

Nexus 1250

High Performance SCADA Monitor

Installation & Operation Manual
Revision 1.21

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Electro Industries/GaugeTech

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“The World Leader in Power Monitoring Systems”

**Nexus 1250
Installation and Operation Manual
Revision 1.21**

Published by:
Electro Industries/GaugeTech
1800 Shames Drive
Westbury, NY 11590

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This symbol indicates that the operator must refer to an explanation in the operating instructions. Please see Chapter 3, Hardware Installation, for important safety information regarding installation and hookup of the Nexus 1250 Monitor.

About Electro Industries/GaugeTech

Electro Industries/GaugeTech was founded in 1973 by Dr. Samuel Kagan. Dr. Kagan's first innovation, an affordable, easy-to-use AC power meter, revolutionized the power-monitoring field. In the 1980s Dr. Kagan and his team at EIG developed a digital multifunction monitor capable of measuring every aspect of power.

EIG further transformed AC power metering and power distribution with the Futura+ device, which supplies all the functionality of a fault recorder, an event recorder and a data logger in one single meter. Today, with the Nexus 1250, EIG is a leader in the development and production of power-monitoring products. All EIG products are designed, manufactured, tested and calibrated at our facility in Westbury, New York.

Applications:

- Multifunction power monitoring
- Single and multifunction power monitoring
- Power-quality monitoring
- Onboard data logging for trending power usage and quality
- Disturbance analysis

Futura+ Series Products:

- Power-quality monitoring
- High-accuracy AC metering
- Onboard data logging
- Onboard fault and voltage recording

DM Series Products:

- Three-phase multifunction monitoring
- Wattage, VAR and amperage
- Modbus, Modbus Plus, DNP 3.0 and Ethernet protocols
- Analog retransmit signals (0–1 and 4–20mA)

Single-Function Meters:

- AC voltage and amperage
- DC voltage and amperage
- AC wattage
- Single-phase monitoring with maximum and minimum demands
- Transducer readouts

Portable Analyzers:

- Power-quality analysis
- Energy analysis

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Chapter 1

Basic Tutorial on AC Power Measurement

1.1: Single Phase Power Systems

The economics of electric power distribution networking dictate several configurations of AC power transmission. The number of phases and voltage levels characterize these configurations.

A single phase system is the basic, two-wire system used in low-power distribution applications, such as residential communities and offices. The voltage is typically 120VAC. For higher power requirements, such as small commercial facilities, the typical power configuration is two lines of 120VAC opposite in phase. This system produces 120 volts from line-to-neutral for lighting and small appliance use. The line-to-line voltage is 240V AC, used for higher loads such as water heaters, electric dryers, ranges and machinery.

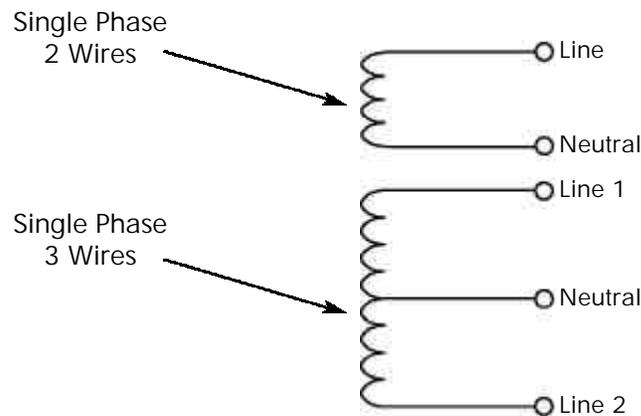


Figure 1.1: Single Phase Power Systems

- **Power (W)** in a single phase system is: $W = E \times I \times \cos \Theta$
E = potential, I = current, and $\cos \Theta$ = phase difference between the potential and the current.
- **Power (W)** in a 120/240VAC system is: $W = (E_{Line1} \times I_{Line1} \times \cos \Theta) + (E_{Line2} \times I_{Line2} \times \cos \Theta)$
Phase differential between the potential and the current results from a non-resistive load, either reactive or capacitive.
- **Reactive power (VAR)** is the additional power consumed that does not produce any work but must be delivered to the load: $VAR = E \times I \times \sin \Theta$
This is a measure of the inefficiency of the electrical system.
- **Apparent power (VA)** is the total power delivered to the load, and the vector sum of real power and reactive power.

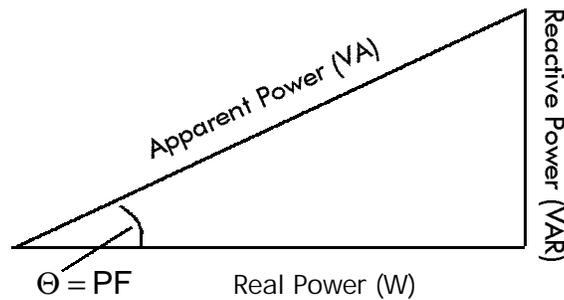


Figure 1.2: Relationships Between Apparent, Real and Reactive Power

- Power Factor (PF)** is the ratio between real power and apparent power. Ideal power distribution should have a PF of 1. This condition can be met only if no reactive power loads exist. In real life applications, many loads are inductive loads. Corrective capacitors are installed to correct poor Power Factor.

$$PF = \frac{W}{VA} = \frac{W}{\sqrt{W^2 + VAR^2}}$$

1.2: Three-Phase Power Systems

A three-phase system delivers higher levels of power for industrial and commercial applications; the three phases correspond to three potential lines. A 120° phase shift exists between the three potential lines. A typical three-phase configuration has either a Delta connection or a Wye connection. In a three phase system, the voltage levels between the phases and the neutral are uniform and defined by:

$$E_{an} = E_{bn} = E_{cn} = \frac{E_{ab}}{\sqrt{3}} = \frac{E_{bc}}{\sqrt{3}} = \frac{E_{ac}}{\sqrt{3}}$$

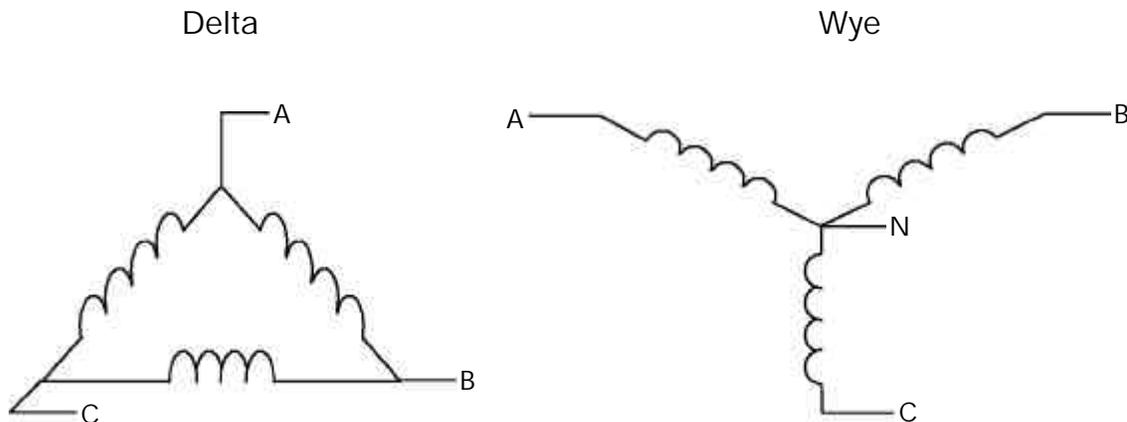


Figure 1.3: Three Phase Power Systems

Voltages between the phases vary depending on loading factors and the quality of distribution transformers. The three phase system is distributed in different voltage levels: 208VAC; 480VAC; 2,400VAC; 4,160VAC; 6,900VAC; 13,800VAC, etc.

1.3: Poly Phase Power Systems

Power measurement in a poly phase system is governed by Blondel's Theorem. Blondel's Theorem states that in a power distribution network that has N conductors, the number of measurement elements required to determine power is N-1. A typical configuration of a poly phase system has either a Delta connection or a Wye connection.

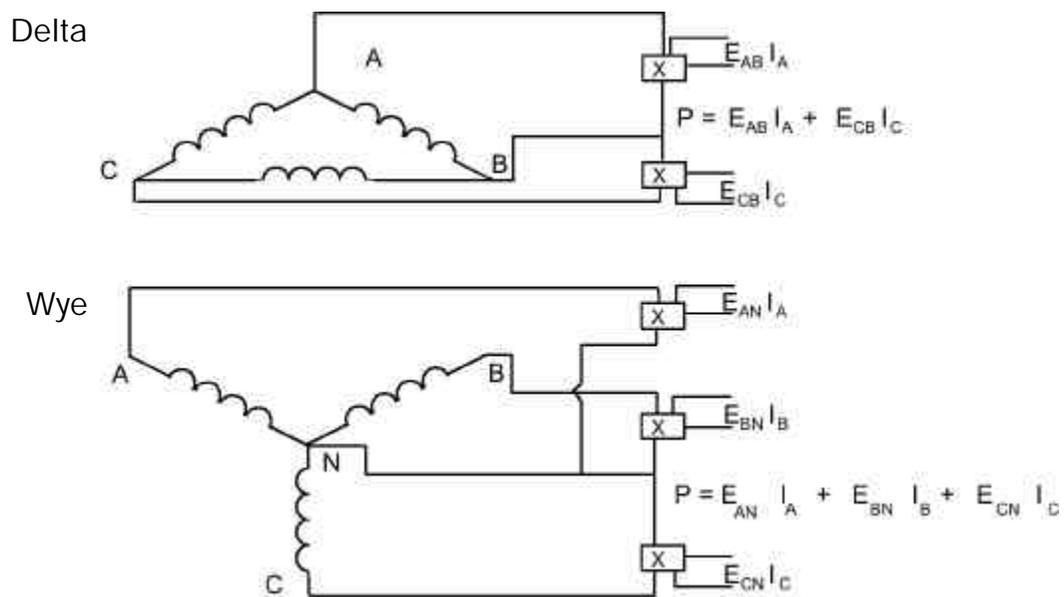


Figure 1.4: Poly Phase Power Systems

1.4: Consumption, Demand and Poor Power Factor

- **Consumption** is the total electric energy usage over a time period, expressed in WH.
W = instantaneous power; T = time in hours.

$$WH = W \times T$$

Consumption is typically measured in kilowatt-hours (kWh): one thousand watts consumed over one hour. Utilities use the WH equation to determine the overall consumption in a billing period.

