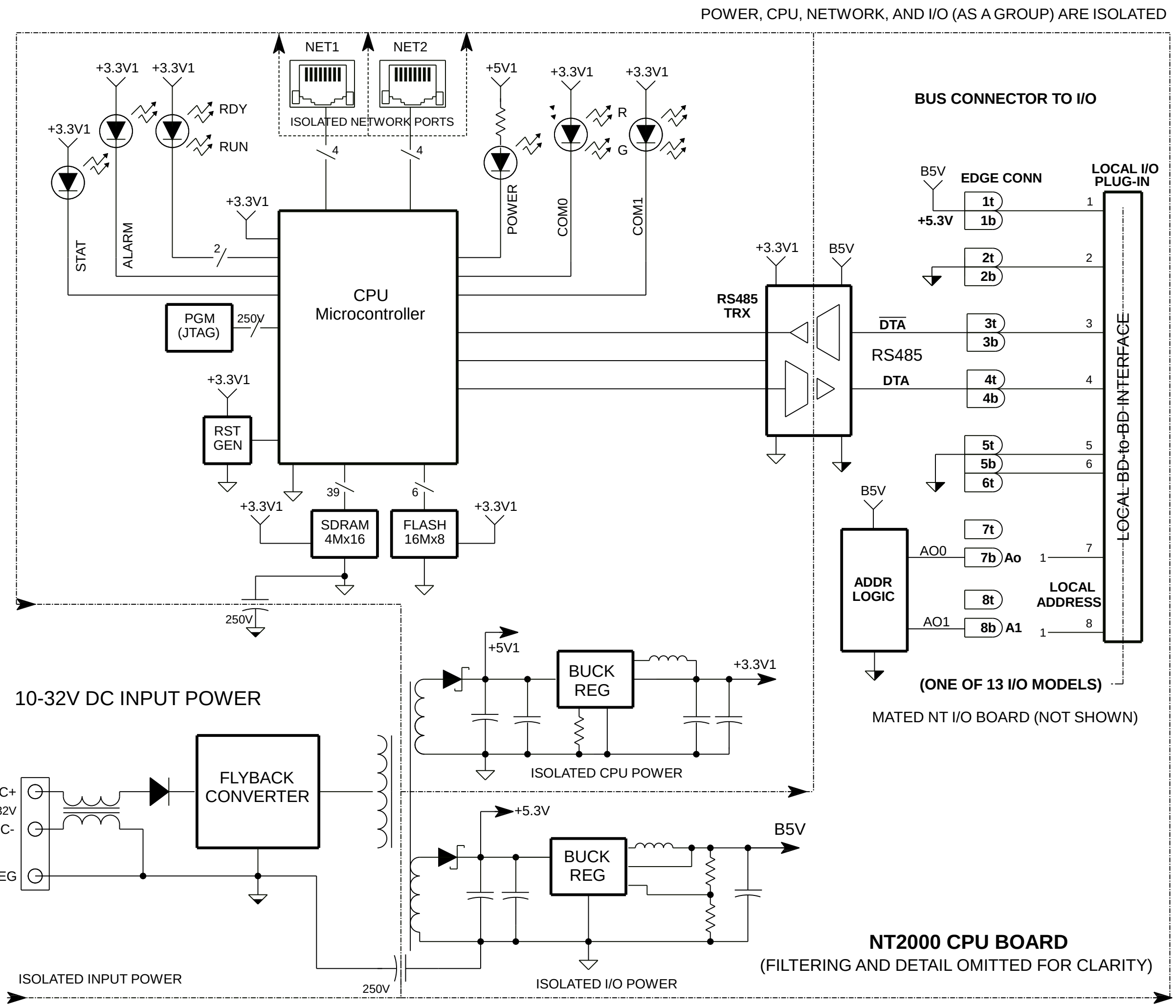
Slot 0: Digital I/O Board (Relay)

Channel	Enable	Invert Output	Coil Register	
1	Disable	Default	0	Update
2	Disable	Default	0	Update
3	Disable	Default	0	Update
4	Disable	Default	0	Update
5	Disable	Default	0	Update
6	Disable	Default	0	Update

Each digital input from all slots can be configured to send to a multicast address. Select **Enable** to allow the channel to be sent. The mapped output can be toggled to invert the output if desired. Select the **Coil Register** to write the input state to. Once the options have been selected, click on the **Update Flash** button to allow the changes to take effect.

Each digital input from all system slots can be configured to send data to a multi-cast address. Select **Enable** to allow the channel to be sent. The mapped output can be toggled to invert the output if desired. Select the **Coil Register** to write the input state to write the input state to. Once the options have been selected, click the **Update** button to finalize the changes.

BLOCK DIAGRAM



How It Works

- The NT supports 14 IO varieties that address discrete, analog, and temperature IO.
- An NTE system always includes one IO module internally and allows up to three more in any mix to be connected along its DIN-rail bus.
- Ethernet communicates to its IO via an isolated RS485 communication bus which drives isolated power to the system IO.
- IO (as a group) is isolated from the network & input power.

The BusWorks NT 2000 is a DIN-rail mounted, DC-powered, modular industrial Ethernet IO system that mates a network module with a variety of NT IO models for the monitor and control of channel IO which includes support for discrete IO, analog current/voltage, millivolt/thermocouple inputs, and Resistance-Temperature-Detector (RTD) signals (there are 14 IO varieties). The system Ethernet provides a dual isolated 10/100MB Ethernet interface to monitor, control, and calibrate channel IO using Modbus TCP/IP, Ethernet/IP, or Profinet application protocols. The NT system is easily setup for Ethernet communication via its network interface using a common web-browser to access built-in web pages. Non-volatile reprogrammable memory in the unit stores configuration, calibration, and other function data. Its input power, network ports (each), and channel IO (as a group) are all safely isolated from each other. The system utilizes an isolated fly-back converter from 10-32V and that drives isolated power to the CPU and isolated 5.3V to the IO bus. The system Ethernet (NTE Model), its mated IO (internal) and up to 3 external NTX expansion modules (as a group), plus each network connection, and its input power circuits are all isolated from each other.

TROUBLESHOOTING

Diagnostic Table

Upon power-up, after blinking momentarily, the green "Run" LED should remain ON. This indicates the unit is properly powered and operating normally. If RUN continues to blink, then the unit may not be connected to the network or the cable connection is bad. Otherwise, a continuous blinking RUN LED can indicate the unit is in "wink" ID mode.

Before attempting repair or replacement, be sure that all installation and configuration procedures have been followed and that the NTE & NTX units are wired properly. Verify that 10-32V system power is applied to the system NTE module at TB6 (left-most module).

If your problem still exists after checking your wiring and reviewing this information, or if other evidence points to another problem with the unit, an effective and convenient fault diagnosis method is to exchange the questionable unit with a known good unit.

Acromag's Application Engineers can provide further technical assistance if required. Repair services are also available from Acromag.

POSSIBLE CAUSE	POSSIBLE FIX
Model Green RUN LED does not light…	
Bad/missing/reversed power connections?	Recheck Power Connections at TB6. Are your power terminals reversed?
Is your input voltage at least 10V and of sufficient capacity?	Check your power supply voltage level and make sure it is at least 10V, and not current-limited below twice the maximum current draw you calculated for your system.
Try a system reset?	Cycle power to the unit.
Internal power failure or fatal processor errot (firmware)?	Return module for repair and/or firmware reprogramming.
Is the input power TVS damaged? This could occur for a sustained voltage surge or continuous over-voltage at the power terminals.	Return unit for repair. Power should be fused externally or current-limited to a safe operating level no less than twice the maximum input current. The system fuse rating should never exceed 3A.
For NTX2131 models, have you added more than 12 relays to your system (2x NTX2131) without connecting additional relay excitation.	If your system contains more than one NTE2131 plus one NTX2131 expansion modules (12 relays), then you must connect additional excitation to power more than 12 relays (see Excitation Connections).
Green RUN LED flashes continuously…	
A network link has not been established. *A normal unit will flash the green RUN LED and maintain a solid STAT LED at startup until link established.*	Check your cable and switch/hub connections. Once a link is established, the green Run LED should not continue to blink but remain ON. If it continues to blink, then the firmware may be in error.
Unit in "wink" mode.	Read Status register to verify "wink" status.
Cannot Communicate…	
Power ON to the unit?	Check if green RUN LED is ON?
IO Bus overloaded?	More than 3 NTX IO cards or possibly four NT2131 IO cards present.
Wrong IP Address	Change IP address of unit or host PC so they match domains. Try the default unit address of 192.168.0.10.
Unit failed to boot firmware.	The SYS LED turns yellow can signify the unit has failed to initialize and may require repair if you are sure of a good network connection and proper power voltage.
Cannot Browse Unit…	
Your browser may be setup to use a proxy server for LAN communications.	Temporarily disable the use of a proxy server by your browser (see procedure of next page).

Diagnostic Table…

Please refer to Acromag's Service Policy and Warranty Bulletins or contact Acromag for complete details on how to obtain repair or replacement.

i2o is not working…	
Check if the upload was corrupted when i2o was written to the module.	If you recheck your i2o configuration and it still fails to operate, try rebooting the module or re-writing the i2o configuration (check address settings, update time, change-of-state, etc).

Trouble Browsing Your Unit?

You may refer to Acromag Application Note 8500-734 for help in setting up Ethernet network communication with your unit (you can download this from www.acromag.com). Application Note 85400-734 gives details for changing your PC's TCP/IP configuration to communicate with Ethernet hardware like your own (see TCP/IP Properties of Network Configuration in Windows). If you have carefully followed this procedure and set the IP addresses correctly, but still cannot browse your unit, you may have the web browser of your host laptop or PC setup to use a proxy server when browsing the web. If you are using Internet Explorer, refer to the "Tools" pull-down menu, select "Internet options…", click the "Connections" tab, then click the "LAN Settings" button.

Trouble Browsing Your Unit…

Locate the Proxy server information and uncheck the box next to the statement "Use a proxy server for your LAN". Then click [OK] to return to the "Connections" screen and click [OK] again to save your settings. You should now be able to use Internet Explorer to browse the unit as required. However, to later restore your PC's connection to your company network, you may have to re-enable the use of a proxy server for your LAN.

Maintenance

This unit contains solid-state components and requires no maintenance, Except for periodic cleaning and possible IO module configuration parameter (zero and full-scale) verification. The enclosure is not normally meant to be opened for access and can be damaged easily if disassembled incorrectly. Thus, it is highly recommended that a non-functioning module be returned to Acromag for repair or replacement. Acromag has automated test equipment that thoroughly checks and calibrates the performance of each module and can also restore firmware.

ACCESSORIES

End Stops

Two End Stops – Order 4001-252

- Two 1027-222 End Stops for 35 mm DIN Rail mounting

For hazardous location installations (Class I, Division 2 or ATEX Zone 2), you can use two end stops (Acromag 1027-222) to help secure modules to 35mm DIN rail (not shown).

Low EMI Double-Shielded Patch Cable

Ethernet Patch Cable, 3 feet long, Model 5035-369
Ethernet Patch Cable, 15 feet long, Model 5035-370

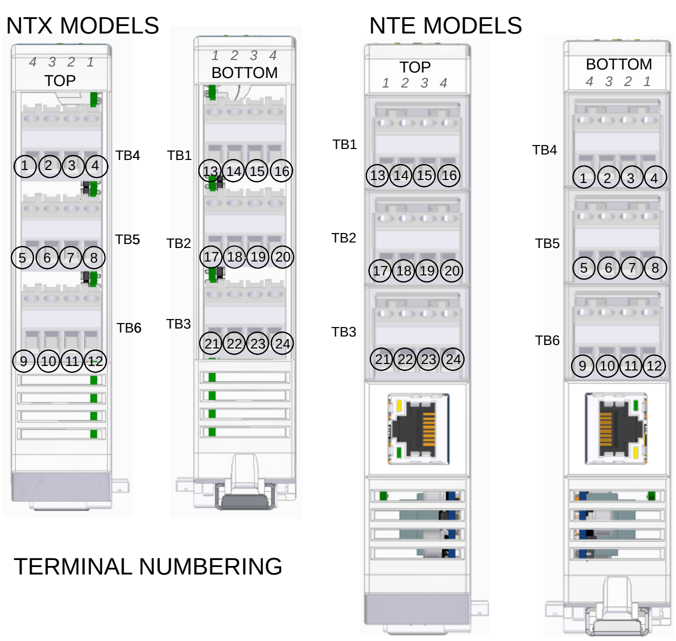
This cable is used to connect an NTE module to a network switch (Acromag 900EN-S005 or equivalent Ethernet switch). It is double-shielded for lower emissions and increased RFI resistance. It has a red, low-smoke, zero halogen jacket and bundles four pairs of 26AWG stranded cable. It uses a 100% foil shield beneath a 60% braided outer shield and includes an RJ45 plug at each end. It is electrically equivalent to L-Com TRD855DSZRD cable and can be obtained in other lengths directly from L-Com (http://www.l-com.com). Double-shielded CAT5e or better cable is recommended for very noisy environments or in the presence of strong electrical fields. You may obtain shielded CAT-5e cable in other lengths and colors as required for your application from other vendors including L-com Connectivity Products, www.L-com.com, Pro-Link, www.prolink-cables.com, Regal, www.regalusa.com, and Lumberg, www.lumbergusa.com.

SPECIFICATIONS

NT IO	I/O FUNCTIONS SUPPORTED			
2111	16CH DI – Active-Low	16CH DO - Sinking		
2121	16CH DI – Active-High	16CH DO - Sourcing		
2131	6CH Mechanical Relay	6CH DI – Active High		
2211	8CH Differential Current	2CH DI – Active Low	2CH DO - Sinking	
2231	8CH Differential Voltage	2CH DI – Active Low	2CH DO - Sinking	
2611	8CH Differential mV/TC	2CH DI – Active Low	2CH DO - Sinking	
2221	16CH Single-Ended Current			
2241	16CH Single-Ended Voltage			
COMING	**New Models Coming Soon…**			
2141	*6CH AC Input 120/240V*	*6CH DI -Active Low*	*6CH DO - Sinking*	
2621	*4CH 2/3/4-Wire RTD/Ω*	*2CH DI – Active Low*	*2CH DO - Sinking*	
2311	*8CH Current Output*			
2321	*8CH Voltage Output*			
2511	*Combo - 4CH Diff Current*	*2CH AO Current*	*4CH DI – Act High*	*4CH DO - Sourcing*
2531	*Combo - 4CH Diff Voltage*	*2CH AO Current*	*4CH DI – Act High*	*4CH DO - Sourcing*

The “BusWorks” NT family is a DC-powered, DIN-rail mounted, modular industrial Ethernet IO system that mates on NTE model network board with 0-3 NTX model IO boards for the monitor and control of channel IO including variations of discrete IO, analog current/voltage, millivolt/ thermocouple inputs, and Resistance-Temperature-Detector (RTD) signals.

The system Ethernet module (NTE model) provides a dual isolated 10/100MB Ethernet interface for monitoring, calibration, and control of all mated IO using Modbus TCP/IP, Ethernet/IP, or Profinet application protocols. It includes one IO module internally and can optionally connect 1-3 additional IO expansion modules externally (NTX models) for additional channels. An NT system is setup via its network interface using a common Ethernet web-browser and their IO can alternately be setup/configured by the NTE unit’s requisite application protocol. System input power, each network port, and all channel IO (as a group) are isolated from each other. Non-volatile reprogrammable memory inside the unit stores configuration, calibration, and totalization data.



All NT modules are mounted on standard “T” Type DIN rail and each include six plug-in 4-position terminal blocks. System power is always wired to the NTE network model (first module on left), but some NTX IO models will additionally require that field excitation be wired directly to the IO module (see Power & Excitation Connections). Modules are CE Approved (pending), plus include UL/cUL Class I, Division 2 approvals (pending).

General Specifications

System Power

Unit power is wired to TB6 of the system NTE CPU/network model only.

NT IO models with DO and AO may require additional field excitation and this must be wired to the EX+ terminal of the unit at each applicable IO module (see excitation Connections).

Power Supply: Wire 10-32V DC SELV (Safety Extra Low Voltage) power to NTE models at TB6 and observe proper polarity (reverse voltage protection is included). NTX Models are powered from their bus connection to a powered NTE Model. While most NTE models may power up to three additional NTX IO expansion modules, some NTX expansion module combinations require more power than others and this can limit the number of NTX expansion modules that can be supported (For example, an NTE2131 module may only support one additional NTE2131 expansion module without adding excitation). Many NTX models additionally require external field excitation be wired directly to the module and the power data provided below does not include that power.