- **Demand** is the average energy consumed over a specified time interval. The interval is determined by the utility, typically, 15 or 30 minutes. The utility measures the maximum demand over a billing period. This measurement exhibits a deviation from average consumption, forcing the utility to provide generating capacity to satisfy a higher maximum consumption demand. The highest average demand is retained in the metering system until the demand level is reset.
- **Poor Power Factor** results in reactive power consumption. Transferring reactive power over a distribution network causes energy loss. To force consumers to correct their Power Factor, utilities monitor reactive power consumption and penalize the user for poor power factor.

1.5: Waveform and Harmonics

Ideal power distribution has sinusoidal waveforms on voltages and currents. In real life applications, where inverters, computers and motor controls are used, distorted waveforms are generated. These distortions consist of harmonics of the fundamental frequency.

- **Sinusoidal waveform:** $A \times \sin(\omega \times t)$
- **Distorted waveform:** $A \times \sin(\omega \times t) + A_1 \times \sin(\omega_1 \times t) + A_2 \times \sin(\omega_2 \times t) + A_3 \times \sin(\omega_3 \times t) + \dots$
- **Percent of Total harmonic distortion (% of THD):**

$$\% \text{ of THD} = \frac{\text{RMS of Total Harmonic Distortion Signal}}{\text{RMS of the Fundamental Signal}} \times 100$$

- **Harmonic distortion** is a destructive force in power distribution systems. It creates safety problems, shortens the life span of distribution transformers, and interferes with the operation of electronic devices. The Nexus 1250 monitors the harmonic distortion to the 83rd harmonic. A waveform capture of the distorted waveform can be read with the Nexus Communicator software.

Chapter 2

Nexus Overview

2.1: The Nexus System

Electro Industries' Nexus 1250 combines high-end revenue metering with sophisticated power quality analysis. Its advanced monitoring capabilities provide detailed and precise pictures of any metered point within a distribution network. Extensive I/O capability is available in conjunction with all metering functions. The optional Nexus Communicator software allows a user to poll and gather data from multiple Nexus monitors installed at local or remote locations (see the *Nexus Communicator User Manual* for details). On-board mass memory enables the Nexus to retrieve and store multiple logs. The Nexus Monitor with Internal Modem (or Network) Option connects to a PC via standard phone line (or MODBUS/TCP) and a daisy chain of Nexus Monitors via an RS-485 connection. See *Chapters 10 and 11* for details.

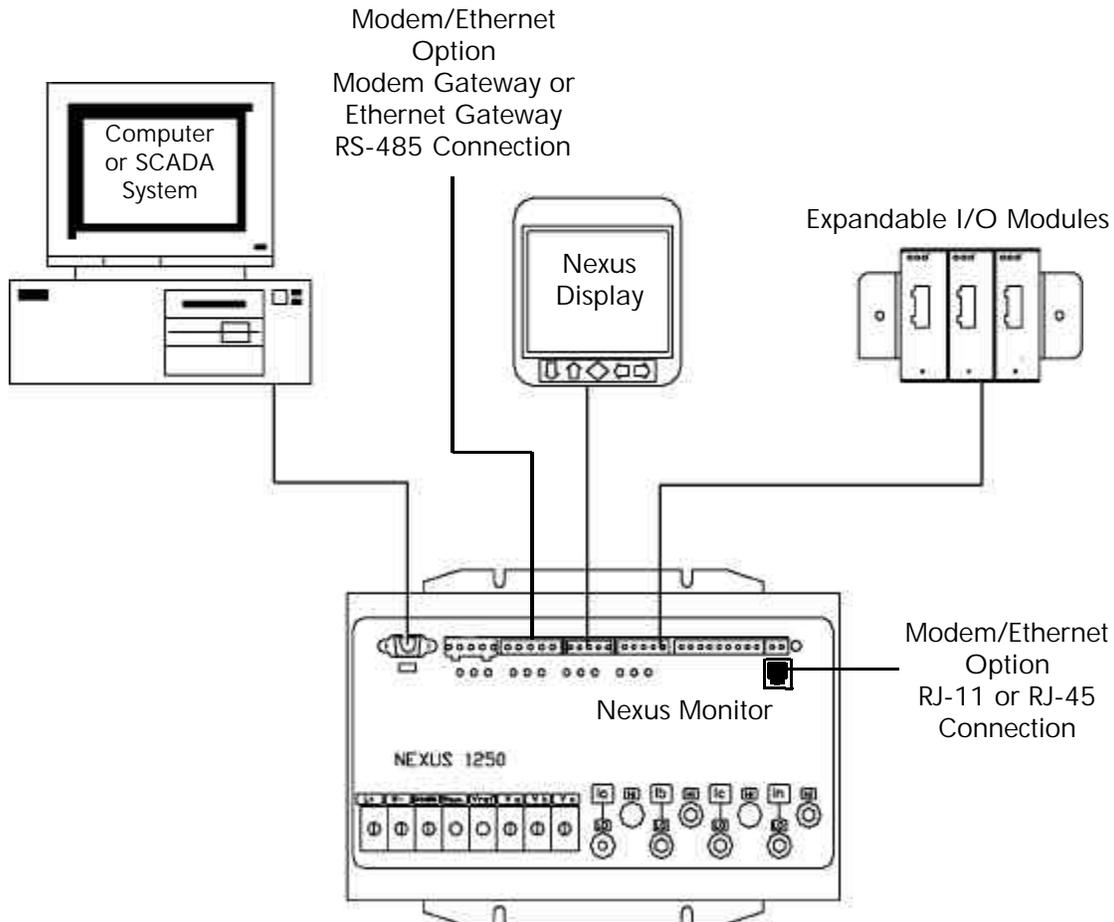


Figure 2.1: The Nexus System

■ **Nexus 1250 Revenue Metering:**

- Delivers laboratory-grade 0.04% Watt-hour accuracy in a field-mounted device.
- Auto-calibrates when there is a temperature change of more than 10 degrees centigrade.
- Exceeds all ANSI C-12 and IEC 687 specifications.
- Adjusts for transformer and line losses, using user-defined compensation factors.
- Automatically logs time-of-use for up to eight programmable tariff registers.
- Counts pulses and aggregates different loads.

■ **Nexus 1250 Power Quality Monitoring:**

- Records up to 512 samples per cycle on an event.
- Records sub-cycle transients on voltage or current readings.
- Measures and records Harmonics to the 83rd order.
- Offers inputs for neutral-to-ground voltage measurements.
- Synchronizes with IRIG-B clock signal.

■ **Nexus 1250 Memory, Communication and Control:**

- Up to 4 Meg NVRAM.
- 4 High Speed Communication Ports.
- Multiple Protocols.
- Built-in RTU functionality.
- Built-in PLC functionality.
- 90msec High Speed Updates for Control.

2.2: Measurements and Calculations

The Nexus 1250 Monitor measures many different power parameters. The following is a list of the formulas used to conduct calculations.

- Root Mean Square (RMS) of Voltages:
n = number of samples

$$\text{RMS} = \sqrt{\frac{\sum_{t=1}^n v_{x(t)}^2}{n}}$$

- Root Mean Square (RMS) of Currents:
n = number of samples

$$I_{rms} = \sqrt{\frac{\sum_{t=1}^n i_{x(t)}^2}{n}}$$

- Root Mean Square (RMS) of Phase to Phase Voltages
n = number of samples

$$xy = \sqrt{\frac{\sum_{t=1}^n (V_{x(t)} - V_{y(t)})^2}{n}}$$

- Apparent Power (VA):

$$\text{VA} = V_{rms} \times I_{rms}$$

- Reactive Power (VAR):

$$\text{VAR}_x = \sqrt{\text{VA}_x^2 - \text{Watt}_x^2}$$

- Power (Watts):

$$\text{W} = V_{\text{sample}} \times I_{\text{samples}}$$

- Power Factor (PF):

$$\text{PF}_x = \frac{\text{Watt}_x}{\text{VA}_x}$$

- Phase Angles:

$$\angle = \cos^{-1}(\text{PF})$$

- % Total Harmonic Distortion (%THD):
f= fundamental; h = harmonic order

$$\%THD = 100 \times \frac{\sqrt{\sum_{h=2}^h (I_h)^2}}{I_f}$$

- K Factor:
h = harmonic order; pu = per unit rms current for each of the harmonic frequencies

$$K \text{ Factor} = \sum_i^h I_h (pu)^2 h^2$$

2.3: Demand Integrators

Power utilities take into account both energy consumption and peak demand when billing customers. Peak demand, expressed in kilowatts (kW), is the highest level of demand recorded during a set period of time, called the interval. The Nexus 1250 supports the following most popular conventions for averaging demand and peak demand: Thermal Demand, Fixed Window Demand, Sliding Window Demand and Predictive Window Demand. You may program and access all conventions concurrently with the Nexus Communicator software (see the *Nexus Communicator User Manual*).