NTE Model	NTE Input Power Required (Watts)	NTX IO Model	NTX Input Power Required (Watts)
NTE2111[1]	1.47 Typ, 1.58 Max	NTX2111[1]	0.423 Avg
NTE2121[1]	1.46 Typ, 1.56 Max	NTX2121[1]	0.363 Avg
NTE2611	1.24 Typ, 1.34 Max	NTX2611	0.144 Avg
NTE2141		NTX2141	
NTE2131		NTX2131	
NTE2211		NTX2211	
NTE2221	1.10 Typ, 1.22 Max	NTX2221	0.12 Avg
NTE2231	1.25 Typ, 1.38 Max	NTX2231	0.18 Avg
NTE2241		*NTX2241*	
NTE2621		*NTX2621*	
NTE2311	*1.091 Typ, 1.20 Max*	*NTX2311*	*0.092*
NTE2321		*NTX2321*	
NTE2511/2531		*NTX2511/2531*	

[1]Note: Power is with all output LED's ON and does not include any IO excitation.

When adding NTX modules to your system, you may add 0-3 NTX IO expansion modules to any NTE IO model, but your max total system input power must be less than 3.3W. That is, add the NTE Max power of your model to the average power required for each expansion module you add (up to 3) and make sure this is less than 3.3W. For the NT2131, you may have to reduce the number of expansion modules to ensure its required power is less than 3.3W. However, the NT2131 will still permit a full system of four NT2131 IO boards to be supported by adding external excitation. You may calculate the potential current consumption of your system by dividing your total power by your input voltage level. Your input power supply should be able to supply at least twice this current to meet potential turn ON inrush demands. Always keep unit power separate from field excitation where applicable. Field excitation is usually computed as a sum of IO loads within IO limits and varies by model.
CAUTION: Terminal voltage at or above 10V minimum must be maintained to the unit during operation. Do not exceed 36VDC peak to avoid damage to the unit.
Power Supply Effect: Less than ±.001% of output span per input volt DC change.

Memory

All Models

Unit contains both volatile and non-volatile solid-state memory on both its NTE System CPU Board and IO boards (does not contain any fixed or removable disk, tape drives, or memory cards). See below for sanitization.

Flash Memory (Non-Volatile on NTE Ethernet Board & IO Board): NTE Ethernet Board-128Mb/16Mx8b flash memory used as a fixed file system for web pages and no user-configured data. NTE Ethernet Board main Microcontroller–1024KB flash plus additional 512KB used to store user-configured communication parameters, username & password, and other web-page information except IO configuration. This is sanitized via the Restore Factory settings button of the Utility Page and its contents reverts to the factory default settings, except for fixed MAC ID and serial number. Integrated in IO Board microcontrollers – 128KB used for storing IO calibration information. This is sanitized via the Restore Factory settings button of the Utility Page.
EEPROM Memory (Non-Volatile on IO Board): 512 Bytes integrated inside IO Board microcontroller and which stores IO configuration information and is sanitized via the Utility Page Restore Factory settings button to revert to factory defaults.
SDRAM (Volatile on NTE Ethernet Board): External chip on Ethernet Board-2Mx16bitx2 bank memory used as scratchpad memory by the processor during run time and whose contents are cleared at power-down. Integrated in Ethernet Board microcontroller is a bank of 576KB with 64KB of it used as scratch-pad memory by the processor during run time and whose contents are cleared at power-down.
FRAM (Non-Volatile on some IO Boards): This 4Kb (4096 bits) of memory is resident on the IO board and is used to store the digital counter value (where applicable), plus scaling and totalization information for the inputs. It is user-modified via channel setup and its contents can be cleared to factory default calibration values by clicking the Restore All Default Calibration Values button of the Utility Page.

Ethernet Interface

NTE Models Only

TIP: You may refer to Acromag Application Note 8500-734 for instructions on how to change the IP address of your PC network interface card to talk to an Acromag Ethernet module at its set address.

Connector: Dual, shielded RJ-45 sockets, 8-pin, 10BaseT/100BaseTX. Note: the metal shield of the network socket is isolated for safety reasons and capacitively coupled to the input power earth ground (EG) terminal via an isolation capacitor.
Wiring: Unit includes auto-crossover for MDI or MDI-X cables.
Data Rate: Auto-sensed, 10Mbps or 100Mbps.
Duplex: Auto-negotiated, Full or Half Duplex.
Compliance: IEEE 802.3, 802.3u, 802.3x.
Protocol: Modbus TCP/IP w/Web-Page Configuration, or Ethernet/IP, or Profinet.
Network-to-Network Isolation: The network port is isolated from the circuit and will withstand HIPOT voltages up to 1000VAC. Network ports are additionally isolated from each other and will withstand HIPOT voltages up to 1500Vrms or 250V.
IP Address: The NTE model default mode static IP address is set to 192.168.0.10.
Modbus Port: Up to 8 sockets supported, uses port 502 (reserved for Modbus).
Communication Distance: Between two devices on an Ethernet network is generally limited to 100 meters using recommended cable. Distance may be extended using hubs, switches, or fiber optic transmission. However, the total round-trip delay time must not exceed 512-bit times for collision detection to work properly.
Port Status Indicator: The yellow LED of the network connector indicates the Ethernet connection is busy and traffic is present.
IP Address: Can be preset (static) by the user via web page. At startup, it can be loaded from internal non-volatile memory, or it can be automatically acquired via a network server using DHCP (Dynamic Host Configuration Protocol).

Enclosure & Physical

All Models

General purpose plastic enclosure for mounting on 35mm “T-type” DIN rail.
Dimensions (NTX): Width = 25mm (1 inch), Length = 100mm (3.94 inches), Depth = 110mm (4.33 inches) for NTX modules and 132mm (5.20 inches) for NTE modules. Refer to Mechanical Dimensions drawing on page 5.
IO Connectors: Six 4-position removable plug-in type terminal blocks rated for 12A/250V; AWG #26-12, stranded or solid copper wire.
Case Material: Self-extinguishing polyamide, UL94 V-0 rated, color light gray. General purpose NEMA Type 1 enclosure.
Circuit Board: Military grade fire-retardant epoxy glass per IPC-4101/98.
DIN-Rail Mounting: Unit is normally mounted to 35x15mm, T-type DIN rails. Refer to the DIN Rail Mounting & Removal section for more details.
Shipping Weight: 0.5 pounds (0.22 Kg) packed.

Environmental

All Models

The minimum requirements of the applicable standard, but this product has typically been tested to comply with higher standards in some cases.

Operating Temperature: -40°C to +70°C (-40°F to +158°F). This data applies to the unit mounted upright on a DIN rail to allow free air flow into the bottom vent up through the unit and out the top vent (required for operation above 60˚C).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Installation Category: Pollution Degree 2 environment with an Installation Category (Over-voltage Category) II rating per IEC 1010-1 (1990).
Isolation: IO channels/field excitation (as a group), the NTE network ports (each port), and the NTE system power circuits are all isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). This complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.
Shock & Vibration Immunity: Conforms to IEC 60068-2-6: 10-500 Hz, 4G, 2 Hours/axis for sinusoidal vibration; IEC 60068-2-64: 10-500 Hz, 4G-rms, 2 Hours/axis for random vibration, and IEC 60068-2-27: 25G, 11ms half-sine, 18 shocks at 6 orientations, for mechanical shock.

Electromagnetic Compatibility (EMC)

Minimum Immunity per BS EN 61000-6-2:
1) Electrostatic Discharge Immunity (ESD), per IEC 61000-4-2.
2) Radiated Field Immunity (RFI), per IEC 61000-4-4.
3) Electrical Fast Transient Immunity (EFT), per IEC 61000-4-4.
4) Surge Immunity, per IEC 61000-4-5.
5) Conducted RF Immunity (CRFI), per IEC 61000-4-6.

This is a Class A Product with Emissions per BS EN 61000-6-4:
1) Enclosure Port, per CISPR 16.
2) Low Voltage AC Mains Port, per CISPR 16.
3) Telecom / Network Port, per CISPR 22.

WARNING: A Class A product in a domestic environment may cause radio interference in which the user may be required to take adequate measures to squelch. The use of low EMI double-shielded grounded Ethernet cable is also recommended to help curb emissions.

Agency Approvals

All Models

Electromagnetic Compatibility (EMC): CE marked, per EMC Directive 2004/108/EC. Consult factory.

Safety Approvals (pending): UL Listed (USA & Canada). Hazardous Locations – Class I, Division 2, Groups A, B, C, D Hazardous Location or Nonhazardous Locations only. These devices are open-type devices that are to be installed in an enclosure suitable for the environment. Consult Factory.

ATEX Certified (pending): NT Modules are ATEX Certified for Explosive Atmospheres per ATEX Directive 94/9/EC which complies with standards BS EN 60079-0:2012 & BS EN 60079-15:2010.

Ex II 3 G Ex nA IIC T4 Gc -40ºC ≤ Ta ≤ +60ºC

DEMKO 15 ATEX 1561X

X = Special Conditions

1) The equipment shall only be used in an area of not more than pollution degree 2, as defined in EN 60664-1.
2) The equipment shall be installed in an enclosure that provides a degree of protection not less than IP 54 and only accessible with the use of a tool in accordance with EN 60079-15.
3) Transient protection shall be provided that is set at a level not exceeding 140 % of the peak rated voltage value at the supply terminals to the equipment.

Reliability (MTBF)

NTX models are channel IO expansion only.

NTE models are channel IO combined with a network CPU.

[1]FIT is Failures in 10^9 Hours.

Shaded Models are Coming Soon.

Reliability Prediction - MTBF (Mean Time Between Failure): MTBF in hours using MIL-HDBK-217F, FN2. *Per MIL-HDBK-217, Ground Benign, Controlled, G_BG_C.*

Model	Temp	MTBF (Hrs)	MTBF (Yrs)	Failure Rate (FIT)
NTX2111	**25°C**	3,807,522	434.6	262.6
16CH DIO SNK	**40°C**	2,522,068	287.9	396.5
NTE2111	**25°C**	1,111,753	126.9	899.5
	40°C	731,356	83.5	1,367.3
NTX2211	**25°C**	2,570,919	293.5	389.0
8CH DIFF+2DIO	**40°C**	1,522,017	173.7	657.0
NTE2211	**25°C**	974,841	111.3	1,025.8
	40°C	614,309	70.1	1627.8
NTX2221	**25°C**	1,976,214	225.6	506.0
16CH SE I-INP	**40°C**	1,214,841	138.7	823.2
NTE2221	**25°C**	874,998	99.9	1,142.9
	40°C	557.421	63.6	1,794.0
NTX2121	**25°C**	2,284,774	260.8	437.7
16CH DIO SRC	**40°C**	1,335,602	152.5	748.7
NTE2121	**25°C**	930,646	106.2	1,074.5
	40°C	581,548	66.4	1,719.5
NTX2131	**25°C**	2,295,257	262.0	435.7
6CH MR+6DI	**40°C**	1,536,785	175.4	650.7
NTE2131	**25°C**	932,381	106.4	1,072.5
	40°C	616,701	70.4	1,621.5
NTX2611	**25°C**	2,651,718	302.7	377.1
8CH mV/TC+2DIO	**40°C**	1,559,143	178.0	641.4
NTE2611	**25°C**	986,236	112.6	1,014.0
	40°C	620,270	70.8	1,612.2
NTX2241	***25°C***	*1,943,049*	*2121.8*	*514.7*
16CH SE VIN	***40°C***	*1,188,874*	*135.7*	*841.1*
NTE2241	***25°C***	*868,435*	*99.1*	*1,151.5*
	40°C	*551,890*	*63.0*	*1,812.0*
NTX2621	***25°C***	*2,626,713*	*299.9*	*380.7*
4CH RTD+2DIO	***40°C***	*1,546,193*	*176.5*	*646.8*
NTE2621	***25°C***	*982,757*	*112.2*	*1,017.5*
	40°C	*618,210*	*70.6*	*1,617.6*
NTX2311	***25°C***	*3,360,113*	*383.6*	*297.6*
8CH I-OUT	***40°C***	*2,069,305*	*236.2*	*483.3*
NTE2311	***25°C***	*1,070,147*	*122.2*	*934.5*
	40°C	*687,721*	*78.5*	*1,454.1*
NTX2321	***25°C***	*2,909,209*	*332.1*	*343.7*
8CH V-OUT	***40°C***	*1,690,637*	*193.0*	*591.5*
NTE2321	***25°C***	*1,019,807*	*116.4*	*980.6*
	40°C	*640,075*	*73.1*	*1,562.3*
NTX25x1	***25°C***	*2,448,946*	*279.6*	*408.3*
4AI+6DIO+2AO	***40°C***	*1,412,214*	*161.2*	*708.1*
NTE25x1	***25°C***	*956,772*	*109.2*	*1,045.2*
	40°C	*595,617*	*68.0*	*1,678.9*

Configuration Controls

All Models

Software Configuration of any NT system is via a web-browser Ethernet connection to its associated NTE Model (System NTE model includes the system CPU)
NTE system modules operates over Ethernet and can be conveniently setup and configured via a common web-browser (NTX expansion models are setup through their corresponding NTE model). Channel IO can also be setup and configured via its requisite application protocol (Modbus TCP/IP, Ethernet/IP, or Profinet). For Modbus TCP/IP, the behavior of this 16-channel digital IO module can also be determined via internal Modbus program registers accessible with an Ethernet connection to a mated NTE model (refer to IO model User Manual for Modbus register definitions). The NTE web interface provides a framework for digital control of all channel configuration parameters and this information is stored in non-volatile memory in the module. Network communication parameters can only be set using a web-browser over Ethernet.

LED Indicators (NTE Model):
RUN (1 Green) – Located at front panel. Constant ON if power is on and unit is OK.
CH (2, 4, 6 or 16 Yellow) – Located at front panel. ON if corresponding sinking/sourcing digital output channel is ON or its tandem input is Low for this model.
ST (1 Orange) – Located at front panel. ON if i2o target stopped communicating. LED will flash if IO Bus failure is detected. OFF indicated normal operation.
SYS (1 Yellow/Green): Located at front panel. Blinks when switching protocols or updating firmware. LED will turn OFF when complete.
COM0 Modbus (2 Green/Red) – Located at front panel. Constant ON Green if running. Rapid Green blink when no client connected. ON Red if Error occurred.
COM0 Ethernet/IP (2 Green/Red) – Located at front panel. Constant ON Green if Module Status is OK. ON Red if error occurred.
COM0 ProfiNet (2 Green/Red) – Located at front panel. Constant ON Red if System Failure occurred.
COM1 Modbus (2 Green/Red) – Located at front panel. Constant ON Green if running. Rapid Green blink when no client connected. ON Red if Error occurred.
COM0 Ethernet/IP (2 Green/Red) – Located at front panel. Constant ON Green if network status OK. Constant ON Red is Network error occurred.
COM1 ProfiNet (2 Green/Red) – Located at front panel. Constant ON Red if Bus Failure occurred.

I/O Specifications

Digital Inputs - Active Low

Applicable NT Models – 2111, 2211, 2231, 2611, 2621.

These models have 2, 4, or 16 discrete input channels with tandem open-drain outputs (turn output OFF if using input to monitor field voltage levels).

You must connect an excitation supply for output operation and to pull-up the active low inputs (excitation is connected between TX6 EX+ and any RTN terminal).

These models include discrete buffered active-low 0-32VDC inputs that sink to return (RTN) and use TTL logic thresholds. These inputs are typically tied in tandem with open-drain outputs and can read back the output ON/OFF states. If the tandem output is kept off, the corresponding input may be used to monitor field voltage levels up to 32VDC. Inputs are pulled-up to EX+ via 10KΩ pull-up resistors at each channel and diode clamp input over-voltages through 100KΩ to their internal +3.3V supply rail to safely sense OFF state input levels up to 32V.

Input Signal Voltage Range: 0 to +32VDC, asserted low below 0.8V.
Input Current: 280uA at 32VDC, computed as the max applied input voltage minus 4V (diode-clamped to 3.3V rail) and divided by the series 200KΩ input resistance.
Input Threshold: TTL with Low-to-High 1.7VDC, High-to-Low 1.6VDC, typical and 0.8VDC Max LOW level, 2.0VDC Min HIGH level logic limits.
Input Transient Voltage Suppressor: Each channel, bipolar up to 38VDC with breakdown at 47V and over-clamping at 77V.
Input Resistance: Series 200KΩ on input after 10KΩ output pullup to EXC.
Input Hysteresis: 100mVDC between L-H and H-L input thresholds, typical.
Input Response Time: 10ms typical, not including network time (actual input response time will vary with network traffic and interrupts).
Input Pull-Ups (Internal): Channels include 10KΩ pullups to EX+ to pull the tandem open drain output and input high or OFF. The installed resistor at each channel is one element of a two or four isolated SIP resistor network (4/8 pins) and rated to 0.3W per element up to 70°C (refer to Bourns 4308M-102-103LF parts). If your application requires a stronger pull-up (lower resistance), you will have to wire it externally in parallel with the internal 10K pull provided. Consider your excitation voltage level and choose a combined pull-up resistance such that you never exceed 250mA of drain current per output ON.
Excitation (per IO Module): This model requires additional field excitation for digital output operation and to pull-up the active-low inputs. An external voltage of 4-32V is required between the IO EX+ (TX6-1) and any RTN terminal (TX3-3,4 or TX5-3,4) at every IO module. Excitation must be able to source 52mA minimum (at 32V). Inputs cannot properly register the output OFF state if their excitation is left floating. Also, each IO channel is pulled-up to the EX+ rail voltage (minus a diode drop) with a 10KΩ resistor. Without excitation connected, one output could pull on adjacent channels via this common connection. Thus, you should not operate IO without connecting excitation. The EX+ terminal is tied in common to one end of each channel pull-up resistor (internally the even-numbered pins of a four-element resistor SIP installed for each group of 4 consecutive channels). The excitation path is reverse voltage protected. For 16 channels at maximum rated load of 250mA, your excitation supply must be able to source 4A. The outputs of this model sink load current to return from excitation through the load when turned ON (you cannot operate outputs of this model without field excitation).
Input Update/Conversion Rate: Fresh Input data is available to the network every 10mS depending on filter level. Raising the number of samples for averaging could increase this time.
Response Time from an Ethernet command: Less than 5mS, typical.
Input Cable Length: IO port interface cables should not exceed 30m in length for rated performance.

Digital Outputs-Sinking

Applicable NT Models – 2111, 2211, 2231, 2611, 2621, 2511

These models have 2, 4, or 16 discrete output channels tied in tandem with active-low inputs which read-back the output states.

Outputs are smart open-drain (low-side) N-channel mosfets that switch the load to ground (return) and include 10K pull-up resistors to EXC.

You must connect an excitation supply for output operation and to pull-up the active low inputs (excitation is connected between TX6 EX+ and any RTN terminal).

These models include smart open-drain, n-channel mosfets with a common source connection to return (RTN) provide low-side or sinking switch action between load and return for DC voltage/current-sinking applications only. Outputs are typically tied in tandem with active-low discrete inputs which provide loopback monitoring of the output state. Channels are pulled up to the IO excitation voltage with 10KΩ resistors. External excitation is required for output operation and to pull the output to the OFF state.

Output "OFF" Voltage Range: 0 to 32V DC (limit voltage < 36Vpk, or damage to the unit may result). Use protection when switching inductive loads, such as placing a reverse shunt diode across the inductive load to shunt the high reverse emf that develops when switching the load OFF.
Output "ON" Current Range: 0 to 250mA DC (up to 4A total for all 16 channels combined with no deration required). Group one return (RTN) to every 4 outputs.
Output R_{ds} ON Resistance: 0.8Ω typical, 1.6Ω Maximum.
Over-Temperature Protection w/Thermal Shutdown: An output may shut down and latch off for thermal overload conditions that may drive the junction temperature into the region from 150°-200°C to prevent destruction. In the rare case of shut down, the IO pin is pulled up and the output must be recycled OFF/ON to reset the output (assuming device has cooled below 150°C).
Overvoltage Shutdown: Active during load dump or inductive load turn-off conditions and will cause the output to shut off if its drain-to-source voltage exceeds 36V. The switch can be turned on again by toggling it OFF/ON after this fault.
Over-Load Protection: The device will switch off to prevent destruction if the switch drain-to-source current exceeds 0.75A. It can be turned on again by toggling the output OFF/ON after this fault condition.
Output Response Time: 10ms typical, not including network time. The actual switch time will vary with network traffic, interrupts, and output load.
Reverse Polarity Protection: An integrated reverse-bias diode in output will shunt reverse current through it, but the reverse current must be limited by the load to prevent damage via excess power dissipation. Note that over-temperature and over-load fault protection are not active for reverse polarity current.
Output "OFF" Leakage Current: 0.1uA typical, 50uA maximum (mosfet only, 25°C, 32V). Does not include the input bias current for the tandem digital input.
Note: The 200KΩ series input buffer resistors and diode clamps to +3.3V will tend to increase the off-state current with increasing voltage (up to 0.28mA at 32V) as this input buffer circuitry connects in tandem to the output mosfet open-drain.
Output Excitation: These outputs switch the low side of their load to return. You must connect 4-32V of excitation for output operation and to pull-up the tandem active low inputs (excitation is normally connected between the EX+ and any RTN terminals—see Connection Diagram for location on your model). It is recommended that output excitation be kept separate from system power to avoid interference with operation. Select excitation with a capacity at least twice the load.
Output Driver for Greater Load Capability: To control higher voltages and/or currents, or for controlling AC, an interposing relay may be used (see Note). **Note:** Per UL, when the outputs are used to control interposing relays for switching AC and DC devices of higher voltage/current, the coil ratings for the interposing relay shall not exceed 24VDC, 100mA.

Digital Inputs – Active High

***Applicable NT Models** – 2121 (16x), 2131 (6x), 2511 (4X), & 2531 (4x).*

Active-high digital inputs are pulled down to Return (RTN), use TTL thresholds, and are wired to monitor their tandem high-side mosfet switch, or to monitor field input levels with the tandem output turned OFF.

These models contain 4, 6, or 16 active-high buffered DC inputs that utilize TTL logic thresholds with each pulled low to a common return connection (RTN). These inputs are tied in tandem to output source leads in order to accomplish loopback monitoring of the output state, or if the tandem output is turned OFF, the corresponding input may be used to monitor voltage levels from the field (TTL active high from 0-32V). Inputs include transient suppression plus 10KΩ pull-down resistors to Return and series connected 200KΩ resistors with diode over-voltage clamps to an internal +3.3V supply rail allowing high voltage input to 32V. External excitation is required for proper output operation and is connected between the EX+ (at TB6) and any channel return RTN (except model NT2131, which only includes inputs pulled low and does not need excitation for input-only operation).

Input Signal Voltage Range: 0 to +32VDC, asserted high above 2.0V.
Input Threshold: TTL with Low-to-High 1.7VDC, High-to-Low 1.6VDC, typical and 0.8VDC Max LOW level, 2.0VDC Min HIGH level logic limits.
Input Current: 280uA at 32VDC, computed as the max applied input voltage minus 4V (diode-clamped to 3.3V rail) and divided by the series 200KΩ input resistance.
Input Resistance: 10KΩ typical with each input pulled down to return with 10KΩ.
Input Hysteresis: 100mVDC between L-H and H-L input thresholds, typical.
Input Response Time: 10ms typical, not including network time. The actual input response time will vary with network traffic and interrupts.
Input Transient Voltage Suppressor: Installed at every IO point, up to 38V working, 47V breakdown, and 72V clamping.

Digital Outputs - Sourcing

***Applicable NT Models** – 2121 (16x), 2511(4x), and 2531(4x).*

These models have tandem input and output channels.

The outputs of these models have smart open-source mosfet switches with a common drain connection to excitation (EX+), allowing them to high-side switch the DC excitation voltage to the load (sourcing) and will drive rated current through the load to ground (return). Outputs are typically paired with tandem active-high inputs to provide true loopback monitoring of the output state. Individual IO channels are pulled down to Return (connected at the RTN terminal) with 10KΩ resistors and will never float. Minimum external excitation of 6V is required for tandem sourcing output operation and connected between EX+ (at TB6) and the RTN terminals (at TB3 or TB5, except for NT2131).

Output "ON" Voltage Range: Requires excitation at 6 to 32V DC. Limit voltage to less than 36V peak, or damage to the unit may result. Use protection when switching inductive loads (for example, a reverse shunt diode at the inductive load).
Active Current Limitation: The output limits load current to a shorted load at 0.6A typical, 0.4A-0.9A range (with EXC=13V and 0.01Ω load resistance). This limit works with a latched thermal shutdown to help protect the output channel from damage due to overload (it requires power cycling to reset latch).
Thermal Shutdown: Individual outputs will shut down and latch off for thermal overload conditions that drive the junction temperature into the region from 150° to 200°C. In this case, the IO pin is pulled low and the output must be recycled OFF/ON to reset the output.
Under-voltage Shutdown: Outputs will shut-down if their excitation voltage is less than 6.0V (triggered via 3V-6V threshold).
Overvoltage Shutdown: Outputs will shut down if their excitation voltage exceeds 36V minimum (requires power-cycling to reset).
Ground Loss Protection: The output automatically turns off if the ground/return lead is disconnected (RTN).

Digital Outputs – Sourcing…

Output "OFF" Leakage Current: 50uA maximum per channel (mosfet only). Does not include the input bias current for the tandem digital input (see Note below).
Note: The 200KΩ series input buffer resistors in combination with the +3.3V voltage diode clamps at the input buffer will tend to increase the off-state current with increasing output voltage (up to 3.5mA at 32V). This is a consequence of the input buffer circuitry being connected in tandem to the output mosfet source lead at every IO channel and the presence of a 10KΩ pull-down on the input.
Output "ON" Current Range: 0 to 250mA DC, continuous, up to 4.8A total for all 16 channels combined. No deration is required at elevated ambient. Group one return connection (RTN) for each group of 4 outputs.
Output R_{ds} ON Resistance: 0.5Ω typical at 0.25A and 25°C, 1.0Ω Maximum.
Output Response Time: 10ms typical. Does not include network time. The actual switch time will vary with network traffic, interrupts, and output load.
Output Excitation: These outputs switch the high side of a loads to excitation. You must connect 6-32V of excitation for output operation (excitation is connected between DEX+ and any RTN terminal). It is recommended that output excitation be kept separate from system power to avoid interference with operation. Select excitation with a capacity at least twice the load for potential inrush service.
Output Driver for Greater Load Capability: To control higher voltages and/or currents, or for controlling AC, an interposing relay may be used (see Note).
Note: Per UL, when the outputs are used to control interposing relays for switching AC and DC devices of higher voltage/current, the coil ratings for the interposing relay shall not exceed 24VDC, 100mA.

Input Event Counters

Applicable NT Model – 2111, 2121 2131.

Input Event Counters: Events are counted in 32-bit registers and optionally stored in non-volatile memory. Event counters are rated from 0-85 Hz. Additionally, the counters are equipped with programmable debounce (0-65535ms), output alarms, selectable count edge, and up/down counting.
Input Counter Debounce: Event counters can each be enabled to debounce an input for a specific amount of time. Debounce time can be set from 0 to 65535ms and applied to all counters with debounce enabled.
Input Counter Direction: Each event counter can set the count direction to either up counting (default), or down counting from a pre-load value.
Input Counter Edge: Each counter can be set to detect the incoming pulse on the rising edge or falling edge (default).
Input Counter Pre-Load Value: Each Input Counter has an associated Pre-Load Value to start counting from. After a roll-over / reset, the counter will default back to this value.
Counter Alarm Enable (Default=Disabled): Event counters are equipped with alarms that can toggle the alarm output state upon reaching the termination value of 0 or 4,294,967,295.
Count Termination Mode (Default=Rollover): The outputs can be programmed to either reset the alarm after the next count (Auto) or hold the alarm state until reset (Latch). **Note:** Once the count rolls over, it returns to the pre-load value.

Mechanical Relay Outputs

***Applicable NT Model** – 2131 with Six 1 FORM A (SPST-NO) mechanical relays rated to 30VDC/240VAC, 5A.*

To control higher voltages and/or currents, or for controlling AC, an interposing relay may be used (see Note).

This unit contains six isolated 1 FORM A electromechanical relay contacts (SPST-NO).

IMPORTANT: The NT IO Model 2131 requires higher current than other NT IO models and includes an input for additional excitation (any system with more than one NTE2131 plus one NTX2131).
Configuration: Six isolated 1 FORM A, Plastic Sealed RTIII w/Epoxy Resin.
Contact Rating: 5A, 250VAC or 30VDC.
Maximum Switching Voltage: 277VAC/125VDC.
Maximum Switching Power: 1250VA or 150W.
Minimum Switching Load: 1mA, 5VDC.
Resistance: 30 mΩ maximum at 6VDC and 1A.
Electrical Life -Mechanical $20x10^6$ Operations Minimum; $100x10^3$ Operations Minimum at 3A/250VAC or 3A/30VDC; $50x10^3$ Operations Minimum at 5A/250VAC or 3A/30VDC 5A, switching frequency 20x/minute. **Note:** External relay contact protection is required for use with inductive loads (see Relay Connection Drawing for a recommended Protection scheme). Failure to use adequate protection may reduce contact life or damage the unit.
Note: To control a higher amperage device, such as a pump, an interposing relay may be used (see Interposing Relay Connections Drawing).
Contact Material: Gold overlay **s**ilver alloy (Ag90 Ni10+Au).
Initial Dielectric Strength: Resistance 1000Mohms at 500VDC. Between open contacts: 7509VAC 50/60Hz, 1 minute. Between Contacts and coil: 3000VAC 50/60Hz, 1 minute.
Relay Response (No Relay Time Delay): Relay contacts will energize bounce-free within 10ms and release bounce-free within 5ms (does not include network time).

Differential I/V Input

***Applicable NT Models** – Eight differential channels for current (2211), or voltage (2231) at TB4, TB5, TB1, and TB2, or Four differential channels for current (2511), or voltage (2531) at TB4 and TB5.*

These models differentially multiplex eight or four input channels of DC current (NT2211 or NT2511), or DC voltage (NT2231 or NT2531), to a 24-bit ΣΔ ADC through unity-gain differential buffers (only 16-bits are used). The NT models ADC has a full-scale bipolar input range of ±2.048V (NT22x1) inside a ±2.5V process window, or +/-1.25V (NT25x1) inside a ±1.8V process window representing ±32768 for 16-bit signed integer counts. All current inputs use precision 24.9Ω shunt resistors to convert differential input current to voltage, such that ±20mA will drive ±0.498V full-scale to the A/D. Voltage inputs drive the A/D through resistor-dividers on each lead (0.17763x factor for NT2231, 0.1108x factor for NT2531). All inputs include transient voltage suppression. Positive current or voltage is delivered to the (+) input terminal and returned on the negative (-) input terminal.

The unit must be wired and configured for the intended input type and range (see Connections section for details). The following paragraphs summarize this model's input types, ranges, and applicable specifications:

Reference Test Conditions: ±20mA (NT2211) or ±5V (NT2231) input; ambient temperature = 25°C; 24VDC supply.
Input Units: Nominal current/voltage ranges are normalized to ±30000 for ±100% of range (or to ±20000 for ±100% of range with legacy support enabled). Unipolar ranges normalize to 0-30000 for 0-100% (or 0-20000 for 0-100% with legacy support enabled).
Input Transient Voltage Protection: Utilizes bipolar TVS diodes with 18V typical clamping, plus series resistance through diode clamps to the 3.3V rail.