- **Thermal Demand:** Traditional analog watt-hour (WH) meters use heat-sensitive elements to measure temperature rises produced by an increase in current flowing through the meter. A pointer moves in proportion to the temperature change, providing a record of demand. The pointer remains at peak level until a subsequent increase in demand moves it again, or until it is manually reset. The Nexus 1250 mimics traditional meters to provide Thermal Demand readings.
- **Fixed Window Demand:** This convention records the average demand for consecutive time intervals (usually 15 minutes). For example, if the user selects fifteen-minute intervals and begins measuring at 12:00, the first window will be from 12:00 to 12:15, the next window will be from 12:15 to 12:30 and, so on.
- **Rolling Window Demand (Sliding Window):** The Rolling Window convention divides a fixed time interval into a programmable number of subintervals. The Nexus calculates the average demand at the end of each subinterval. At the conclusion of the time interval, all calculations from the subintervals are totaled and averaged together. This provides a more accurate demand reading than Fixed Window Demand.
- **Predictive Window Demand:** Predictive Window Demand enables the user to forecast average demand for future time intervals. The Nexus uses the delta rate of change of a Rolling Window Demand interval to predict average demand for an approaching time period. The user can set a relay or alarm to signal when the Predictive Window reaches a specific level, thereby avoiding unacceptable demand levels. The Nexus 1250 calculates Predictive Window Demand using the following formula:

$$\frac{(\text{Thermal Avg.} \times \text{Time Left in Sub-Interval}) + (\text{Accumulated Value in Period}) + [\text{Prev. SWD} \times (\# \text{ of Sub-Intervals}-1) \times \text{Sub-Interval Length}]}{\text{Total Sliding Window Demand Period}}$$

2.4: Nexus External I/O Modules (Optional)

The following multiple analog or digital I/O modules mount externally to the Nexus Monitor. The Monitor supports up to four I/O modules using internal power. Use the additional power supply, EIG Power Brick (PB1), to extend I/O capability. See section 3.4 for mounting diagrams. See Chapter 9 for details on installation and usage of the Nexus External I/O Modules.

- **Analog Transducer Signal Outputs** (Up to two modules can be used with the Nexus.)
 - 1mAON4: 4 Analog Outputs, self powered, scalable, bi-directional.
 - 1mAON8: 8 Analog Outputs, self powered, scalable, bi-directional.
 - 20mAON4: 4 Analog Outputs, self powered, scalable.
 - 20mAON8: 8 Analog Outputs, self powered, scalable.

- **Analog Transducer Inputs** (Multiple modules can be used.)
 - 8AI1: 8 Analog Inputs 0–1mA, scalable and bi-directional.
 - 8AI2: 8 Analog Inputs 0–20mA, scalable.
 - 8AI3: 8 Analog Inputs 0–5 VDC.
 - 8AI4: 8 Analog Inputs 0–10 VDC.

- **Digital Dry Contact Relay Outputs** (Multiple modules can be used.)
 - 4RO1: 4 Relay Outputs 10 Amps, 125 VAC, 30 VDC, Form C.

- **Digital Solid State Pulse Outputs** (Multiple modules can be used.)
 - 4PO1: 4 Solid State Pulse Outputs, Form A KYZ pulses.

- **Digital Inputs** (Multiple modules can be used.)
 - 8DI1: 8 Digital status inputs Wet/Dry Auto Detect, up to 300 VAC/DC.

- **Other I/O Accessories**
 - PSIO: Additional power supply for up to six I/O modules. This unit is necessary if you are connecting more than four I/O modules to a Nexus Monitor.
 - MBIO: Bracket for surface-mounting I/O modules to any enclosure.

2.5: Nexus Monitor Specifications

| Specification | Nexus Monitor |
|---------------------------------|--|
| Control Power Requirements | Option D: 24VDC (-20%) – 48VDC (+20%) |
| | Option D2: 120VAC/DC (-20%) – 230VAC (+20%) |
| Input Voltage Range | 150 Volts Phase to Neutral (Standard; for use with PTs) |
| | 300 Volts Phase to Neutral (Option -G) |
| Input Current Range | 10A Maximum (Programmable to any CT Ratio) |
| Input Withstanding Capabilities | Current: Continuous 200% Rated |
| | Current: Surge 10x maximum input for 3 seconds |
| | Surge Withstanding Per IEEE C37.90.1 |
| Burden | Voltage: 0.05VA @ 120V rms |
| | Current: 0.002VA @ 5A rms |
| I/O Isolation | 2500 VDC, 60 Hz |
| Sensing Method | RMS |
| Update Time | 90 msec |
| Frequency Range | Fundamental 20–65 Hz |
| | Up to 83rd Harmonic Measuring Capability |
| Dimensions (HxWxL) | 3.4 x 7.3 x 10.5 inches / 8.6 x 18.5 x 26.6 centimeters |
| Maximum Power Consumption | 40 watts (with optional modules and display) |
| Nominal Power Consumption | Approximately 12 watts (without optional modules and display) |
| Operating Temperature | -40°C to +70°C / -40°F to +158°F |
| Auxiliary Output Power Voltage | 15–20 VDC at 50–200mA |
| Maximum Auxiliary Power Current | 1.6A (short protected) |
| UL Listing | 1244* |
| | *Not evaluated for accuracy, reliability or capability to perform intended function. |

2.6: Nexus P40N LED External Display Specifications

| Specification | Nexus P40N LED External Display |
|-----------------------------|---|
| Maximum Input Voltage | 30 VDC |
| Minimum Input Voltage | 7 VDC |
| Maximum Power Consumption | 8 watts |
| Nominal Power Consumption | Approximately 6 watts |
| Operating Temperature Range | -40°C to + 70°C / -40°F to +158°F |
| Overall Dimensions (HxWxL) | 2.2 x 4.4 x 4.4 in / 5.9 x 11.1 x 11.1 cm |

2.7: Nexus P60N Touch Screen Display Specifications

| Specification | Nexus P60N Touch Screen Display |
|-----------------------------|---|
| Maximum Input Voltage | 30 VDC |
| Minimum Input Voltage | 10 VDC |
| Maximum Power Consumption | 5 watts |
| Nominal Power Consumption | Approximately 4.5 watts |
| Operating Temperature Range | 0°C to + 50°C / +32°F to +122°F |
| Overall Dimensions (HxWxL) | 1.6 x 5.4 x 8.0 in / 4.0 x 13.7 x 20.3 cm |

Chapter 3

Hardware Installation

3.1: Mounting the Nexus Monitor

■ The Nexus Monitor is designed to mount against any firm, flat surface. Use a #10 screw in each of the four slots on the flange to ensure that the unit is installed securely. For safety reasons, mount the Monitor in an **enclosed and protected environment**, such as in a switchgear cabinet. Install a **switch or circuit breaker** nearby and label it clearly as the Monitor's disconnecting mechanism. NOTE: The Nexus Monitor with Internal Modem Option mounts the same way.

■ Maintain the following conditions:

- Operating Temperature: -40°C to +70°C / -40°F to +158°F
- Storage Temperature: -45°C to +85°C / -49°F to +185°F
- Relative Humidity: 5 to 95% non-condensing