Differential I/V Input…

***Applicable NT Models** – Eight differential channels for current (2211), or voltage (2231) at TB4, TB5, TB1, and TB2, or Four differential channels for current (2511), or voltage (2531) at TB4 and TB5.*

DC Input Voltage Range (NT2231 & NT2531): These NT models use balanced resistor dividers at every voltage input that automatically reference the potential to COM (divider factor is 0.17763x for NT2231, and 0.1108x for NT2531). The divided differential node voltage is then unity-gain buffered before connecting to the ADC. The ADC of NT2231 uses a ±2.5V process window corresponding to ±14V at the module input before the divider. For the NT2531, a ±1.8V ADC process window is used which corresponds to ±16V at the module input. NT2531 DC input voltage is digitally converted via the expression 32768*Vin*0.17763/2.048 + 32767, while NT2531 uses 32768*Vin*0.17763/1.25 + 32767. For differential voltage, each input node is first converted relative to ADC COM and then subtracted to get the relative difference. NT2231 differential voltages up to +/-11.5V wrt COM (±32768) can be converted between node voltages that vary within a ±14V process window (based on a 0.17763 divider, a ±2.048V full-scale ADC signal operating in a ±2.5V process window after the divider). NT2531 differential voltages up to +/-11.3V wrt COM (±32768) can be converted between node voltages residing within a ±16V process window (for 0.1108 divider, ±1.25V full-scale ADC signal, and a ±1.8V process window after the divider). For NT2531 differential voltage input up to +/-11.2V wrt COM (±32768) can be converted with node voltages within a ±16V process window (based on a ±1.25V full-scale ADC signal in a ±1.8V process window after the divider).
DC Current Range: NT2211 and NT2511 models utilize 24.9Ω shunt resistors to convert input current to differential voltage supporting nominal DC current ranges ±20mA (±0.498V), 0-20mA (0-0.498V), 4-20mA (0.0996 to 0.498V), 10-50mA (0.249-1.245V), and 0-50mA (0-1.245V) through unity-gain differential buffers. The NT2211 converts this voltage based on a ±2.048V full-scale ADC signal inside a ±2.5V process window while the NT2511 utilizes a ±1.25V full-scale ADC signal inside a ±1.8V process window and does not support 10-50mA/0-50mA ranges. The input current (I) is digitally converted by the ADC via the modified expression 32768*I*24.9*/Vref + 32767. The NT2211 current input nodes will float relative to the ADC return unless you also wire an input node to COM or establish a series channel relationship to an adjacent channel that connects one node to COM. For example, you may connect two to five inputs in series to the same current source at 20mA as the NT2211 inputs are buffered inside a ±2.5V process window. The NT2531 inputs are different in that they automatically reference to COM and do not float relative to the ADC return and do not need a third wire connection to COM. For the NT2511, you may connect two to three inputs in series to the same current source at 20mA as these ADC inputs use a ±1.8V process window.
Input Resolution: The effective resolution of the input signal will be limited to the lowest resolution of either the ADC converter or the Normalization applied. The ADC count is calculated via the expression ADC=32768*Vin*DIV/Vref + 32767 (DIV/Vref = 1/2.048 for NT2211/NT2511, 0.177630/2.048 for NT2231, and 0.1108/1.25 for NT2531). For simplification, outputs are normalized such that ±30000=±100% (bipolar), 0-30000=0-100% (unipolar), or ±20000=±100% (bipolar), 0-20000=0-100% (unipolar) with Legacy Support enabled (bold resolution of table is the effective resolution of the input range). Resolution is illustrated in the following table:

Differential I/V Input…

***Applicable NT Models** – Eight differential channels for current or voltage at TB4, TB5, TB1, and TB2 (NT22x1), or Four differential channels for current or voltage at TB4 and TB5 (NT25x1).*

CURRENT RANGES	NT2211 Raw ADC	NT2511 Raw ADC	Normalized 30K	Normalized 20K
±20mA	**1/15936**	**1/26110**	1/60000	1/40000
0-20mA	**1/7968**	**1/13055**	1/30000	1/20000
4-20mA	**1/6374**	**1/10444**	1/23398	1/15598
0-50mA	**1/19920**	*NA*	---	---
10-50mA	**1/15536**	*NA*	---	---
0-11.17mA	**1/4450**	**1/11392**	1/30000	1/20000
VOLTAGE RANGES	**NT2231 Raw ADC**	**NT2531 Raw ADC**	**Normalized 30K**	**Normalized 20K**
±10V	**1/56842**	1/58118	1/60000	**1/40000**
0-10V	1/28421	1/29059	1/30000	**1/20000**
±5V	**1/28421**	1/58118	1/60000	**1/40000**
0-5V	**1/14210**	1/29059	1/30000	**1/20000**
1V	**1/5684**	1/46494	1/60000	**1/40000**
0-1V	**1/2842**	1/23247	1/30000	**1/20000**

Sampling Rate (A/D): Inputs are sampled at a variable rate according to the input filter selection as follows:

A/D SAMPLING RATE (SAMPLES/SECOND) PER INPUT FILTER			
NONE	**LOW**	**MED**	**HIGH**
1007sps	100.5sps	27.27sps	16.67sps

Input Filter: Normal mode RC filtering, plus digital filtering, optimized and fixed per filter selection within the Σ-Δ ADC. See Normal Mode Noise Rejection and Output Response Time.

Input Zero and Full-Scale Adjustment: Input range endpoints are selectable over the full range indicated in Table 1 for each input type. Input Zero and Full-Scale selections must be within the nominal ranges indicated and will be mapped to the output zero and full-scale (100%) current or voltage endpoints, according to output range selected. Keep in mind that your input resolution is reduced as your scaled input range is reduced. Likewise, error in degrees is magnified as the input span is reduced. Rated performance is based on a 10mV minimum input span.

Noise Rejection (Normal Mode): Varies with input filter selection. Table below indicates the typical rejection at 60Hz for each input filter selection. Note that at the medium and high input filter settings, the A/D converter adds 47dB minimum of rejection for frequencies around 60Hz.

	TYPICAL 60Hz REJECTION PER INPUT FILTER			
INPUT	**NONE**	**LOW**	**MED**	**HIGH**
V/mA	xxdB	xxdB	> 47dB	> 92dB

Analog Input – Diff TC/mV

***Applicable NT Model** - 2611.*

Eight Differential mV/TC channels at TB4, TB5, TB1, and TB2.

The NT2611 model has eight differential thermocouple channels and can be optionally factory calibrated to your own specifications which is a service ordered as a separate line item at time of purchase on a per unit basis. Factory calibration will require the specification of input type/range (J, K, T, R, S, E, B, N, ±100mVDC, or ±500mV), input filtering, upscale or downscale break, CJC On or OFF (consult with factory).

A standard model without adding custom factory calibration is calibrated by default to input TC Type J, -210°C to +760°C, low filter (25ms), CJC ON, and downscale break detection.

Table 1: Range/Accuracy		**Wire Color**	**°C Temp Range**	**Typical[1]**
T/C	**T/C Material**	**ISA/ANSI**		**Accuracy**
J	+Iron, -Constantan	White/Red	-210 to +760°C	±0.5°C
K	+Chromel, -Alumel	Yellow/Black	-200 to +1372°C	±0.5°C
T	+Copper, -Constantan	Blue/Red	-260 to +400°C	±0.5°C
R	+Pt/13%Rh, -Constantan	Black/Red	-50 to +1768°C	±1.0°C
S	+Pt/10%Rh, -Constantan	Black/Red	-50 to +1768°C	±1.0°C
E	+Chromel, -Constantan	Purple/Red	-200 to +1000°C	±0.5°C
B	+Pt/10%Rh, -Pt/6%Rh	Gray/Red	+260 to 1820°C	±1.0°C
N	+Nicrosil, -NISIL	Orange/Red	-230 to -170°C; -170 to +1300°C	±1.0°C ±0.5°C
mV	NA	NA	±100/±500mV	±0.05% Typ ±0.1% Max

[1]**Note (Table 1):** Accuracy is generally ±0.1% of the full-scale span, typical, or per the table 1 specification, whichever is greater.

[2]**Note (Table 1): Accuracy in Table 1 is given with CJC switched off.** CJC uncertainty should be combined with the uncertainty numbers of Table 1 to determine a potential overall inaccuracy. Relative inaccuracy with CJC enabled may increase by as much as ±1.0°C during the power-ON warm-up period and will typically be ±0.5°C after nearing thermal equilibrium in about five minutes.

Analog Input – Diff TC/mV…

Reference Test Conditions: TC Type J with a 10mV minimum span (e.g. Type J with 200°C span), or ±100mV range with a 10mV minimum calibrated span; Medium filtering, Ambient = 25°C; Power Supply = 24VDC.

Input & Accuracy: Configurable for native input types/ranges shown in Table 1 below. Unit provides T/C linearization, T/C Cold-Junction Compensation (CJC), and lead break detection.

Break Detection: Can be set for Upscale or Downscale open sensor or lead break detection. Module checks for a lead break every 10 seconds.

Input Linearization (T/C Inputs): Within ±0.25°C of the NIST tables.

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 5.6V clamp level typical. Also includes differential input diode clamping, capacitive filtering, and series resistance.

Analog to Digital Converter (A/D): Input utilizes a 24-bit, Σ-Δ A/D converter, with only the first 16-bits used. Its signal is then normalized to a bipolar range count of ±30000 (or ±20000) to simplify IO scaling (see Input Resolution below).

Sampling Rate (A/D): Inputs are sampled at a variable rate according to the input filter selection as follows:

A/D SAMPLING RATE (SAMPLES/SECOND) PER INPUT FILTER					
NONE	**LOW**	**LOW**	**MED**	**MED**	**HIGH**
4800sps	320sps	80sps	60sps	50sps	10sps

Input Filter: Normal mode RC filtering, plus digital filtering, optimized and fixed per filter selection within the Σ-Δ ADC. See Normal Mode Noise Rejection and Output Response Time.

Input Zero and Full-Scale Adjustment: Input range endpoints are selectable over the full range indicated in Table 1 for each input type. Input Zero and Full-Scale selections must be within the nominal ranges indicated and will be mapped to the output zero and full-scale (100%) current or voltage endpoints, according to output range selected. Keep in mind that your input resolution is reduced as your scaled input range is reduced. Likewise, error in degrees is magnified as the input span is reduced. Rated performance is based on a 10mV minimum input span.

Input Burnout Current: 4uA typical every 10 seconds (TC break current).

Noise Rejection (Normal Mode): Varies with input filter selection. Table below indicates the typical rejection at 60Hz for each input filter selection. Note that at the medium and high input filter settings, the A/D converter adds 80dB minimum of rejection for frequencies around 60Hz.

	TYPICAL 60Hz REJECTION PER INPUT FILTER			
INPUT	**NONE**	**LOW**	**MED**	**HIGH**
TC/mV	xxdB	xxdB	> 82dB	> 120dB

Analog Input – Diff TC/mV…

Input Resolution: The 24-bit ADC divides the input range into a number of parts that can be calculated using an expression for the bipolar 16-bit signed integer ADC_count = (Vin*Gain/1.25)*32768 + 32767 (only 16-bits are used) with gain set to 1, 8, 16, or 32 per input type/range such that the maximum signal is ≤ 0.7V (see table). The ADC utilizes a 1.25V reference to convert ±1.25V to ±32768 full-scale. The resultant A/D count is then converted to equivalent thermoelectric temperature via a TC lookup table for temperature with 0.05°C resolution for TC inputs (For example, an input span of 200°C would yield a linearizer resolution of 200/0.05=4000 parts). The effective resolution of the input signal is normally limited to the lowest resolution of either the ADC converter, the TC type linearization table (uses 0.05C intervals), or the Normalization. An indication of relative ADC input resolution is expressed as the number of parts between the input range low and high endpoints as shown in the table below for the nominal range of each input type.

Input	Gain	Nominal Range °C (mV)	ADC Count, Resolution
±500mV	1	-500mV to +500mV	19660 to 45874, 1/26214
±100mV	4	-100mV to +100mV	22281 to 43253, 1/20972
TC-J	16	-210 to +760°C (-8.095mV to 42.919mV)	29372 to 50769, 1/21397
TC-K	8	-200 to +1372°C (-5.891mV to 54.886mV)	31532 to 44277, 1/12746
TC-T	32	-260 to +400°C (-6.232mV to 20.872mV)	27539 to 50276, 1/22736
TC-R	32	-50°C to +1768°C (-0.226mV to 21.101mV)	32577 to 50468, 1/17890
TC-S	32	-50°C to +1768°C (-0.236mV to 18.693mV)	32569 to 48448, 1/15879
TC-E	8	-200 to +1000°C (-8.825mV to 76.373mV)	30916 to 48784, 1/17867
TC-B	32	+260 to 1820°C (0.317mV to 13.820mV)	33033 to 44360, 1/11327
TC-N	8	-230 to +1300°C (-4.226mV to 47.513mV)	31872 to 42731, 1/10859

Note that the input is normalized such that ±30000=±100% (bipolar) or ±20000=±100% (bipolar) with Legacy Support enabled (the ADC dominates the resolution of the input before TC linearization to temperature).

RANGE	ADC	Normalized 30K	Normalized 20K
±500mV	1/26214	-30K to +30K, 1/60000	-20K to +20K, 1/40000
±100mV	1/20972	-30K to +30K, 1/60000	-20K to +20K, 1/40000
TC-J	1/21397	-5658 to +30K, 1/35658	-3772 to +20K, 1/23772
TC-K	1/12746	-3220 to +30K, 1/33220	-2147 to +20K, 1/22147
TC-T	1/22736	-8957 to +30K, 1/38957	-5972 to +20K, 1/25972
TC-R	1/17890	-321 to +30K, 1/30321	-214 to +20K, 1/20214
TC-S	1/15879	-379 to +30K, 1/30379	-253 to +20K, 1/20253
TC-E	1/17867	-3467 to +30K, 1/33467	-2311 to +20K, 1/22311
TC-B	1/11327	+688 to +30K, 1/29312	+459 to +20K, 1/19541
TC-N	1/10859	-2694 to +30K, 1/32694	-1796 to +20K, 1/21796

Analog Input – Diff TC/mV…

From the table, we see that the raw ADC resolution dominates, except that for TC input types, the "effective" input resolution is further limited by the 0.05C resolution of the internal lookup table for determining the temperature that corresponds to a determined thermoelectric mV (resolves TC to 0.05°C=1/20 increments). For all TC inputs, the resolution will be dominated by this 0.05°C resolution for the thermocouple linearizer.

Thermocouple CJC Reference: This model embeds one CJC reference at every thermocouple terminal (2 inputs/terminal w/4 sensors to 8 inputs). Table 2 below shows the relative accuracy of the CJC sensor itself. In this application, CJC has been factory calibrated at 25°C to ±0.1°C at room temperature. The accuracy of CJC in this application over the full operating range will be less than ±1.0°C.

Table 2: CJC[1] Sensor Accuracy

CJC Range	Sensor	Compensation
-20°C to +50°C	±0.25°C	±1°C
-40 to 85°C	±0.5°C	±1°C

[1]**Note:** Cold Junction Compensation may be switched off to permit the direct connection of millivolts via copper wires to the input to simplify calibration. Otherwise, a hand-held calibrator may be used. For best results, allow the module to reach thermal equilibrium and warm up for 5-10 minutes prior to calibrating CJC. Also, position the module as it will be in its final application. The input is normally calibrated with CJC OFF, and CJC calibration is done separately.

Analog to Digital Converter (A/D): Input utilizes a 24-bit, Σ-Δ A/D converter, with only the first 16-bits used. Its signal is then normalized to a bipolar range count of 0-30000 (or 20000 with legacy support) to simplify scaling (see Resolution).

Analog Input – SE I/V

Applicable NT Models – 2221 and 2241.

Sixteen single-ended inputs for DC current (NT2221) or DC voltage (NT2241).

All input ranges are supported using 16-bit bipolar conversion (±32768) based on a nominal ADC input range of ±1.25V. NT 2241 voltage inputs are first resistor-divided (10.5K/97.1K) to reduce up to ±11.56V to ±1.25V at the ADC input (divider factor is 0.1081x). The NT 2241 input supports fixed DC voltage ranges of ±1V, ±5V, ±10V, 0-1V, 0-5V, or 0-10V, on a per channel basis. The NT2221 current inputs are shunted through 49.9Ω resistors to a common return and will support current ranges of ±20mA, 0-20mA, 0-11.17mA, and 4-20mA. Thus, ±20mA DC drives ±0.998V full-scale to the ADC. All selectable input ranges are normalized to ±30000 for ±100% of range, or optionally to ±20000 for ±100% of range (w/ legacy support). The polarity convention is that positive current or voltage delivered to the (+) input terminal and returned at the common return (RTN) terminal.

DC Current (NT2221 Only): Supports ±20mA, 0-20mA, 4-20mA, and 0-11.17mA DC nominal input ranges. Utilizes a precision 49.9Ω (0.125W) sink resistor to convert input current to voltage processed by the A/D converter. NT2221 units utilize the ±1.25V A/D range with ±20mA DC driving ±0.998V full-scale to the A/D. An optional external sensor is required to monitor AC current signals (Acromag Model 5020-350). The AC sensor drives 0 to 11.17mA DC to the module (see Table 1 below for scaling to AC current).

DC Voltage (NT2241 Only): Bipolar DC voltage ranges of ±10V, 0-10V, ±5V, and 0-5V are driven to the A/D through resistive dividers (0.1081x factor) and unity-gain buffers. The A/D has a native 16-bit nominal bipolar range of ±1.25V. You may select DC input voltage ranges of ±5V, ±10V, ±1V, 0-1V, 0-5V, or 0-10V, on a per channel basis.

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 5.5V clamp level typical (NT2221), or 18V clamp level typical (NT2241). Inputs also include triple diode over-voltage clamps.