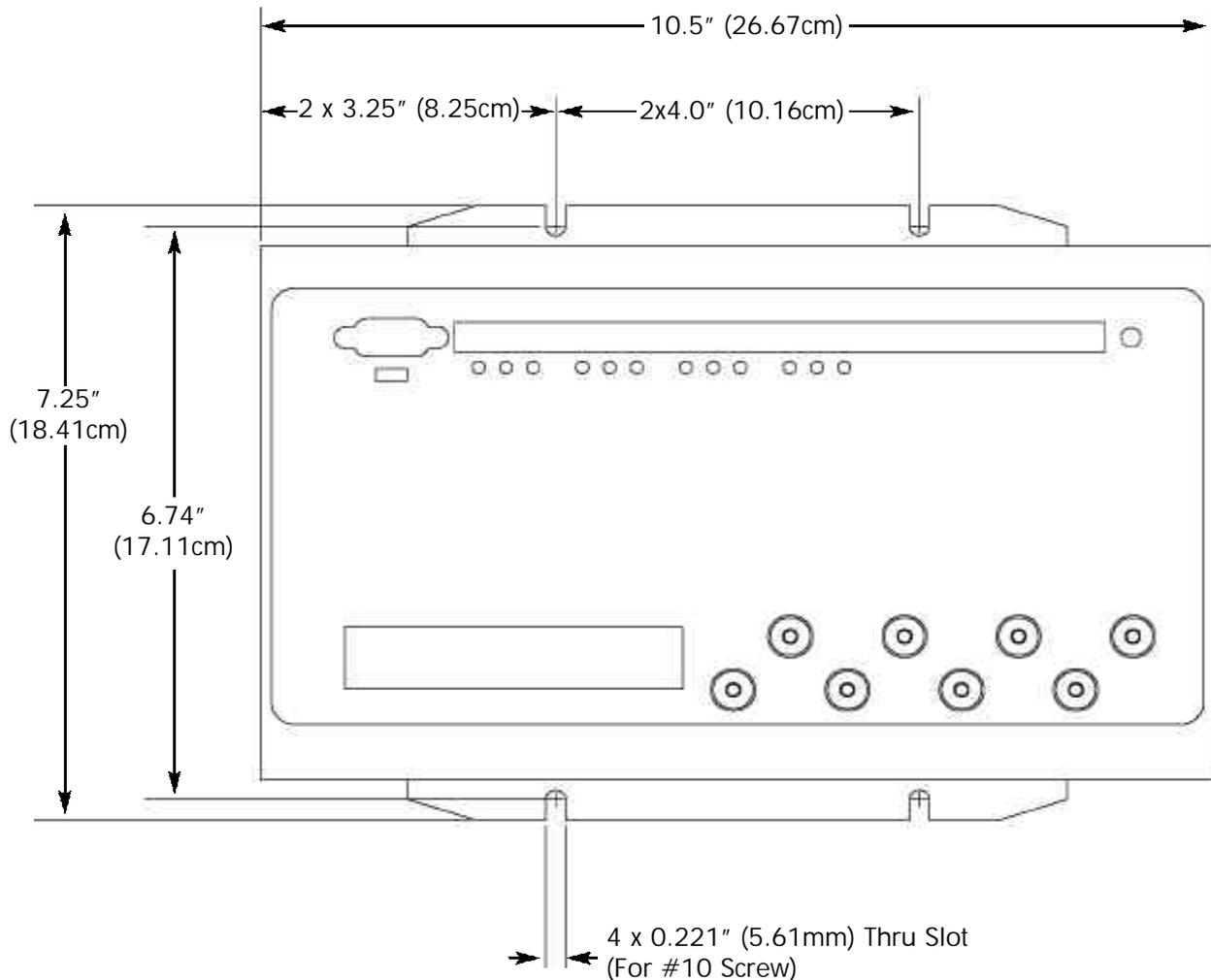


Figure 3.1: Nexus Monitor Mounting Diagram, Top View

Nexus Monitor Mounting Diagram, Side View

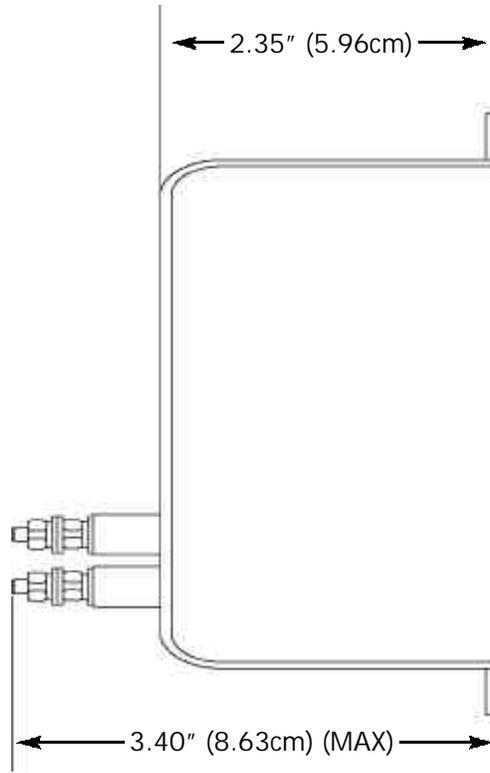


Figure 3.2

3.2: Mounting the Nexus P40N LED External Display

- The Nexus 1250 LED Display, Model # P40N, mounts using a standard ANSI C39.1 drill plan.
- Secure the four mounting studs to the back of the panel with the supplied nuts.
- Six feet of RS-485 communication/power cable harness is supplied. Allow for at least a 1.25-inch (3.17cm) diameter hole in the back for the cable harness. See Chapter 5 for communication and power supply details.
- The cable harness brings power to the display from the Nexus Monitor, which supplies 15–20 VDC. The P40N can draw up to 500 mA in display test mode.

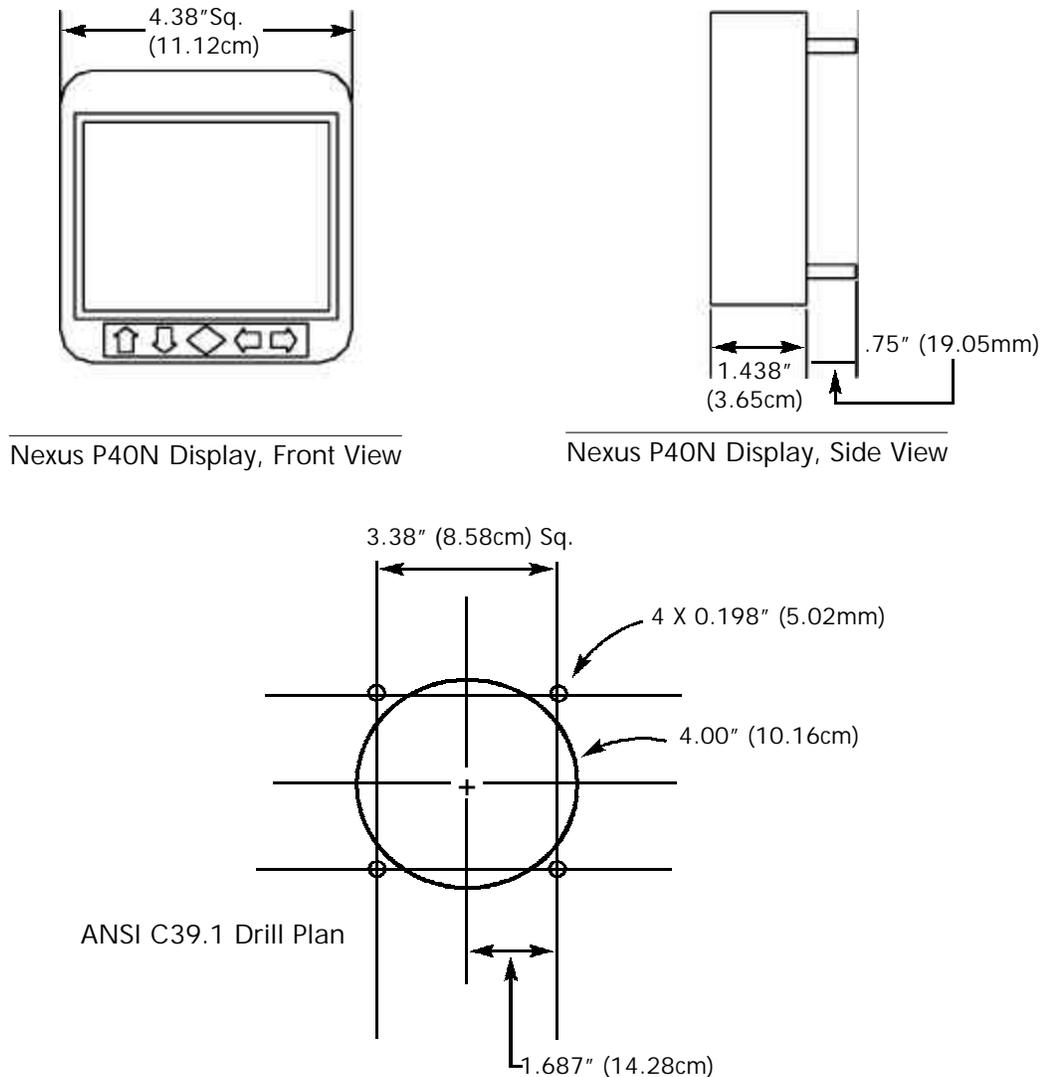


Figure 3.3: Nexus P40N LED External Display Mounting Diagrams

3.3: Mounting the Nexus P60N Touch Screen External Display

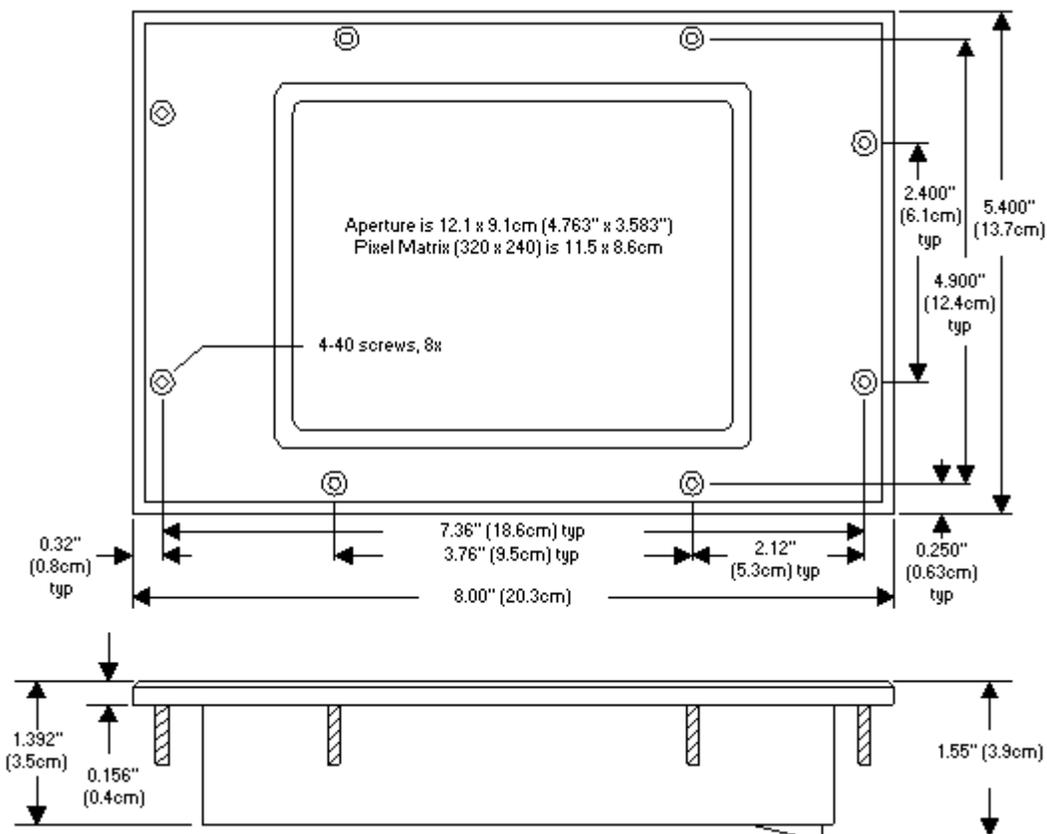


Figure 3.4: Nexus P60N Touch Screen Display Mounting Diagram

■ The Nexus 1250 P60N Touch Screen Display mounts easily, using the diagrams above and on the next page. A bezel and a gasket are included with the P60N. Since the P60N employs an LCD display, the viewing angle must be considered when mounting. Install the P60N at a height and angle that make it easy for the operator to see and access the screen.

■ For optimum performance, maintain the following conditions where the Touch Screen Display is mounted:

- Operating Temperature: 0°C to +50°C / +32°F to +122°F
- Storage Temperature: -20°C to +70°C / -36°F to +158°F
- Relative Humidity: 25 to 65% non-condensing

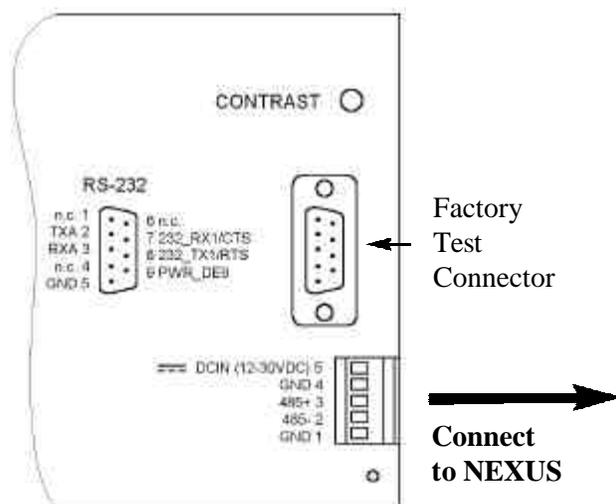


Figure 3.5: Nexus P60N Back Detail

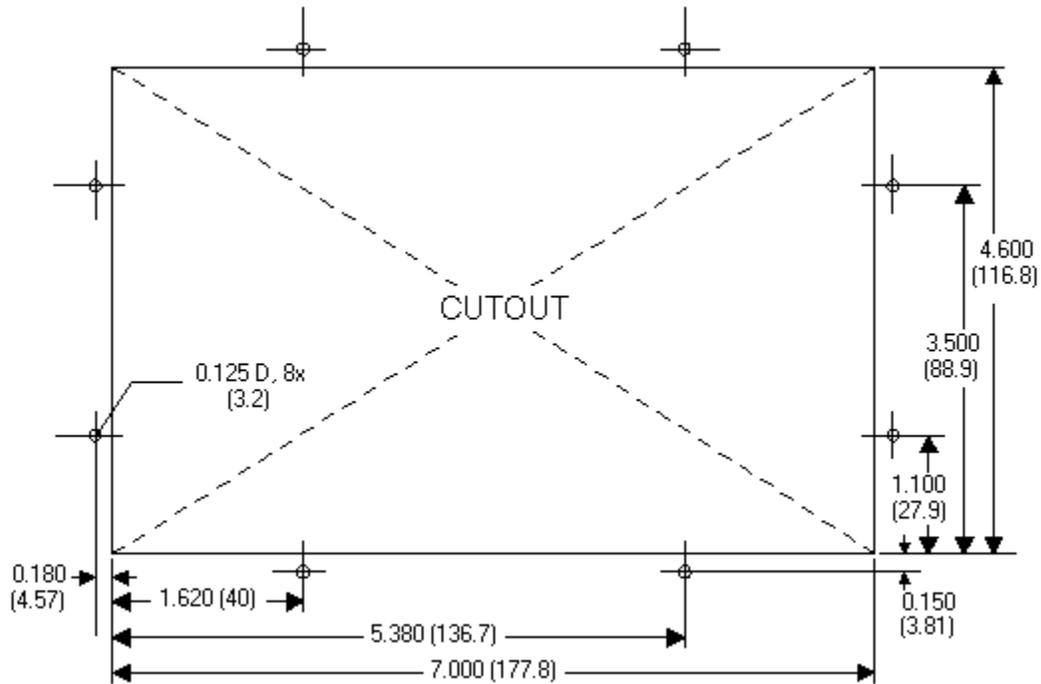


Figure 3.6: Cutout for Nexus P60N Touch Screen Display

- To bezel mount the P60N, cut an opening in the mounting panel. Follow above cutout dimensions.
- Carefully “drop in” the P60N with bezel and gasket attached. See Figure 3.7 below for details.
- Fasten the unit securely with the four 6-32 hex nuts supplied.

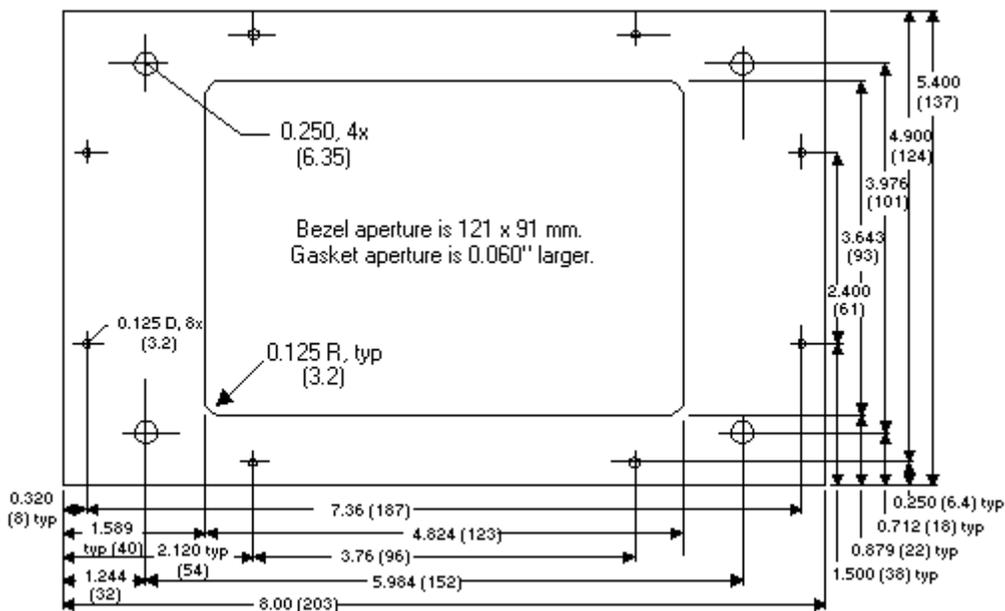


Figure 3.7: Nexus P60N Touch Screen Display Bezel Mounting Diagram

3.4: Mounting the Nexus External I/O Modules

- Secure the mounting brackets to the I/O using the screws supplied (#440 pan-head screws). Next, secure the brackets to a flat surface using a #8 screw with a lock washer.
- If multiple I/O modules are connected together, as shown in Figure 3.4, secure a mounting bracket to both ends of the group. One Nexus will supply power for up to **four I/O modules**. To connect more than four I/O modules, use an additional power supply, such as the EIG Power Brick. Connect multiple I/O modules using the RS-485 side ports.
- Six feet of RS-485 cable harness is supplied. The cable harness brings power to the display from the Nexus Monitor, which supplies 15–20 VDC at 50–200mA. See Chapter 5 for power supply and communication details.