Reference Test Conditions: ±20mA (NT2221) or ±5V (NT2241) input; ambient temperature = 25°C; 24VDC supply.

Optional AC Current Sensor (Model 5020-350, for AC Current Input to NT2221): The 5020-350 sensor can be connected to any of the current input terminals of this model for AC current sensing and is a toroidal instrument transformer that converts the sinusoidal 50-60Hz AC current signal into a low-level DC milliampere signal of 0 to 11.17mA. The input AC current range is a function of the number of turns placed through the toroid as shown in Table 2 below. This sensor is isolated and requires no calibration or adjustment. When used with the NT2221 module, it also facilitates current input isolation channel-to-channel, and redundant current input isolation with respect to the network and power of this transmitter.

The output wires of this sensor are polarized with red as plus (+) and black as minus (-). Normally these output wires are attached to one end of a user supplied cable, while the other end connects to the current input terminals of this module similar to that shown below.

Analog Input – SE I/V Input…

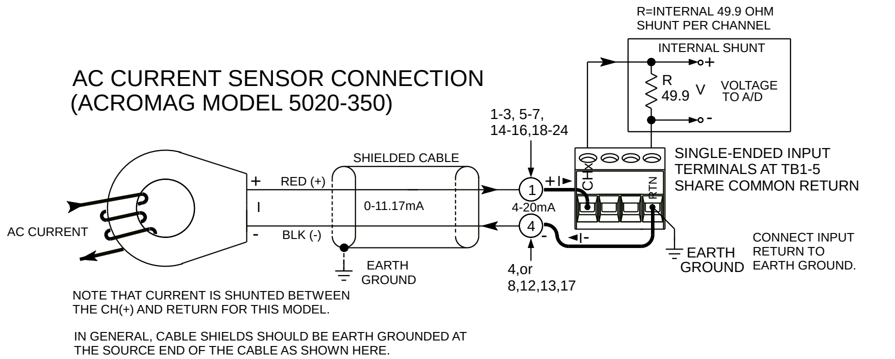


Table 2: Optional 5020-350 AC Current Sensor Turns & Range

AC Current Input Range	Primary Turns	Sensor Output (Red/Black Wires)
0 to 20A AC	1	0 to 11.17mA DC
0 to 10A AC	2	"
0 to 5A AC	4	"
0 to 2A AC	10	"
0 to 1A AC	20	"

AC Input Burden: A function of the wire gauge resistance used for primary turns (the current carrying wire being monitored).

AC Current Sensor to Transmitter Wiring Distance: 400 feet maximum for 18 AGW wire. Other wire gauges may be used if the resistance of both wires is less than 5Ω.

AC Input Overload: The AC current sensor will withstand overload conditions as follows:

- 20 times full scale for 0.01 seconds.
- 10 times full scale for 0.1 seconds.
- 5 times full scale for 1.0 second.

Input Analog to Digital Converter (A/D): A 24-bit delta-sigma converter, connected in bipolar mode with 16-bits used and a 1.25V reference, yielding a 16-bit A/D input range of ±1.25V corresponding to a count of ±32768

Analog Input – SE I/V Input…

Input Accuracy: Better than ±0.05% of span typical, ±0.1% maximum. This includes the effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.

Input Measurement Temperature Drift: Better than ±50ppm/°C (±0.0050%/°C).

Input Update/Conversion Rate: Your response time will vary as averaging is increased. The fastest response time with no averaging (averaging set to 1) is less than 1ms typical for both models.

Input Resolution (Minimum Discernible Change): Unit has a fundamental 16-bit ADC input range of ±1.25V after its input divider. The ADC of this model will divide the input signal range into a number of parts that can be calculated by subtraction using the expression for ADC counts as (Vin_eff/1.25)*32768+32767 for its bipolar ±1.25V A/D full-scale input range with 16 bit corresponding to ±32768 counts. Vin_eff is the effective DC input voltage of this model after the input voltage divider (0.1081x on NT2241 voltage units), or the current input shunted through 49.9Ω on NT2221 models (0.998V @20mA into 49.9Ω for NT2241 Models). The resultant raw A/D count is then normalized using a bipolar conversion scheme of ±30000 (bipolar ranges), or ±20000 (bipolar ranges w/legacy support), each corresponding to ±100% of input range. That is, -100%, 0% and +100% are represented by decimal values –30000, 0, and 30000, respectively, or -20000, 0, 20000 respectively (w/legacy support). The effective input resolution for a given range is the lowest resolution of either the A/D conversion, or its normalized value as shown in the table below.

RANGE	Raw ADC	Normalized 30K	Normalized 20K
±20mA	1/52324	1/60000	**1/40000**
0-20mA	1/26162	1/30000	**1/20000**
4-20mA	1/20930	1/24000	**1/16000**
0-11.17mA	**1/14612**	1/30000	1/20000
±10V	1/63570	1/60000	**1/40000**
0-10V	1/31785	1/30000	**1/20000**
±5V	**1/31782**	1/60000	1/40000
0-5V	**1/15891**	1/30000	1/20000
±1V	**1/6360**	1/60000	1/40000
0-1V	**1/3180**	1/30000	1/20000

[1] NT2221 current inputs use a 49.9Ω shunt resistor to drive ±0.998V at ±20mA to a 16-bit ±1.25V input A/D. NT2241 voltage ranges are coupled to the A/D after a 10.5K/97.1K resistive voltage divider (0.1081x). All input ranges are normalized to ±30000 for ±100%, and 0-30000 for 0-100% (or ±20000 for ±100%, and 0-20000 for 0-100% with legacy support enabled).

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 5.6V clamp level typical (NT2221), or 18V clamp level typical (NT2241). Inputs also include current-limited (series resistance) diode clamps to the +3.3V rail.

Input Impedance: 97.1KΩ minimum (NT2241 input divider), or 49.9Ω (NT2221 shunt resistor).

Input Calibration: Inputs can be calibrated manually by driving the input channel with a precision reference current or voltage signal source.

Input Filter: Normal mode filtering fixed per input type.

Input Filter Bandwidth: -3dB at 7.5Hz, typical, no averaging (2241).

Input Noise Rejection (Common Mode): Better than -110dB @ 60Hz, typical with 100Ω input unbalance.

About Modbus TCP/IP

Modbus TCP/IP is one of three application protocols supported by this model. Its application protocol offers another way to configure and control channel data besides a web-browser. This is only available via connection to its associated NTE model (either mated or bussed).

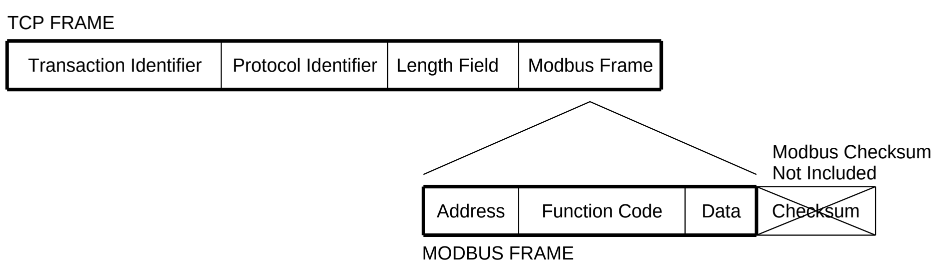
This module may support up to three Ethernet application protocols: Modbus TCP/IP, Ethernet/IP, or Profinet. With Modbus, TCP/IP refers to Transmission Control Protocol and Internet Protocol. TCP/IP allows blocks of binary data to be EXChanged between computers. TCP/IP is used world-wide and is the foundation for the World Wide Web. The primary function of TCP is to ensure that all packets of data are received correctly, while IP makes sure that messages are correctly addressed and routed. Note that the TCP/IP combination does not define what the data means or how the data is to be interpreted, it is merely a *transport protocol*. Modbus operates on the actual data for this model.

You can find more information on Modbus TCP/IP by visiting our web site and downloading whitepaper 8500-765, Introduction to Modbus TCP/IP.

Modbus is an *application protocol*. It defines rules for organizing and interpreting data and is essentially a messaging structure that is independent of the underlying physical layer. It is freely available and accessible to anyone, easy to understand, and widely supported by many manufacturers.

Modbus TCP/IP uses TCP/IP and Ethernet to carry the data of the Modbus message structure between devices. That is, Modbus TCP/IP combines a physical network (Ethernet), with a networking standard (TCP/IP), and a standard method of representing data (Modbus). A Modbus TCP/IP message is simply a Modbus communication encapsulated in an Ethernet TCP/IP wrapper.

In practice, Modbus TCP embeds a Modbus data frame into a TCP frame, sans the Modbus checksum, as shown in the following diagram. The Modbus checksum is not used, as the standard Ethernet TCP/IP link layer checksum methods are instead used to guaranty data integrity.



Note that the Modbus address field is referred to as the *Unit Identifier* in Modbus TCP. In a typical slave application, the Unit ID is ignored and just echoed back in the response.

The operation over Ethernet is essentially transparent to the Modbus register/command structure. If you are already familiar with Modbus or with the Acromag Modbus modules, then you are already somewhat familiar with the operation of these modules over Ethernet.

MODBUS REGISTERS

Access to IO module Modbus registers can only be obtained through the system NTE module which mates with NTX IO expansion modules.

Modbus registers are organized into different reference types identified by the leading number of the reference address:

Reference	Description
0xxxx	Read/Write Discrete Outputs or Coils. A 0x reference address is used to drive output data to a digital output channel.
1xxxx	Read Discrete Inputs. The ON/OFF status of a 1x reference address is controlled by the corresponding digital input channel.
3xxxx	Read Input Registers. A 3x reference register contains a 16-bit number received from an external source—(e.g. an analog signal).
4xxxx	Read/Write Output or Holding Registers. A 4x register is used to store 16-bits of numerical data (binary or decimal), or to send the data from the CPU to an output channel.

The "Reference" leading character indicated above is generally implied by the function code and omitted from the address specifier for a given function. The leading character also identifies the IO data type. The "x" following the leading character represents a four-digit address location in user data memory.

Note: The ON/OFF state of discrete inputs and outputs is represented by a 1 or 0 value assigned to an individual bit in a 16-bit data word. This is Sixteen 0x or 1x references per data word. With respect to mapping, the LSB of the word maps to the lowest numbered channel of a group and channel numbers increase sequentially as you move towards the MSB. Unused bit positions are set to zero.

All IO values are accessed via the 16-bit Input Registers or 16-bit Holding Registers given in the Register Map. Input registers contain information that is read-only. For example, the current input value read from a channel, or the states of a group of digital inputs. Holding registers contain read/write information that may be configuration data or output data. For example, the high limit value of an alarm function operating at an input, or an output value for an output channel.

Register Functions

For detailed information on Modbus, feel free to download our technical reference 8500-648, "Introduction to Modbus", at https://www.acromag.com/. You can also find more information specific to Modbus TCP/IP by down-loading whitepaper 8500-765, "Introduction to Modbus TCP/IP".

Each module has a default factory configuration as noted in its specifications. Your application will likely differ from the default configuration and the IO module may need to be reconfigured for your application. You may reconfigure NTE systems using an Ethernet web-browser. Generally, IO configuration can also be done via its application protocol, but some configuration parameters do not have Modbus registers for configuration, as they are only set using a web-browser over Ethernet (communication parameters for example). Below is a subset of standard Modbus functions supported by NTE models along with the reference register address group that the function operates on. Use these functions to access these registers as outlined in the Register Map that follows for sending and retrieving data. The following Modbus functions operate on register map registers to monitor and control expansion module IO:

Register Functions…

CODE	FUNCTION	REFERENCE
01 (01H)	Read Coils	0xxxx
02 (02H)	Read Discrete Inputs	1xxxx
03 (03H)	Read Holding Registers	4xxxx
04 (04H)	Read Input Registers	3xxxx
05 (05H)	Force Single Coil	0xxxx
06 (06H)	Preset Single Register	4xxxx
15 (15H)	Force Multiple Coils	0xxxx
16 (10H)	Preset Multiple Registers	4xxxx
17 (11H)	Report Slave ID (See Below)	Hidden Function

If an unsupported function code is sent to a module, exception code 01 (Illegal Function) will be returned in the response. If a holding register is written with an invalid value, exception code 03 (Illegal Data Value) will be returned in the response message. Refer to the Modbus specification for a complete list of possible error codes.

NTE2111 Report Slave ID Example Response

FIELD	DESCRIPTION
Unit ID	Echo Unit ID Sent in Query
Function Code	11
Byte Count	30
Slave ID	00
Run Indicator Status	FFH (ON)
Firmware Number String (Additional Data Field)	41 63 72 6F 6D 61 67 2C 58 54 32 31 31 31 2D 78 78 78 2C 39 33 30 30 2D 33 31 31 (“Acromag,NT2111-xxx,9300-311”)

Data Types

IO values for this model are generally indicated by a single bit of a 16-bit word for discrete on/off control or indication, except for watchdog time, which uses an unsigned integer value in range of 0-65535. Digital IO channels will typically use a single bit for discrete on/off control or indication (except for watchdog time, which uses an unsigned integer value in range of 0-65535) and the bit number/position typically corresponds to the discrete channel number unless otherwise defined. For DO a 1 bit means the corresponding output is closed or ON, a 0 bit means the output is open or OFF. For DI, a value of 1 means the input is ON (Active-low < 2.0V for this model), while a value of 0 specifies the input is OFF or in its high state (asserted high > 0.8V). This assumes that the Input Logic Invert function is set to “No” or disabled.

NT2111/2121 Registers

The table at right outlines the register map for the NT Model 2111 active-low sinking digital IO module. It is very similar to its complimentary NT Model 2121 with active-high, sourcing outputs.

Modbus functions operate on these registers using the data types noted.

For the Read Discrete Input registers, a set lsb means input = 1 = ON or High (Active-High Input Asserted > 2.0V), while 0 = OFF or Low (Input < 0.8V). This assumes that the Input Logic Invert function is set to "No" or disabled.

Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Coil Registers (0x References, Read/Write, 16 DO on this model)					
Slot 0	Slot 1	Slot 2	Slot 3		
00001	00017	00033	00049	Digital Out CH1	16-bit Discrete Output word with its lsb state used to control/monitor the ON/OFF state of the output (gate signal of the n-channel mosfet) w/ 0=OFF and 1=ON
00002	00018	00034	00050	Digital Out CH2	Word lsb set to CH state
00003	00019	00035	00051	Digital Out CH3	Word lsb set to CH state
00004	00020	00036	00052	Digital Out CH4	Word lsb set to CH state
00005	00021	00037	00053	Digital Out CH5	Word lsb set to CH state
00006	00022	00038	00054	Digital Out CH6	Word lsb set to CH state
00007	00023	00039	00055	Digital Out CH7	Word lsb set to CH state
00008	00024	00040	00056	Digital Out CH8	Word lsb set to CH state
00009	00025	00041	00057	Digital Out CH9	Word lsb set to CH state
00010	00026	00042	00058	Digital Out CH10	Word lsb set to CH state
00011	00027	00043	00059	Digital Out CH11	Word lsb set to CH state
00012	00028	00044	00060	Digital Out CH12	Word lsb set to CH state
00013	00029	00045	00061	Digital Out CH13	Word lsb set to CH state
00014	00030	00046	00062	Digital Out CH14	Word lsb set to CH state
00015	00031	00047	00063	Digital Out CH15	Word lsb set to CH state
00016	00032	00048	00064	Digital Out CH16	Word lsb set to CH state
Read Discrete Input Registers (1x References, Read Only, 16 DI on this model)					
10001	10101	10201	10301	Digital Inp CH1	16-bit Discrete Input word with its lsb state matching the ON/OFF state of the input w/ 0=OFF and 1=ON
10002	10102	10202	10302	Digital Inp CH2	Word lsb is CH IN state
10003	10103	10203	10303	Digital Inp CH3	Word lsb is CH IN state
10004	10104	10204	10304	Digital Inp CH4	Word lsb is CH IN state
10005	10105	10205	10305	Digital Inp CH5	Word lsb is CH IN state
10006	10106	10206	10306	Digital Inp CH6	Word lsb is CH IN state
10007	10107	10207	10307	Digital Inp CH7	Word lsb is CH IN state
10008	10108	10208	10308	Digital Inp CH8	Word lsb is CH IN state
10009	10109	10209	10309	Digital Inp CH9	Word lsb is CH IN state
10010	10110	10210	10310	Digital Inp CH10	Word lsb is CH IN state
10011	10111	10211	10311	Digital Inp CH11	Word lsb is CH IN state
10012	10112	10212	10312	Digital Inp CH12	Word lsb is CH IN state
10013	10113	10213	10313	Digital Inp CH13	Word lsb is CH IN state
10014	10114	10214	10314	Digital Inp CH14	Word lsb is CH IN state
10015	10115	10215	10315	Digital Inp CH15	Word lsb is CH IN state
10016	10116	10216	10316	Digital Inp CH16	Word lsb is CH IN state

NT2111/2121 Registers

For the Read Discrete Input registers, a set lsb means input = 1 = ON or High (Active-High Input Asserted > 2.0V), while 0 = OFF or Low (Input < 0.8V). This assumes that the Input Logic Invert function is set to "No" or disabled.