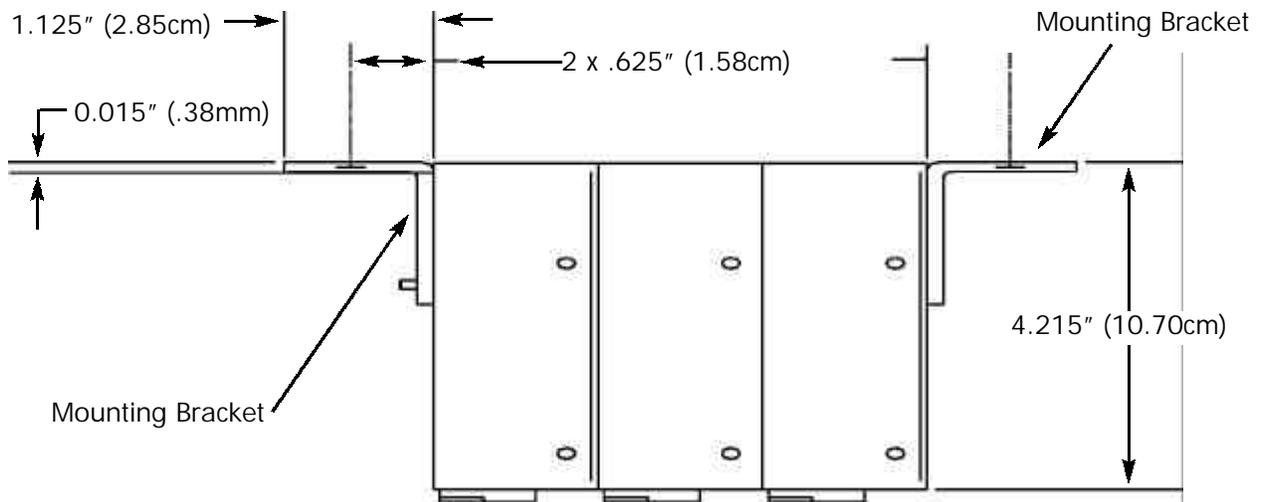


Figure 3.8: Nexus I/O Modules Mounting Diagram, Overhead View

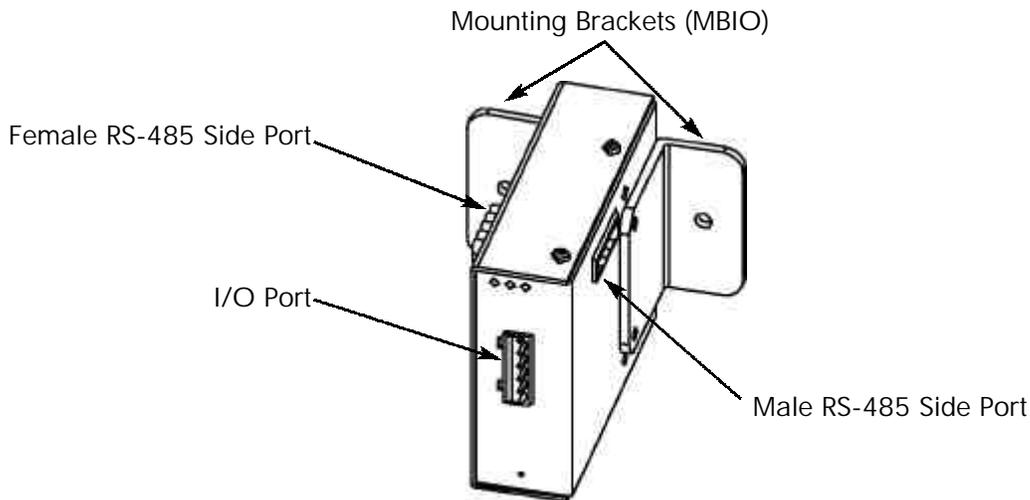


Figure 3.9: Nexus I/O Module Communication Ports

Nexus I/O Modules Mounting Diagram, Front View

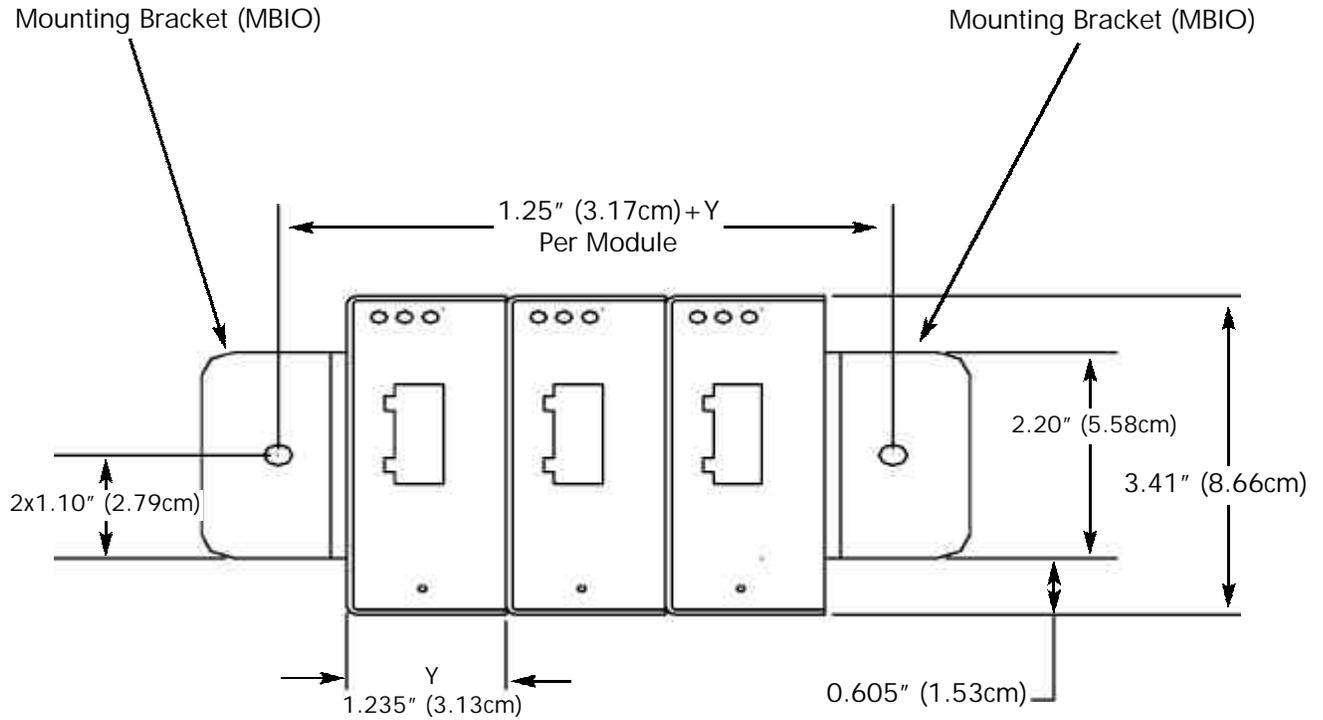


Figure 3.10

Chapter 4

Electrical Installation

4.1: Wiring the Monitored Inputs and Voltages

- Select a wiring diagram from section 4.8 that best suits your application. Wire the Nexus Monitor exactly as shown. For proper operation, the voltage connection must be maintained and must correspond to the correct terminal. Program the CT and PT ratios in the Device Profile section of the Nexus Communicator software; see the *Nexus Communicator User Manual* for details.
- The cable required to terminate the voltage sense circuit should have an insulation rating greater than 600VAC and a current rating greater than 0.1 Amp.
- Use AWG 14 wire for all phase voltage and current connections.

4.2: Fusing the Voltage Connections

- For accuracy of the readings and for protection, EIG requires using 0.25-Amp rated fuses on all voltage inputs, as shown in the wiring diagrams (see section 4.8).
- The Nexus Monitor can handle a maximum voltage of 150V phase to neutral and 300V phase to phase. Potential Transformers (PTs) are required for higher voltages with the standard rating. With option –G, the voltage input is extended to 300V phase to neutral and 600V phase to phase.

4.3: Wiring the Monitored Inputs - VRef

- The Voltage Reference connection references the monitor to ground or neutral.

4.4: Wiring the Monitored Inputs - VAux

- The Voltage Reference connection is an auxiliary voltage input that can be used for any desired purpose, such as monitoring neutral to ground voltage or monitoring two different lines on a switch.

4.5: Wiring the Monitored Inputs - Currents

- Install the cables for the current at 600VAC minimum insulation. The cable connector should be rated at 10 Amps or greater and have a cross-sectional area of 14 AWG.
- Mount the current transformers (CTs) as close as possible to the meter. The following table illustrates the maximum recommended distances for various CT sizes, assuming the connection is via 14 AWG cable.

| CT Size (VA) | Maximum Distance from CT to Nexus (Feet) |
|--------------|--|
| 2.5 | 10 |
| 5.0 | 15 |
| 7.5 | 30 |
| 10.0 | 40 |
| 15.0 | 60 |
| 30.0 | 120 |



Warning: DO NOT leave the secondary of the CT open when primary current is flowing. This may cause high voltage, which will overheat the CT. If the CT is not connected, provide a shorting block on the secondary of the CT.

- It is important to maintain the polarity of the CT circuit when connecting to the Nexus. If this polarity is reversed, the Nexus Monitor will not provide accurate readings. CT polarities are dependent upon correct connection of CT leads and the direction CTs are facing when clamped around the conductors. EIG recommends using shorting blocks to allow removal of the Nexus Monitor from an energized circuit, if necessary. Shorting blocks are not required for proper meter operation.

4.6: Isolating a CT Connection Reversal

- For a WYE System you may either:
 - Check the current phase angle reading on the Nexus External Display (see Chapter 6). If it is negative, reverse the CTs.
 - Or, go to the Phasors screen of the Nexus Communicator Software (see the *Nexus Communicator User Manual*). Note the Phase relationship between the Current and Voltage; they should be in phase.
- For a Delta System:
 - Go to the Phasors screen of the Nexus Communicator software program. The current should be 30 degrees off the phase-to-phase voltage.

4.7: Instrument Power Connections

- The Nexus requires a separate power source. To use AC power, connect the line supply wire to the L+ terminal and the neutral supply wire to the N- terminal on the Nexus. To use DC power, connect the positive supply wire to the L+ terminal and the negative (ground) supply wire to the N- terminal on the Nexus. Power supply options and corresponding suffixes are listed in the following table.

| Control Power | Option Suffix |
|--------------------|---------------|
| 18–60 Volts DC | D |
| 90–276 Volts AC/DC | D2 |

- Do not ground the unit through the negative of the DC supply. Separate grounding is required.
- Externally fuse the power supply with a 5 Amp fuse.

4.8: Wiring Diagrams

Choose the diagram that best suits your application. Diagrams appear on the following pages. If the connection diagram you need is not listed, contact EIG for a custom connection diagram.

Note: If you purchased a “G” Option Nexus for a 300 Volt secondary, be sure to enable the option in the CT and PT section of the Nexus Communicator software’s Device Profile (see the *Nexus Communicator User Manual* for details).

| Figure # | Description |
|----------|---|
| 4.1 | 4-Wire Wye, 3-Element Direct Voltage with 4 CTs |
| 4.2 | 4-Wire Wye, 3-Element with 3 PTs and 4 CTs |
| 4.3 | 3-Wire, 2-Element Open Delta with 2 PTs and 3 CTs |
| 4.4 | 3-Wire, 2-Element Open Delta with 2 PTs and 2 CTs |
| 4.5 | 3-Wire, 2-Element Delta Direct Voltage with 3 CTs |
| 4.6 | 3-Phase, 4-Wire Wye, 2.5 Element with 2 PTs and 3 CTs |
| 4.7 | 4-Wire, 3-Element Grounded Delta with 4 CTs |