It is possible that the input state indicated may not reflect the actual state of the tandem output if the IO channel is experiencing contention between via a field signal and an output that happens to be turned ON. If monitoring field signals, the corresponding tandem output must be turned OFF to avoid this contention between the output channel and the field signal.

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Input Registers (3x References, Read-Only)					
Slot 0	Slot 1	Slot 2	Slot 3		
30001	30101	30201	30301	DI CH1 Inp State	16-bit Discrete Input word with its lsb state matching the ON/OFF state of the input w/ 0=OFF and 1=ON
30002	30102	30202	30302	DI CH2 Inp State	Word lsb is CH state
30003	30103	30203	30303	DI CH3 Inp State	Word lsb is CH state
30004	30104	30204	30304	DI CH4 Inp State	Word lsb is CH state
30005	30105	30205	30305	DI CH5 Inp State	Word lsb is CH state
30006	30106	30206	30306	DI CH6 Inp State	Word lsb is CH state
30007	30107	30207	30307	DI CH7 Inp State	Word lsb is CH state
30008	30108	30208	30308	DI CH8 Inp State	Word lsb is CH state
30009	30109	30209	30309	DI CH9 Inp State	Word lsb is CH state
30010	30110	30210	30310	DI CH10 Inp State	Word lsb is CH state
30011	30111	30211	30311	DI CH11 Inp State	Word lsb is CH state
30012	30112	30212	30312	DI CH12 Inp State	Word lsb is CH state
30013	30113	30213	30313	DI CH13 Inp State	Word lsb is CH state
30014	30114	30214	30314	DI CH14 Inp State	Word lsb is CH state
30015	30115	30215	30315	DI CH15 Inp State	Word lsb is CH state
30016	30116	30216	30316	DI CH16 Inp State	Word lsb is CH state
30017	30117	30217	30317	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
30032	30132	30232	30332	*Reserved*	*Reserved – Do Not Use*
30033	30133	30233	30333	CH1 Count High	16-bit UINT Word representing the upper portion of a 32-bit count value for Ch1.
30034	30134	30234	30334	CH1 Count Low	16-bit UINT Word representing the lower portion of a 32-bit count value for Ch1.
30035	30135	30235	30335	CH2 Count High	16-bit Count High Bytes
30036	30036	30036	30036	CH2 Count Low	16-bit Count Low Bytes
30037	30037	30037	30037	CH3 Count High	16-bit Count High Bytes
30038	30038	30038	30038	CH3 Count Low	16-bit Count Low Bytes
30039	30039	30039	30039	CH4 Count High	16-bit Count High Bytes
30040	30040	30040	30040	CH4 Count Low	16-bit Count Low Bytes
30041	30041	30041	30041	CH5 Count High	16-bit Count High Bytes
30042	30042	30042	30042	CH5 Count Low	16-bit Count Low Bytes
30043	30043	30043	30043	CH6 Count High	16-bit Count High Bytes

NT2111/2121 Registers

There are no registers for setting communication configuration variables, as this model is configured via a web-browser. Configuration should be done prior to connecting to the network.

Unless otherwise noted, Holding Register values are maintained in non-volatile flash memory.

NT 2111 outputs are the open drains of mosfet switches pulled up to EX+ via 10KΩ resistors and their drains tied return. NT 2121 outputs have their drain leads connected to Excitation and their source leads connected to the output and pulled to return (RTN) via 10KΩ resistors.

Note: The holding register signal corresponds to the gate signal of the n-channel output mosfet. The bit position corresponds to the output channel number (output 0 uses bit 0 of the 16-bit word at address 0, output 1 uses bit 1 of the 16-bit word at address 1, etc.) A set bit (1) means the output is turned ON (sinking current). A clear bit (0) means output is turned OFF (open). excitation must be provided to operate the outputs. A read of this register may not reflect the actual output level at the drain of the mosfet if the open-drain output is not pulled up or is left floating. You can read the Input Registers to obtain the actual output drain state(s) via closed loop feedback.

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Input Registers (3x References, Read-Only)					
Slot 0	Slot 1	Slot 2	Slot 3		
30044	30044	30044	30044	CH6 Count Low	16-bit Count Low Bytes
30045	30045	30045	30045	CH7 Count High	16-bit Count High Bytes
30046	30046	30046	30046	CH7 Count Low	16-bit Count Low Bytes
30047	30047	30047	30047	CH8 Count High	16-bit Count High Bytes
30048	30048	30048	30048	CH8 Count Low	16-bit Count Low Bytes
30049	30149	30249	30349	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
30098	30198	30298	30398	Reserved	Reserved – Do Not Use
30099				Err Status Register 30099 Only	Error Status Register Bits 4..11 i2o error. Indicates a bus error with I/O cards. Bit 3 = Slot 3 Bit 2 = Slot 2 Bit 1 = Slot 1 Bit 0 = Slot 0 (NTE)
30100	30200	30300	30400	Heartbeat Reg	16-bit UINT incrementer register will increment 1 to 65535 for each host to network data transfer to indicate that fresh input data is present relative to the prior transfer and useful to detect if the unit has halted for some reason. Count will wrap around back to 1 from 65535.
Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40001	40101	40201	40301	Set DO States	16-bit UINT w/ bit/ch
This register is used to set/clear the output state of the corresponding output and will trigger the gate of the output switch to turn ON or OFF as required (1=Output ON, 0=Output OFF). NT2111 outputs sink a load to RTN when ON while NT2121 outputs source the load to excitation when ON. Failure to provide excitation will render outputs inoperable.					Each bit represents the state of a channel corresponding to its bit position w/ msb15 = CH16, lsb0 =CH0 for the corresponding IO slot.
40002	40102	40202	40302	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	*:*	*:*
40017	40117	40217	40317	*Reserved*	*Reserved – Do Not Use*

NT2111/2121 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40018	40118	40218	40318	CH1 Watchdog St	16-bit UINT with its lsb representing the output channel watchdog timeout logic state with 0000H=Set CH to OFF state 0001H=Set CH to ON state
40019	40119	40219	40319	CH2 Watchdog St	16-bit Unsigned INT
40020	40120	40220	40320	CH3 Watchdog St	16-bit Unsigned INT
40021	40121	40221	40321	CH4 Watchdog St	16-bit Unsigned INT
40022	40122	40222	40322	CH5 Watchdog St	16-bit Unsigned INT
40023	40123	40223	40323	CH6 Watchdog St	16-bit Unsigned INT
40024	40124	40224	40324	CH7 Watchdog St	16-bit Unsigned INT
40025	40125	40225	40325	CH8 Watchdog St	16-bit Unsigned INT
40026	40126	40226	40326	CH9 Watchdog St	16-bit Unsigned INT
40027	40127	40227	40327	CH10 Watchdog St	16-bit Unsigned INT
40028	40128	40228	40328	CH11 Watchdog St	16-bit Unsigned INT
40029	40129	40229	40329	CH12 Watchdog St	16-bit Unsigned INT
40030	40130	40230	40330	CH13 Watchdog St	16-bit Unsigned INT
40031	40131	40231	40331	CH14 Watchdog St	16-bit Unsigned INT
40032	40132	40232	40332	CH15 Watchdog St	16-bit Unsigned INT
40033	40133	40233	40333	CH16 Watchdog St	16-bit Unsigned INT
40034	40134	40234	40334	CH1 Timeout Time in seconds	16-bit UINT representing watchdog time from 1 to 65535 seconds in 1 second intervals. Set to 0 (0000H) to disable the watchdog timer. Watchdog is cleared with a write to any DO channel of slot
40035	40135	40235	40335	CH2 Timeout sec	16-bit Unsigned INT
40036	40136	40236	40336	CH3 Timeout sec	16-bit Unsigned INT
40037	40137	40237	40337	CH4 Timeout sec	16-bit Unsigned INT
40038	40138	40238	40338	CH5 Timeout sec	16-bit Unsigned INT
40039	40139	40239	40339	CH6 Timeout sec	16-bit Unsigned INT
40040	40140	40240	40340	CH7 Timeout sec	16-bit Unsigned INT
40041	40141	40241	40341	CH8 Timeout sec	16-bit Unsigned INT
40042	40142	40242	40342	CH9 Timeout sec	16-bit Unsigned INT
40043	40143	40243	40343	CH10 Timeout sec	16-bit Unsigned INT
40044	40144	40244	40344	CH11 Timeout sec	16-bit Unsigned INT
40045	40145	40245	40345	CH12 Timeout sec	16-bit Unsigned INT
40046	40146	40046	40346	CH13 Timeout sec	16-bit Unsigned INT
40047	40147	40047	40347	CH14 Timeout sec	16-bit Unsigned INT
40048	40148	40048	40348	CH15 Timeout sec	16-bit Unsigned INT
40049	40149	40049	40349	CH16 Timeout sec	16-bit Unsigned INT

NT2111/2121 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40050	40150	40250	40350	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
40065	40165	40265	40365	*Reserved*	*Reserved – Do Not Use*
40066	40166	40066	40066	CH1 Debounce Time in milliseconds	16-bit UINT debounce time set from 1 to 65535ms. Set to 0 (0000H) to disable the watchdog timer.
40067	40167	40067	40067	CH2 Debounce ms	16-bit UINT Debounce ms
40068	40168	40068	40068	CH3 Debounce ms	16-bit UINT Debounce ms
40069	40169	40069	40069	CH4 Debounce ms	16-bit UINT Debounce ms
40070	40170	40070	40070	CH5 Debounce ms	16-bit UINT Debounce ms
40071	40171	40071	40071	CH6 Debounce ms	16-bit UINT Debounce ms
40072	40172	40072	40072	CH7 Debounce ms	16-bit UINT Debounce ms
40073	40173	40073	40073	CH8 Debounce ms	16-bit UINT Debounce ms
40074	40174	40074	40074	CH1 Preload High	This 16-bit UINT defines the upper word portion of the 32-bit Pre-Load value of counter 1.
40075	40175	40075	40075	CH1 Preload Low	This 16-bit UINT defines the lower word portion of the 32-bit Pre-Load value of counter 1.
40076	40176	40076	40076	CH2 Preload High	16-bit Unsigned INT
40077	40177	40077	40077	CH2 Preload Low	16-bit Unsigned INT
40078	40178	40078	40078	CH3 Preload High	16-bit Unsigned INT
40079	40179	40079	40079	CH3 Preload Low	16-bit Unsigned INT
40080	40180	40080	40080	CH4 Preload High	16-bit Unsigned INT
40081	40181	40081	40081	CH4 Preload Low	16-bit Unsigned INT
40082	40182	40082	40082	CH5 Preload High	16-bit Unsigned INT
40083	40183	40083	40083	CH5 Preload Low	16-bit Unsigned INT
40084	40184	40084	40084	CH6 Preload High	16-bit Unsigned INT
40085	40185	40085	40085	CH6 Preload Low	16-bit Unsigned INT
40086	40186	40086	40086	CH7 Preload High	16-bit Unsigned INT
40087	40187	40087	40087	CH7 Preload Low	16-bit Unsigned INT
40088	40188	40088	40088	CH8 Preload High	16-bit Unsigned INT
40089	40189	40089	40089	CH8 Preload Low	16-bit Unsigned INT

NT2131 Registers

The table at right outlines the register map for the NT Model 2131 discrete IO model with 6 mechanical SPST relays and 6 active-high digital inputs.

Modbus functions operate on these registers using the data types noted.

Unless otherwise noted, Holding Register values are not maintained in non-volatile flash memory.

For the Read Discrete Input registers, a set lsb means input = 1/ON/High (Active-High Input is Asserted > 2.0V), while clear lsb means input = OFF/0/Low (Input < 0.8V). This assumes that the Input Logic Invert function is set to "No" or disabled.

Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Coil Registers (0x References, Read/Write, 6 Mechanical relays on This Model)					
Slot 0	Slot 1	Slot 2	Slot 3		
00001	00017	00033	00049	Digital Out CH1	16-bit UINT whose lsb controls/monitors the ON/OFF status of the corresponding discrete output relay with 0=OFF (de-energized) and 1=ON (energized).
00002	00018	00034	00050	Digital Out CH2	16-bit UINT w/lsb=out st
00003	00019	00035	00051	Digital Out CH3	16-bit UINT w/lsb=out st
00004	00020	00036	00052	Digital Out CH4	16-bit UINT w/lsb=out st
00005	00021	00037	00053	Digital Out CH5	16-bit UINT w/lsb=out st
00006	00022	00038	00054	Digital Out CH6	16-bit UINT w/lsb=out st
Read Discrete Input Registers (1x References, Read Only, 6 DI on this model)					
10001	10101	10201	10301	Digital Out CH1	16-bit UNIT whose lsb monitors the ON/OFF status of the corresponding discrete input with 0=OFF and 1=ON.
10002	10102	10202	10302	Digital Out CH2	16-bit UINT w/lsb=input st
10003	10103	10203	10303	Digital Out CH3	16-bit UINT w/lsb=input st
10004	10104	10204	10304	Digital Out CH4	16-bit UINT w/lsb=input st
10005	10105	10205	10305	Digital Out CH5	16-bit UINT w/lsb=input st
10006	10106	10206	10306	Digital Out CH6	16-bit UINT w/lsb=input st
Input Registers (3x References, Read-Only)					
30001	30101	30201	30301	CH1 Input Data	16-bit UNIT whose lsb monitors the ON/OFF status of the corresponding discrete input with 0=OFF and 1=ON.
30002	30102	30202	30302	CH2 Input Data	16-bit UINT w/lsb=input st
30003	30103	30203	30303	CH3 Input Data	16-bit UINT w/lsb=input st
30004	30104	30204	30304	CH4 Input Data	16-bit UINT w/lsb=input st
30005	30105	30205	30305	CH5 Input Data	16-bit UINT w/lsb=input st
30006	30106	30206	30306	CH6 Input Data	16-bit UINT w/lsb=input st
30007	30107	30207	30307	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
30032	30132	30232	30332	*Reserved*	*Reserved – Do Not Use*

NT2131 Registers

Note: The 30x33-30x48 registers reflect the high byte and low byte count data for up to 6 possible event counters at each input for up to four system modules. This signal is active-high.

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Input Registers (3x References, Read-Only)					
Slot 0	Slot 1	Slot 2	Slot 3		
30033	30133	30233	30333	CH1 Count Data High Bytes	16-bit UINT register contains the upper/high portion of the 32-bit count value of Channel 1.
30034	30134	30234	30334	CH1 Count Data Low Bytes	16-bit UINT register contains the lower/low portion of the 32-bit count value of Channel 1.
30035	30135	30235	30335	CH2 Count Data	CH2 Count High Bytes
30036	30136	30236	30336	CH2 Count Data	CH2 Count Low Bytes
30037	30137	30237	30337	CH3 Count Data	CH3 Count High Bytes
30038	30138	30238	30338	CH3 Count Data	CH3 Count Low Bytes
30039	30139	30239	30339	CH4 Count Data	CH4 Count High Bytes
30040	30140	30240	30340	CH4 Count Data	CH4 Count Low Bytes
30041	30141	30241	30341	CH5 Count Data	CH5 Count High Bytes
30042	30142	30242	30342	CH5 Count Data	CH5 Count Low Bytes
30043	30143	30243	30343	CH6 Count Data	CH6 Count High Bytes
30044	30144	30244	30344	CH6 Count Data	CH6 Count Low Bytes
30045	30145	30245	30345	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
30098	30198	30298	30398	*Reserved*	*Reserved – Do Not Use*
30099				Err Status Register 30099 Only	Error Status Register Bits 4..11 i2o error. Indicates a bus error with I/O cards. Bit 3 = Slot 3 Bit 2 = Slot 2 Bit 1 = Slot 1 Bit 0 = Slot 0 (NTE)
30100	30200	30300	30400	Heartbeat Reg	16-bit UINT incrementer that increments from 1 to 65535 for every host to network data transfer to help indicate if fresh data is present relative to the last data transfer, useful to detect if the unit has halted for some reason. Counts wraps back around to 1 from 65535.

NT2131 Registers

There are no registers for setting configuration variables, as this model is configured via a web-browser. Configuration should be done prior to connecting to the network.

Note: *A watchdog timeout is triggered if an established client-server relationship to the module is severed by a cable break or power disruption at the client. A client-server network connection to the module is created for the EXChange of data between devices, such as that between a Modbus Master and slave, or that between a networked PLC, HMI, or other client device and its target server module. Thus, a watchdog timeout can only be cleared at the server by first restoring the broken client-server relationship. Clearing a timeout by restoring the client-server connection to the module does not return output(s) to their initial "pre-timeout" state and they remain in their timeout states until otherwise written via the holding registers.*

Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40001	40101	40201	40301	Set Output States of Module (NTE2131)	16-bit Unsigned INT representing up to 16 channels or bits 5…bits0 for the six outputs of this model w/ bit=CH06…bit0=lsb=CH1
Note: The outputs of this model are six SPST mechanical relay contacts CH1-CH6. This register is used to energize/deenergize the corresponding output relay (1 FORM A, Normally Open SPST switch).					1 = Relay Energized (Close Contacts) 0 = Relay De-Energized (Open Contacts) The Invert Input Logic function does not affect output logic.
40002	40102	40202	40302	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
40017	40117	40217	40317	*Reserved*	*Reserved – Do Not Use*
40018	40118	40218	40318	CH1 Watchdog State	16-bit UINT w/lsb=channel Sets the output state to assume upon watchdog timeout. With 0000H = Set Channel to OFF, 0001H = Set Channel to ON.
40019	40119	40219	40319	CH2 Watchdog St	16-bit UINT w/lsb=channel
40020	40120	40220	40320	CH3 Watchdog St	16-bit UINT w/lsb=channel
40021	40121	40221	40321	CH4 Watchdog St	16-bit UINT w/lsb=channel
40022	40122	40222	40322	CH5 Watchdog St	16-bit UINT w/lsb=channel
40023	40123	40223	40323	CH6 Watchdog St	16-bit UINT w/lsb=channel
40024	40124	40224	40324	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
40033	40133	40233	40333	*Reserved*	*Reserved – Do Not Use*
40034	40134	40234	40334	CH1 Timeout Time seconds	16-bit UINT seconds Set a watchdog time from 1 to 65535 second interval. Set 0 (0000H) to disable the timer. Clear a Watchdog is timeout with a write to any DO channel of slot
40035	40135	40235	40335	CH2 Timeout	16-bit Unsigned INT
40036	40136	40236	40336	CH3 Timeout	16-bit Unsigned INT
40037	40137	40237	40337	CH4 Timeout	16-bit Unsigned INT
40038	40138	40238	40338	CH5 Timeout	16-bit Unsigned INT
40039	40139	40239	40339	CH6 Timeout	16-bit Unsigned INT

NT2131 Registers

There are no registers for setting configuration variables, as this model is configured via a web-browser. Configuration should be done prior to connecting to the network.

Note: *A watchdog timeout is triggered if an established client-server relationship to the module is severed by a cable break or power disruption at the client. A client-server network connection to the module is created for the EXChange of data between devices, such as that between a Modbus Master and slave, or that between a networked PLC, HMI, or other client device and its target server module. Thus, a watchdog timeout can only be cleared at the server by first restoring the broken client-server relationship. Clearing a timeout by restoring the client-server connection to the module does not return output(s) to their initial "pre-timeout" state and they remain in their timeout states until otherwise written via the holding registers.*

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40040	40140	40240	40340	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
40065	40165	40265	40365	*Reserved*	*Reserved – Do Not Use*
40066	40166	40266	40366	CH1 Debounce milliseconds	16-bit UINT ms Debounce time from 1 to 65535 ms. Set to 0 (0000H) to disable the timer.
40067	40167	40267	40367	CH2 Debounce	16-bit Unsigned INT ms
40068	40168	40268	40368	CH3 Debounce	16-bit Unsigned INT ms
40069	40169	40269	40369	CH4 Debounce	16-bit Unsigned INT ms
40070	40170	40270	40370	CH5 Debounce	16-bit Unsigned INT ms
40071	40171	40271	40371	CH6 Debounce	16-bit Unsigned INT ms
40072	40172	40272	40372	*Reserved*	*Reserved – Do Not Use*
40073	40173	40273	40373	*Reserved*	*Reserved – Do Not Use*
40074	40174	40274	40374	CH1 Preload High	This 16-bit register defines the upper word of the Pre-Load value for counter 1. 16-bit Unsigned INT
40075	40175	40275	40375	CH1 Preload Low	This 16-bit register defines the lower word of the Pre-Load value for counter 1. 16-bit Unsigned INT
40076	40176	40276	40376	CH2 Preload High	16-bit Unsigned INT
40077	40177	40277	40377	CH2 Preload Low	16-bit Unsigned INT
40078	40178	40278	40378	CH3 Preload High	16-bit Unsigned INT
40079	40179	40279	40379	CH3 Preload Low	16-bit Unsigned INT
40080	40180	40280	40380	CH4 Preload High	16-bit Unsigned INT
40081	40181	40281	40381	CH4 Preload Low	16-bit Unsigned INT
40082	40182	40282	40382	CH5 Preload High	16-bit Unsigned INT
40083	40183	40283	40383	CH5 Preload Low	16-bit Unsigned INT
40084	40184	40284	40384	CH6 Preload High	16-bit Unsigned INT
40085	40185	40285	40385	CH6 Preload Low	16-bit Unsigned INT
40086	40186	40286	40386	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
40097	40197	40297	40397	*Reserved*	*Reserved – Do Not Use*
40098	40198	40298	40398	Map Input to Relay	16-bit UINT This register directs the digital input state to be written to its corresponding output relay. 1 = Map DI to Relay 0 = Do not map DI to Relay

NT2211/2231 Registers

The table at right outlines the register map for the NT Model 2211 and 2231 8 channel differential I/V modules.

Modbus functions operate on these registers using the data types noted.

For the Read Discrete Input registers, a set lsb means input = 1 = ON or High (Active-High Input Asserted > 2.0V), while 0 = OFF or Low (Input < 0.8V). This assumes that the Input Logic Invert function is set to "No" or disabled.

Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Coil Registers (0x References, Read/Write, 6 Mechanical relays on This Model)					
Slot 0	Slot 1	Slot 2	Slot 3		
00001	00017	00033	00049	Digital Out CH1	Discrete Output Value. Addresses a specific bit of a 16-bit word that controls/monitors the ON/OFF status for the corresponding output relay. 0=OFF; 1=ON. State corresponds to lsb of byte
00002	00018	00034	00050	Digital Out CH2	State corresponds to lsb of byte
Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Read Discrete Input Registers (1x References, Read Only, 16 DI on this model)					
Slot 0	Slot 1	Slot 2	Slot 3		
10001	10101	10201	10301	Digital Input CH1	Discrete Input Value. Addresses a specific bit of a 16-bit word that flags the ON/OFF status for the corresponding input or tandem output. 0=OFF; 1=ON. State corresponds to lsb of word
10002	10102	10202	10302	Digital Inp CH2	State corresponds to lsb of word
Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Input Registers (3x References, Read-Only)					
30001	30101	30201	30301	Digital Input Data of CH1	Discrete Input Value. Addresses a specific bit of a 16-bit word that flags the ON/OFF status for the corresponding input or tandem output. 0=OFF; 1=ON. 16-bit UNS INT w/lsb as CH state
30002	30102	30202	30302	CH2 Digital Input Data	16-bit UNS INT w/lsb as CH state

NT2211/2231 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format		
Input Registers (3x References, Read-Only)							
Slot 0	Slot 1	Slot 2	Slot 3				
30003	30103	30203	30303	CH1 Analog Input Data	The 16-bit Signed Integer Data stored here refers to the input range A/D count, after normalizing it to ±30000/0-30000, or ±20000/0-20000, corresponding to ±100%/0-100% of the input range. 16-bit Signed INT		
30004	30104	30204	30304	CH2 Analog Input Data	16-bit Signed INT		
30005	30105	30205	30305	CH3 Analog Input Data	16-bit Signed INT		
30006	30106	30206	30306	CH4 Analog Input Data	16-bit Signed INT		
30007	30107	30207	30307	CH5 Analog Input Data	16-bit Signed INT		
30008	30108	30208	30308	CH6 Analog Input Data	16-bit Signed INT		
30009	30109	30209	30309	CH7 Analog Input Data	16-bit Signed INT		
30010	30110	30210	30310	CH8 Analog Input Data	16-bit Signed INT		
30011	30111	30211	30311	*Reserved*	*Reserved – Do Not Use*		
30012	30112	30212	30312	*Reserved*	*Reserved – Do Not Use*		
30013	30113	30213	30313	*Reserved*	*Reserved – Do Not Use*		
30014	30114	30214	30314	*Reserved*	*Reserved – Do Not Use*		
30015	30115	30215	30315	*Reserved*	*Reserved – Do Not Use*		
30016	30116	30216	30316	*Reserved*	*Reserved – Do Not Use*		
30017	30117	30217	30317	*Reserved*	*Reserved – Do Not Use*		
30018	30118	30218	30318	*Reserved*	*Reserved – Do Not Use*		
30019	30119	30219	30319	AIN CH1 Config	Input Range Selection:		
					VAL	**NT2211**	**NT2231**
					5	Reserved	0-1V
					4	Reserved	±1V
					3	0-11.17mA	0-5V
					2	4-20mA	±5V
					1	0-20mA	0-10V
					0	±20mA	±10V
30020	30120	30220	30320	AIN CH2 Config	16-bit UNS INT		
30021	30121	30221	30321	AIN CH3 Config	16-bit UNS INT		

NT2211/2231 Registers

There are no registers for setting communication configuration variables, as this model is configured via a web-browser. Configuration should be done prior to connecting to the network.

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Input Registers (3x References, Read-Only)					
Slot 0	Slot 1	Slot 2	Slot 3		
30022	30122	30222	30322	AIN CH4 Config	16-bit UNS INT
30023	30123	30223	30323	AIN CH5 Config	16-bit UNS INT
30024	30124	30224	30324	AIN CH6 Config	16-bit UNS INT
30025	30125	30225	30325	AIN CH7 Config	16-bit UNS INT
30026	30126	30226	30326	AIN CH8 Config	16-bit UNS INT
30027	30127	30227	30327	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	*:*	*:*
30099				*Err Status Register* 30099 Only	Error Status Register Bits 4..11 i2o error. Indicates a bus error with I/O cards. Bit 3 = Slot 3 Bit 2 = Slot 2 Bit 1 = Slot 1 Bit 0 = Slot 0 (NTE)
30100	30200	30300	30400	Heartbeat Reg	An integer counter that increments by 1 for every host to network data transfer to help indicate if fresh data is present relative to the last transfer, or if the unit has halted for some reason. This register counts from 1 to 65535 and wraps back around to 1.
Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40001	40101	40201	40301	Set Output States of Module	16-bit Unsigned INT representing up to 2 channels or bit 1…bit 0 for the two outputs of this model. bit1=CH2 bit0=CH1
Note: The outputs of the module are open drain mosfet switches to return and are pulled up to (EXC) via 10KΩ resistors. This register is used to set/clear the output state of the corresponding output and will trigger the gate of the output switch to turn ON or OFF as required. Output channels sink from EX+ through the load to RTN when turned ON. Failure to provide excitation will render the open-drain outputs inoperable.					1 = Output ON 0 = Output OFF

NT2211/2231 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format		
Holding Registers (4x References, Read/Write)							
Slot 0	Slot 1	Slot 2	Slot 3				
40002	40102	40202	40302	AIN CH1 Config	Input Range Selection:		
					VAL	**NT2211**	**NT2231**
					5	10-50mA	0-1V
					4	0-50mA	±1V
					3	0-11.17mA	0-5V
					2	4-20mA	±5V
					1	0-20mA	0-10V
					0	±20mA	±10V

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format	
Holding Registers (4x References, Read/Write)						
Slot 0	Slot 1	Slot 2	Slot 3			
40003	40103	40203	40303	AIN CH2 Config	See explanation for CH1	
40004	40104	40204	40304	AIN CH3 Config	See explanation for CH1	
40005	40105	40205	40305	AIN CH4 Config	See explanation for CH1	
40006	40106	40206	40306	AIN CH5 Config	See explanation for CH1	
40007	40107	40207	40307	AIN CH6 Config	See explanation for CH1	
40008	40108	40208	40308	AIN CH7 Config	See explanation for CH1	
40009	40109	40209	40309	AIN CH8 Config	See explanation for CH1	
40010	40110	40210	40310	*Reserved*	*Reserved – Do Not Use*	
40011	40111	40211	40311	*Reserved*	*Reserved – Do Not Use*	
:	:	:	:	*:*	*:*	
40017	40117	40217	40317	*Reserved*	*Reserved – Do Not Use*	
40018	40118	40218	40318	In Filter Level	16bit UINT Filter Selection:	
Sets the level of digital filtering to apply to all input channels at once.					**VAL**	**FILTER LEVEL**
					3	None (8mS/8 Ch)
					2	Low (80mS/8 Ch)
					1	Med (293mS/8 Ch) w/50-60 Hz Rejection
					0	High (480mS/8 Ch) w/50-60 Hz Rejection

NT2211/2231 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40019	40119	40219	40319	*Settling Delay*	16bit UINT Settling Time
This register adjusts the settling time for the ADC between switching channels.					**VAL** / **ADC SETTLING TIME** 7 – 8ms 6 – 4ms 5 – 1.6ms 4 – 800us 3 – 320us 2 – 128us 1 – 32us 0 – 0us
40020	40120	40220	40320	*Reserved*	*Reserved – Do Not Use*
40021	40121	40221	40321	*Reserved*	*Reserved – Do Not Use*
40022	40122	40222	40322	Legacy Support	This register changes the normalized values to ±20000 for compatibility with legacy Acromag devices. 1 = Legacy Support Enabled 0 = Legacy Support Disabled
40023	40123	40223	40323	*Reserved*	*Reserved – Do Not Use*
40024	40124	40224	40324	CH1 Timeout Val	16bit UINT Tells what to do to the outputs of CH 1 upon watchdog timeout. 0000H = Change Channel 1 to off state 0001H = Change Channel 1 to ON state
40025	40125	40225	40325	CH2 Timeout Val	See explanation for CH1
40026	40126	40226	40326	CH1 Watchdog Time	16-bit UINT seconds Watchdog time from 1 to 65534 second. Set to 0 (0000H) to disable the timer. All watchdog timers are reset with write to any DO channel of a slot.
40027	40127	40227	40327	CH2 Watchdog Time	16-bit UINT seconds

NT2221/2241 Registers

The table at right outlines the register map for the NT Model 2221 and 2241 16 channel single-ended I/V modules.

Modbus functions operate on these registers using the data types noted.

Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Coil Registers (0x References, Read/Write, 6 Mechanical relays on This Model)					
Slot 0	Slot 1	Slot 2	Slot 3		
00001	00017	00033	00049	NA	No Discrete DIO
Ref.	**Ref.**	**Ref.**	**Ref.**	**Description**	**Data Type/Format**
Read Discrete Input Registers (1x References, Read Only, 16 DI on this model)					
Slot 0	Slot 1	Slot 2	Slot 3		
10001	10101	10201	10301	NA	No Discrete DIO
Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Input Registers (3x References, Read-Only)					
30001	30101	30201	30301	Analog Input Data of Channel 1 using Normalized Value	16-bit SINT equal to the normalized input range ADC count. Nominal Bipolar/unipolar input ranges are normalized to ±30000/0-30000, or ±20000/0-20000 w/Legacy, corresponding to ±100%/0-100% of the input range.
30002	30102	30202	30302	CH2 AIN Data	16-bit SIGNED INT
30003	30103	30203	30303	CH3 AIN Data	16-bit SIGNED INT
30004	30104	30204	30304	CH4 AIN Data	16-bit SIGNED INT
30005	30105	30205	30305	CH5 AIN Data	16-bit SIGNED INT
30006	30106	30206	30306	CH6 AIN Data	16-bit SIGNED INT
30007	30107	30207	30307	CH7 AIN Data	16-bit SIGNED INT
30008	30108	30208	30308	CH8 AIN Data	16-bit SIGNED INT
30009	30109	30209	30309	CH9 AIN Data	16-bit SIGNED INT
30010	30110	30210	30310	CH10 AIN Data	16-bit SIGNED INT
30011	30111	30211	30311	CH11 AIN Data	16-bit SIGNED INT
30012	30112	30212	30312	CH12 AIN Data	16-bit SIGNED INT
30013	30113	30213	30313	CH13 AIN Data	16-bit SIGNED INT
30014	30114	30214	30314	CH14 AIN Data	16-bit SIGNED INT
30015	30115	30215	30315	CH15 AIN Data	16-bit SIGNED INT
30016	30116	30216	30316	CH16 AIN Data	16-bit SIGNED INT
30017	30117	30217	30317	*Reserved*	*Reserved – Do Not Use*
30018	30118	30218	30318	*Reserved*	*Reserved – Do Not Use*

NT2221/2241 Registers

<table>
<tr><th>Ref.</th><th>Ref.</th><th>Ref.</th><th>Ref.</th><th>Description</th><th>Data Type/Format</th></tr>
<tr><td colspan="6">Holding Registers (4x References, Read/Write)</td></tr>
<tr><td>Slot 0</td><td>Slot 1</td><td>Slot 2</td><td>Slot 3</td><td></td><td></td></tr>
<tr><td>30019</td><td>30119</td><td>30219</td><td>30319</td><td>AIN CH1 Config</td><td>Input Range Selection:<table>
<tr><th>VAL</th><th>NT2211</th><th>NT2231</th></tr>
<tr><td>5</td><td>Reserved</td><td>0-1V</td></tr>
<tr><td>4</td><td>Reserved</td><td>±1V</td></tr>
<tr><td>3</td><td>0-11.17mA</td><td>0-5V</td></tr>
<tr><td>2</td><td>4-20mA</td><td>±5V</td></tr>
<tr><td>1</td><td>0-20mA</td><td>0-10V</td></tr>
<tr><td>0</td><td>±20mA</td><td>±10V</td></tr>
</table></td></tr>
<tr><td>30020</td><td>30120</td><td>30220</td><td>30320</td><td>AIN CH2 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30021</td><td>30121</td><td>30221</td><td>30321</td><td>AIN CH3 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30022</td><td>30122</td><td>30222</td><td>30322</td><td>AIN CH4 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30023</td><td>30123</td><td>30223</td><td>30323</td><td>AIN CH5 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30024</td><td>30124</td><td>30224</td><td>30324</td><td>AIN CH6 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30025</td><td>30125</td><td>30225</td><td>30325</td><td>AIN CH7 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30026</td><td>30126</td><td>30226</td><td>30326</td><td>AIN CH8 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30027</td><td>30127</td><td>30227</td><td>30327</td><td>AIN CH9 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30028</td><td>30128</td><td>30228</td><td>30328</td><td>AIN CH10 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30029</td><td>30129</td><td>30229</td><td>30329</td><td>AIN CH11 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30030</td><td>30130</td><td>30230</td><td>30330</td><td>AIN CH12 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30031</td><td>30131</td><td>30231</td><td>30331</td><td>AIN CH13 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30032</td><td>30132</td><td>30232</td><td>30332</td><td>AIN CH14 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30033</td><td>30133</td><td>30233</td><td>30333</td><td>AIN CH15 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30034</td><td>30134</td><td>30234</td><td>30334</td><td>AIN CH16 Config</td><td>16-bit UNS INT</td></tr>
<tr><td>30035</td><td>30135</td><td>30235</td><td>30335</td><td>Reserved</td><td>Reserved – Do Not Use</td></tr>
<tr><td>:</td><td>:</td><td>:</td><td>:</td><td>:</td><td>:</td></tr>
<tr><td>30099</td><td>30199</td><td>30299</td><td>30399</td><td>Err Status Register
30099 Only</td><td>Error Status Register
Bits 4..11 i2o error.
Indicates a bus error with I/O cards.
Bit 3 = Slot 3
Bit 2 = Slot 2
Bit 1 = Slot 1
Bit 0 = Slot 0 (NTE)</td></tr>
<tr><td>30100</td><td>30200</td><td>30300</td><td>30400</td><td>Heartbeat Reg</td><td>16-bit UINT incrementer that increments from 1 to 65535 for every host to network data transfer to help indicate if fresh data is present relative to the last data transfer, useful to detect if the unit has halted for some reason. Counts wrap back around to 1 from 65535.</td></tr>
</table>

NT2221/2241 Registers

There are no registers for setting communication configuration variables, as this model is configured via a web-browser. Configuration should be done prior to connecting to the network.

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format		
Holding Registers (4x References, Read/Write)							
Slot 0	Slot 1	Slot 2	Slot 3				
40001	40101	40201	40301	*Reserved*	*Reserved – Do Not Use*		
40002	40102	40202	40302	AIN CH1 Config	Input Range Selection:		
Sets the nominal input range for the channel.					**VAL**	**NT2221**	**NT2241**
					5	Reserved	0-1V
					4	Reserved	±1V
					3	0-11.17mA	0-5V
					2	4-20mA	±5V
					1	0-20mA	0-10V
					0	±20mA	±10V
40003	40103	40203	40303	AIN CH2 Config	See CH1 explanation above		
40004	40104	40204	40304	AIN CH3 Config	See CH1 explanation above		
40005	40105	40205	40305	AIN CH4 Config	See CH1 explanation above		
40006	40106	40206	40306	AIN CH5 Config	See CH1 explanation above		
40007	40107	40207	40307	AIN CH6 Config	See CH1 explanation above		
40008	40108	40208	40308	AIN CH7 Config	See CH1 explanation above		
40009	40109	40209	40309	AIN CH8 Config	See CH1 explanation above		
40010	40110	40210	40310	AIN CH9 Config	See CH1 explanation above		
40011	40111	40211	40311	AIN CH10 Config	See CH1 explanation above		
40012	40112	40212	40312	AIN CH11 Config	See CH1 explanation above		
40013	40113	40213	40313	AIN CH12 Config	See CH1 explanation above		
40014	40114	40214	40314	AIN CH13 Config	See CH1 explanation above		
40015	40115	40215	40315	AIN CH14 Config	See CH1 explanation above		
40016	40116	40216	40316	AIN CH15 Config	See CH1 explanation above		
40017	40117	40217	40317	AIN CH16 Config	See CH1 explanation above		
40018	40118	40218	40318	AIN Filter Level	16bit UINT Filter Selection:		
Sets the level of digital filtering to apply to all input channels at once. Setting Medium or High provides 50-60Hz rejection for the input.					**VAL**	**FILTER LEVEL**	
					3	None (8mS/8 Ch)	
					2	Low (80mS/8 Ch)	
					1	Med (293mS/8 Ch)	
					0	High (480mS/8 Ch)	
40019	40119	40219	40319	*Settling Delay*	16bit UINT Settling Time		
This register adjusts the settling time for the ADC between switching channels.					**VAL**	**ADC SETTLING TIME**	
					7	8ms	
					6	4ms	
					5	1.6ms	
					4	800us	
					3	320us	
					2	128us	
					1	32us	
					0	0us	

NT2221/2241 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40020	40120	40220	40320	*Reserved*	*Reserved – Do Not Use*
40021	40121	40221	40321	*Reserved*	*Reserved – Do Not Use*
40022	40122	40222	40322	Legacy Support Enable Switch	16-bit UINT w/lsb=Legacy Set lsb=1 to changes the normalization of the input to ±20000 = ±100% for i2o compatibility with legacy Acromag devices (set 0 for ±30000=±100%).

NT2611 Registers

The table at right outlines the register map for the NT Model 2611 8 channel thermocouple/ millivolt module.

Modbus functions operate on these registers using the data types noted above.

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Coil Registers (0x References, Read/Write, 2 DO on This Model)					
Slot 0	Slot 1	Slot 2	Slot 3		
00001	00017	00033	00049	Digital Out CH1	16-bit Discrete Output word with its lsb state used to control/monitor the ON/OFF state of the output (gate signal of the n-channel mosfet) w/ 0=OFF and 1=ON
00002	00018	00034	00050	Digital Out CH2	Word lsb set to CH state
Read Discrete Input Registers (1x References, Read Only, 2 DI on this model)					
Slot 0	Slot 1	Slot 2	Slot 3		
10001	10101	10201	10301	Digital Inp CH1	16-bit Discrete Input word with its lsb state matching the ON/OFF state of the input w/ 0=OFF and 1=ON
10002	10102	10202	10302	Digital Inp CH2	Word lsb set to CH state
Input Registers (3x References, Read-Only)					
30001	30101	30201	30301	CH1 Digital Input Data	16-bit Discrete Input word with its lsb state matching the ON/OFF state of the input w/ 0=OFF and 1=ON
30002	30102	30202	30302	CH2 Digital Input Data	Word lsb is CH state

NT2611 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
30003	30103	30203	30303	CH1 Analog Input Data as 10x°C or normalized mV	16-bit SIGNED INTEGER representing input range ADC count after translating to temperature. Value is Temp°C x10 or normalized mV range w/ ±30000/20000 = ±100%
30004	30104	30204	30304	CH2 Analog Input Data as 10x°C or normalized mV	See CH1 Explanation
30005	30105	30205	30305	CH3 Analog Input Data as 10x°C or normalized mV	See CH1 Explanation
30006	30106	30206	30306	CH4 Analog Input Data as 10x°C or normalized mV	See CH1 Explanation
30007	30107	30207	30307	CH5 Analog Input Data as 10x°C or normalized mV	See CH1 Explanation
30008	30108	30208	30308	CH6 Analog Input Data as 10x°C or normalized mV	See CH1 Explanation
30009	30109	30209	30309	CH7 Analog Input Data as 10x°C or normalized mV	See CH1 Explanation
30010	30110	30210	30310	CH8 Analog Input Data as 10x°C or normalized mV	See CH1 Explanation
30011	30111	30211	30311	CJC1 Input Data of CH1/CH2 sensor	16bit SINT CJC Temp Data as Temp°C x10
30012	30112	30212	30312	CJC1 Input Data of CH1/CH2 sensor	16bit SINT CJC Temp Data as Temp°C x10
30013	30113	30213	30313	CJC2 Input Data of CH3/CH4 sensor	16bit SINT CJC Temp Data as Temp°C x10
30014	30114	30214	30314	CJC2 Input Data of CH3/CH4 sensor	16bit SINT CJC Temp Data as Temp°C x10
30015	30115	30215	30315	CJC3 Input Data of CH5/CH6 sensor	16bit SINT CJC Temp Data as Temp°C x10
30016	30116	30216	30316	CJC3 Input Data of CH5/CH6 sensor	16bit SINT CJC Temp Data as Temp°C x10
30017	30117	30217	30317	CJC4 Input Data of CH7/CH8 sensor	16bit SINT CJC Temp Data as Temp°C x10
30018	30118	30218	30318	CJC4 Input Data of CH7/CH8 sensor	16bit SINT CJC Temp Data as Temp°C x10

NT2611 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format	
Holding Registers (4x References, Read/Write)						
Slot 0	Slot 1	Slot 2	Slot 3			
30019	30119	30219	30319	AIN CH1 Config	**VAL**	**INPUT RANGE**
					9	±500mV
					8	±100mV
					7	Type N
					6	Type B
					5	Type E
					4	Type S
					3	Type R
					2	Type T
					1	Type K
					0	Type J
30020	30120	30220	30320	AIN CH2 Config	16-bit UINT, see CH1 above	
30021	30121	30221	30321	AIN CH3 Config	16-bit UINT, see CH1 above	
30022	30122	30222	30322	AIN CH4 Config	16-bit UINT, see CH1 above	
30023	30123	30223	30323	AIN CH5 Config	16-bit UINT, see CH1 above	
30024	30124	30224	30324	AIN CH6 Config	16-bit UINT, see CH1 above	
30025	30125	30225	30325	AIN CH7 Config	16-bit UINT, see CH1 above	
30026	30126	30226	30326	AIN CH8 Config	16-bit UINT, see CH1 above	
30027	30127	30227	30327	*Reserved*	*Reserved – Do Not Use*	
:	:	:	:	:	*:*	
30099				*Err Status Register* 30099 Only	Error Status Register Bits 4..11 i2o error. Indicates a bus error with I/O cards. Bit 3 = Slot 3 Bit 2 = Slot 2 Bit 1 = Slot 1 Bit 0 = Slot 0 (NTE)	
30100	30200	30300	30400	Heartbeat Reg	16-bit UINT incrementer that increments from 1 to 65535 for every host to network data transfer to help indicate if fresh data is present relative to the last data transfer, useful to detect if the unit has halted for some reason. Counts wraps back around to 1 from 65535.	

NT2611 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40001	40101	40201	40301	Set Output States of Module	16-bit Unsigned INT representing up to 2 channels or bits 1…bits0 for the two outputs of this model with bit1=CH2 & bit0=CH1.
Note: The outputs of the module are open drain mosfet switches to return and are pulled up to (EXC) via 10KΩ resistors. This register is used to set/clear the output state of the corresponding output and will trigger the gate of the output switch to turn ON or OFF as required. Output channels sink from EX+ through the load to RTN when turned ON. Failure to provide excitation will render the open-drain outputs inoperable.					1 = Output ON 0 = Output OFF
40002	40102	40202	40302	AIN CH1 Config	**VAL** / **INPUT RANGE** 9 / ±500mV 8 / ±100mV 7 / Type N 6 / Type B 5 / Type E 4 / Type S 3 / Type R 2 / Type T 1 / Type K 0 / Type J
40003	40103	40203	40303	AIN CH2 Config	See AIN CH1 explanation
40004	40104	40204	40304	AIN CH3 Config	See AIN CH1 explanation
40005	40105	40205	40305	AIN CH4 Config	See AIN CH1 explanation
40006	40106	40206	40306	AIN CH5 Config	See AIN CH1 explanation
40007	40107	40207	40307	AIN CH6 Config	See AIN CH1 explanation
40008	40108	40208	40308	AIN CH7 Config	See AIN CH1 explanation
40009	40109	40209	40309	AIN CH8 Config	See AIN CH1 explanation
40010	40110	40210	40310	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	*:*	*:*
40017	40117	40217	40317	*Reserved*	*Reserved – Do Not Use*

NT2611 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40018	40118	40218	40318	Input Filter	**VAL** **FILTER** 5 None (1.67ms/8CH) 4 LOW (25ms/8CH) 3 LOW (100ms/8CH) 2 MED (133.3ms/8CH) 1 MED (160ms/8CH) 0 HIGH (800ms/8CH)
Sets the level of input digital filtering to apply to all eight input channels. Selecting Medium or High includes 50-60Hz signal rejection.					
40019	40119	40219	40319	*Reserved*	*Reserved – Do Not Use*
40020	40120	40220	40320	*Reserved*	*Reserved – Do Not Use*
40021	40121	40221	40321	*Reserved*	*Reserved – Do Not Use*
40022	40122	40222	40322	Legacy Support Enable Switch	16-bit UINT w/lsb=Legacy Set lsb=1 to changes the normalization of the input to ±20000 = ±100% for i2o compatibility with legacy Acromag devices (set 0 for ±30000=±100%).
40023	40123	40223	40323	*Reserved*	*Reserved – Do Not Use*
40024	40124	40224	40324	Timeout State of CH1	16-bit UINT w/lsb=State Sets the state of output channel upon watchdog timeout with 0000H = Set to OFF state, 0001H = Set to ON state.
40025	40125	40225	40325	Timeout State of CH2	See CH1 Timeout Explanation

NT2611 Registers

Ref.	Ref.	Ref.	Ref.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)					
Slot 0	Slot 1	Slot 2	Slot 3		
40026	40126	40226	40326	Watchdog Time CH1	*16-bit UINT seconds* Set a watchdog time from 1 to 65535, set 0 (0000H) to disable the watchdog timer. All watchdog timers are reset with a write to any DO of the IO slot.
40027	40127	40227	40327	Watchdog Time CH2	See CH1 Watchdog Time Explanation
40028	40128	40228	40328	*Reserved*	*Reserved – Do Not Use*
:	:	:	:	:	:
40095	40195	40295	40395	*Reserved*	*Reserved – Do Not Use*
40096	40196	40296	40396	CJC Enable (All CH)	16-bit UINT w/ 1 = CJC ON, 0 = CJC OFF
40097	40197	40297	40397	TC Break UP/ Down (All CH)	16-bit UINT w/ 1 = Upscale, 0 = Downscale
40098	40198	40298	40398	Temperature Units	16-bit UINT w/ 1 = Fahrenheit, 0 = Celsius

REVISION HISTORY

The following table details the revision history for this document:

Release	Version	EGR/DOC	Description of Revision
June 2021	A	BC	NT Phase I User's Manual