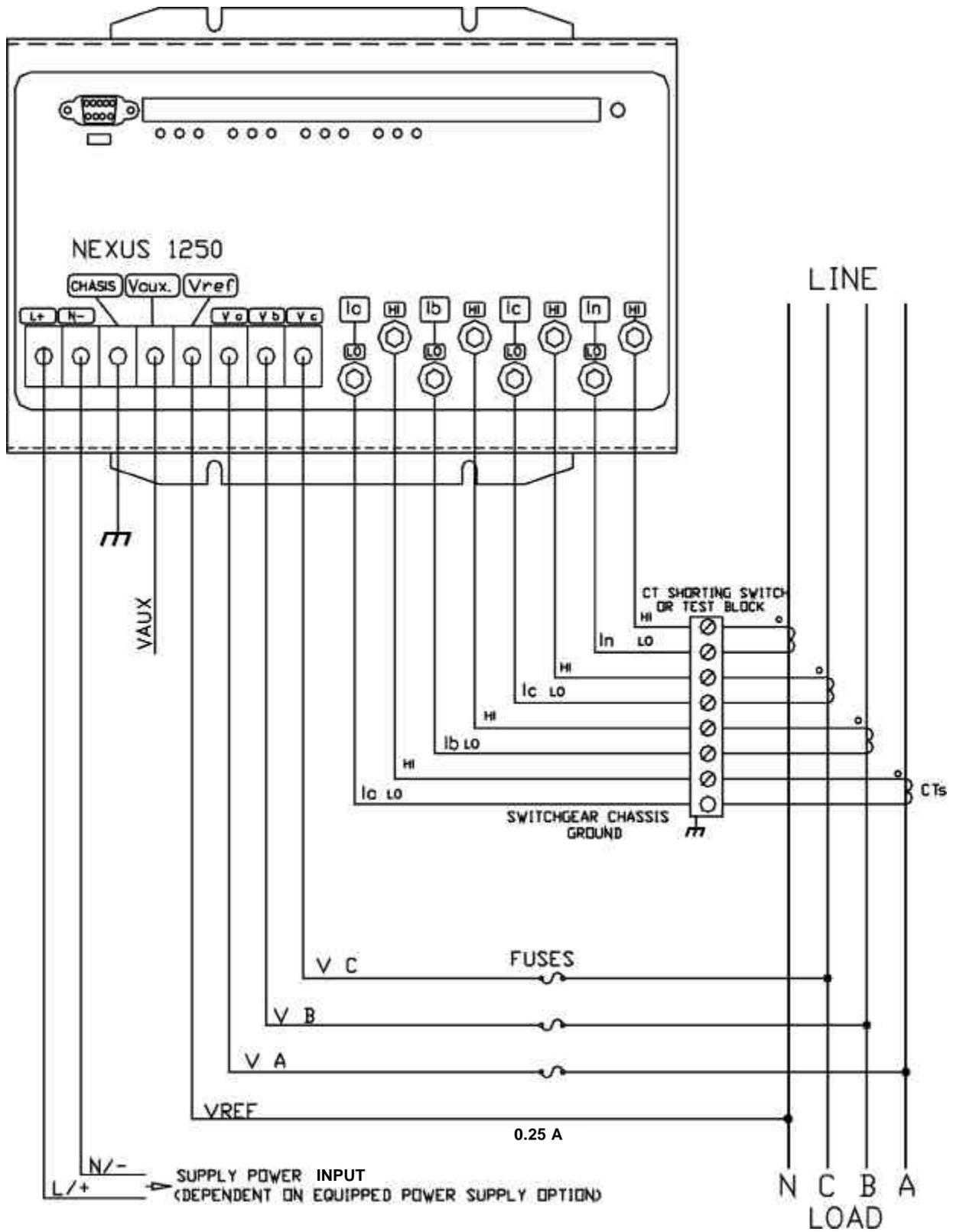


Figure 4.1: 4-Wire Wye, 3-Element Direct Voltage with 4 CTs

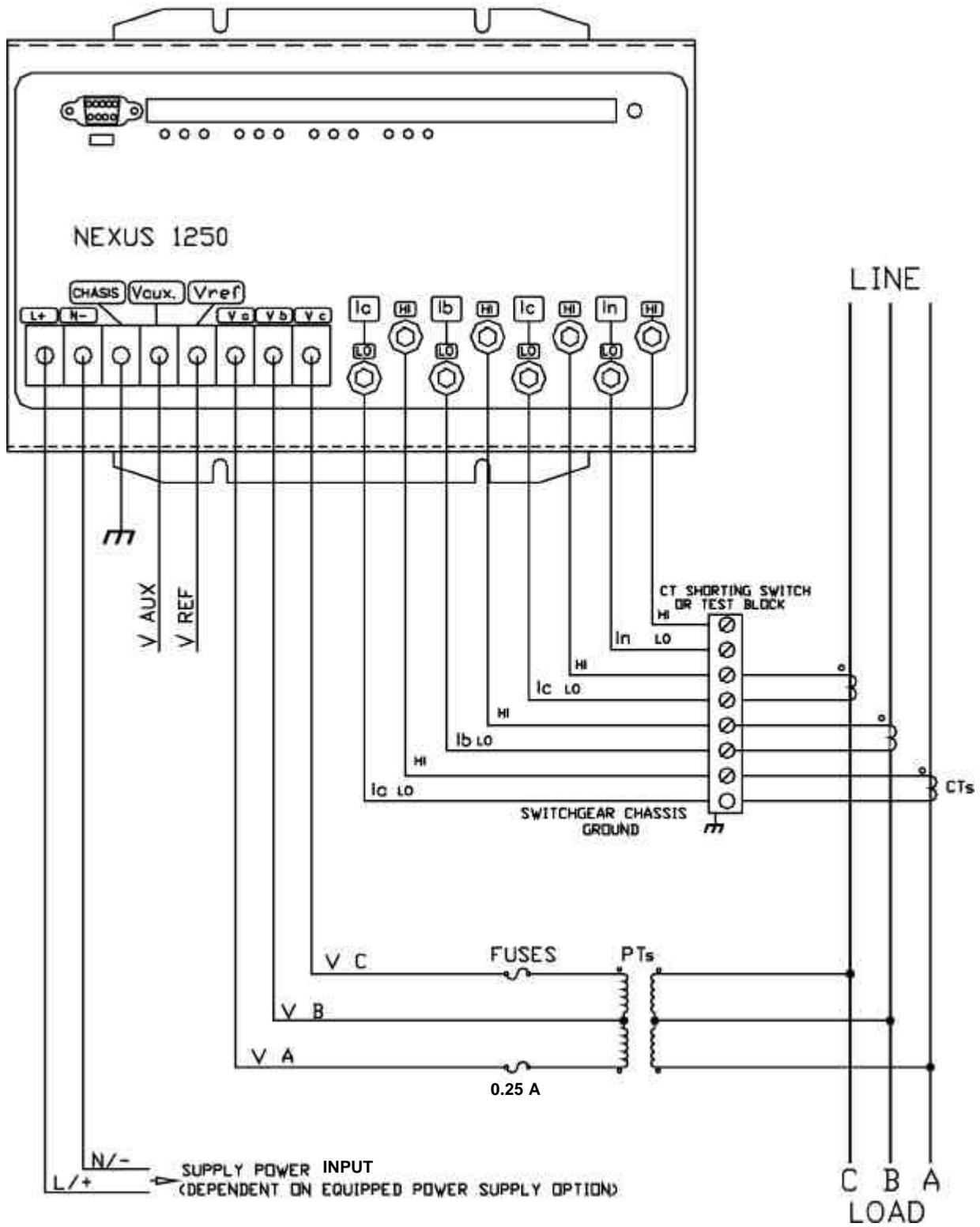


Figure 4.3: 3-Wire, 2-Element Open Delta with 2 PTs and 3 CTs

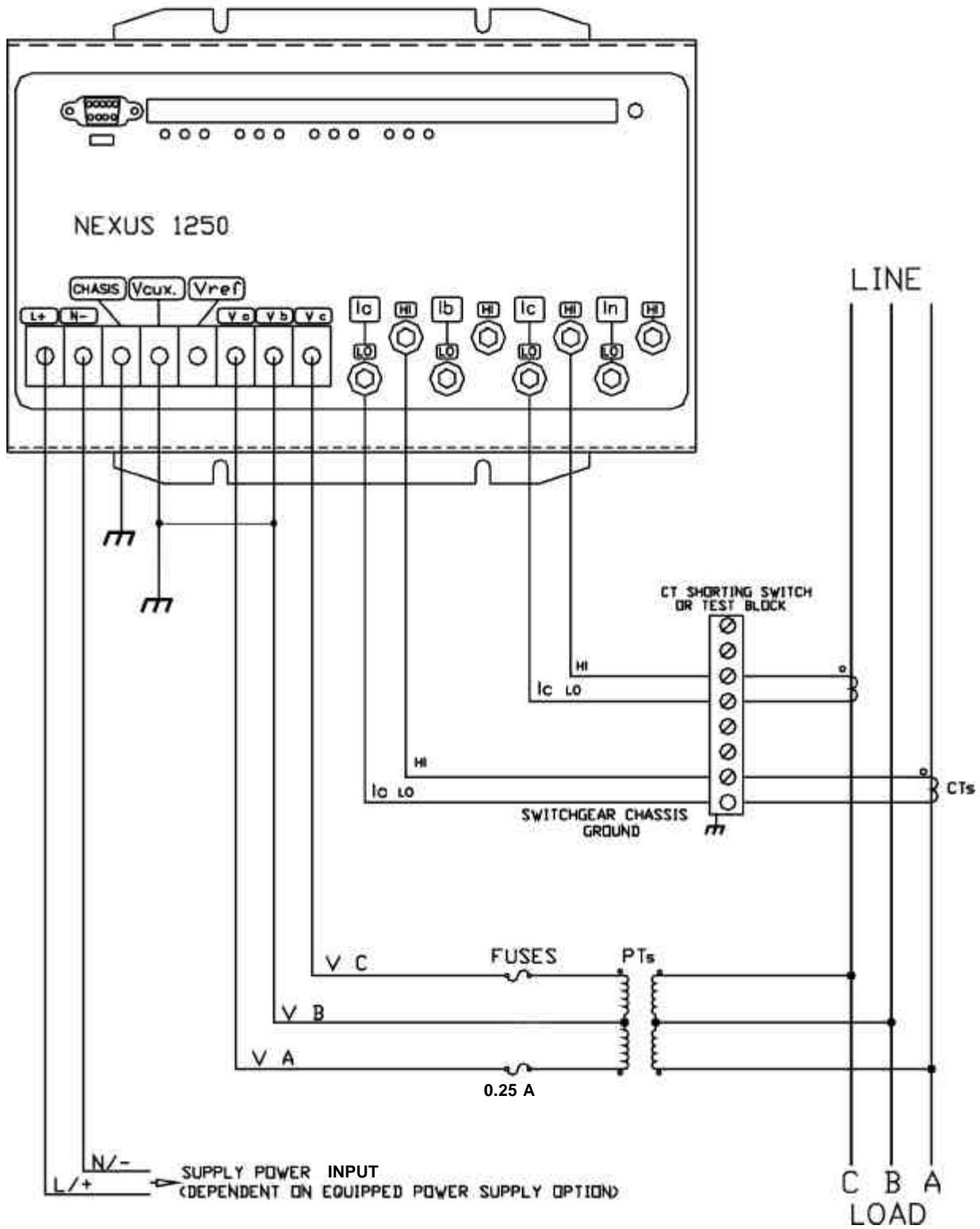


Figure 4.4: 3-Wire, 2-Element Open Delta with 2 PTs and 2 CTs

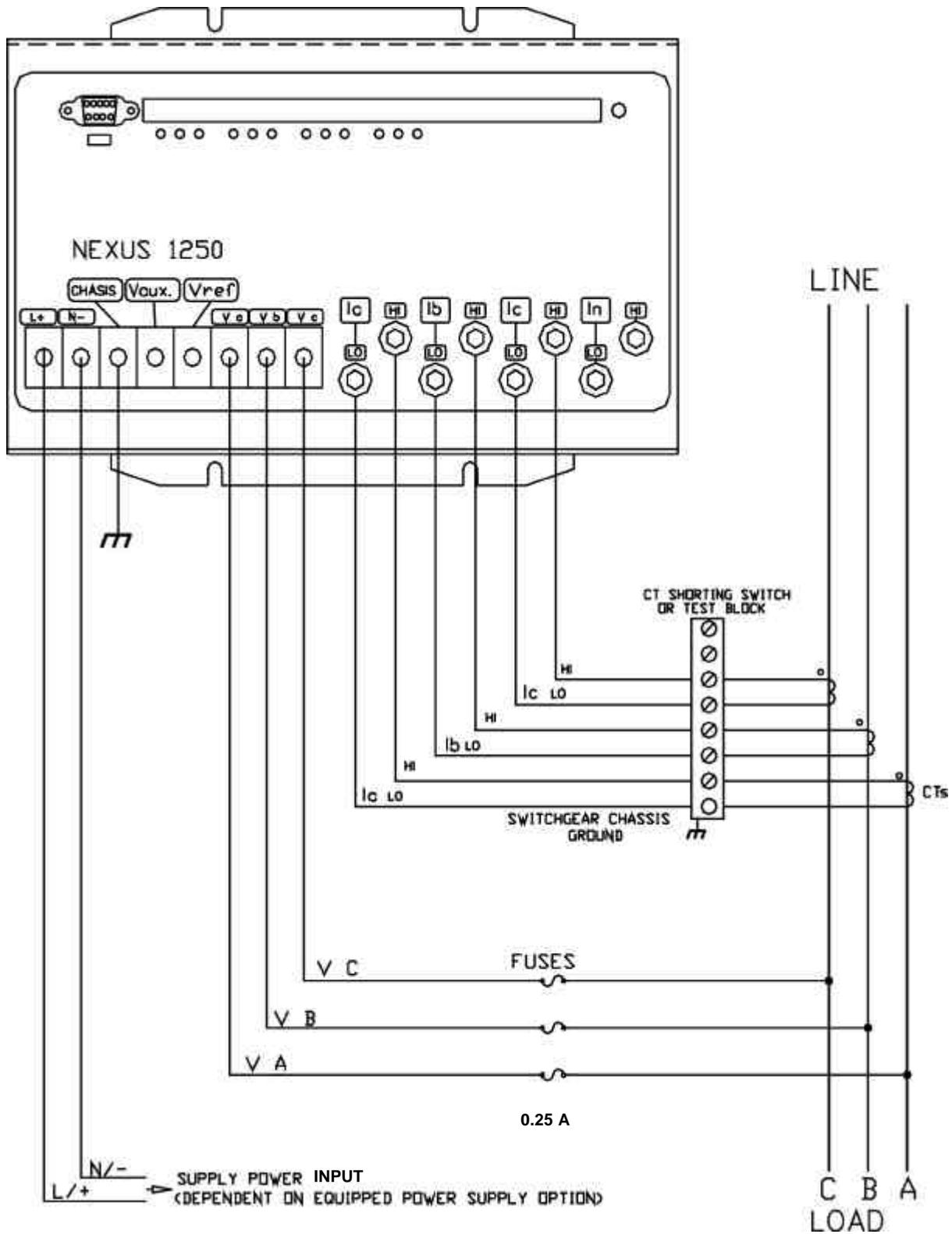


Figure 4.5: 3-Wire, 2-Element Delta Direct Voltage with 3 CTs

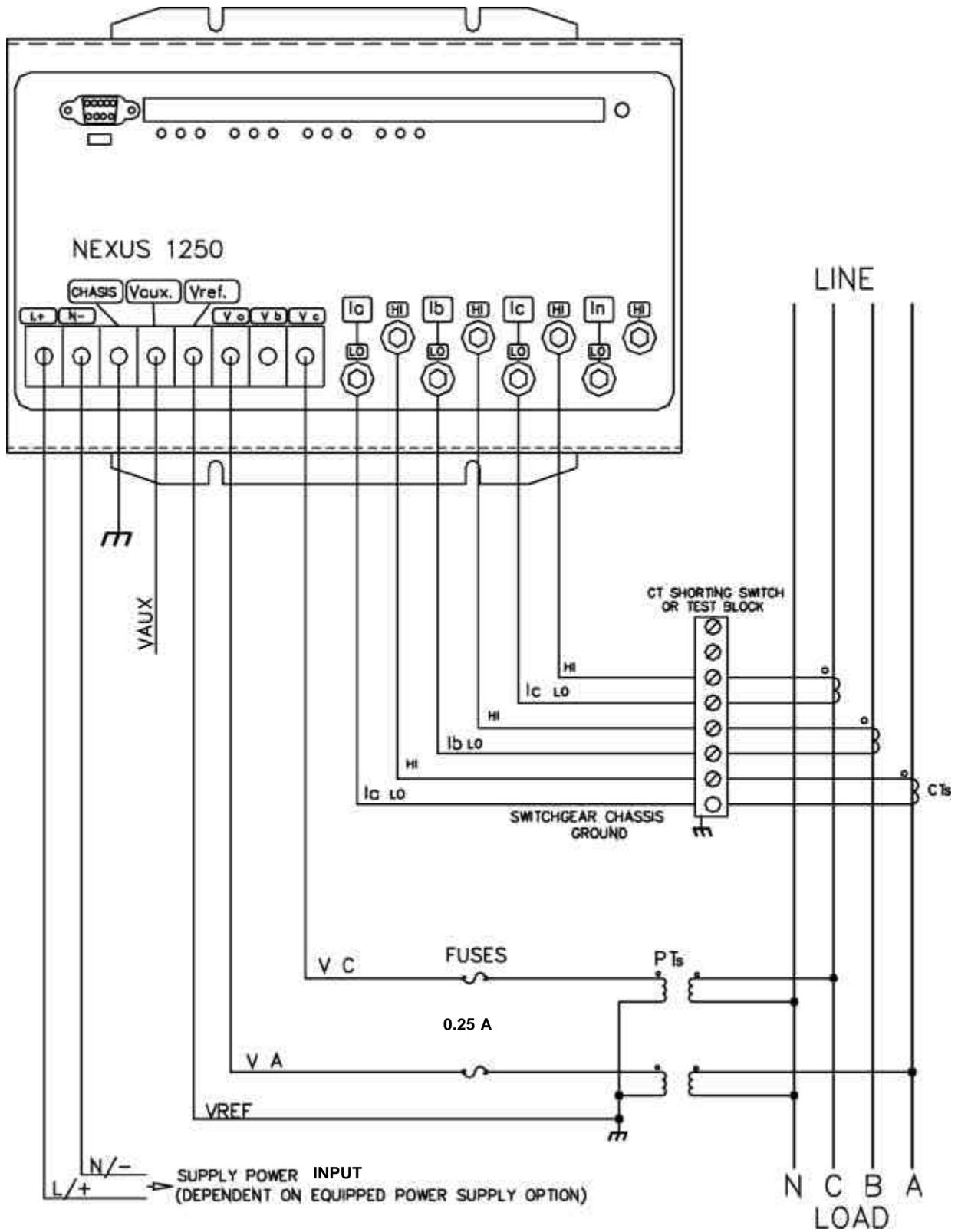


Figure 4.6: 3-Phase, 4-Wire Wye, 2.5 Element with 2 PTs and 3 CTs

Chapter 5 Communication Wiring

5.1: Communication Overview

- RS-232 communication is used to connect a single Nexus Monitor with another device, such as a computer, RTU or PLC. The link is capable for a distance up to 50 feet (15.2 m) and is available only through the Nexus Monitor's Port 1. You must set the selector switch beneath the port to RS-232 (see Figure 5.3).
- RS-485 communication allows multiple Nexus Monitors to communicate with another device at a local or remote site. The I/O modules and the Nexus Display use RS-485 to communicate with the Nexus Monitor. All RS-485 links are capable for a distance up to 4000 feet (1220 m). Ports 1 through 4 on the Nexus Monitor are two-wire, RS-485 connections operating up to 115,200 baud. To use Port 1 for RS-485, set the selector switch to RS-485 (see Figure 5.3).

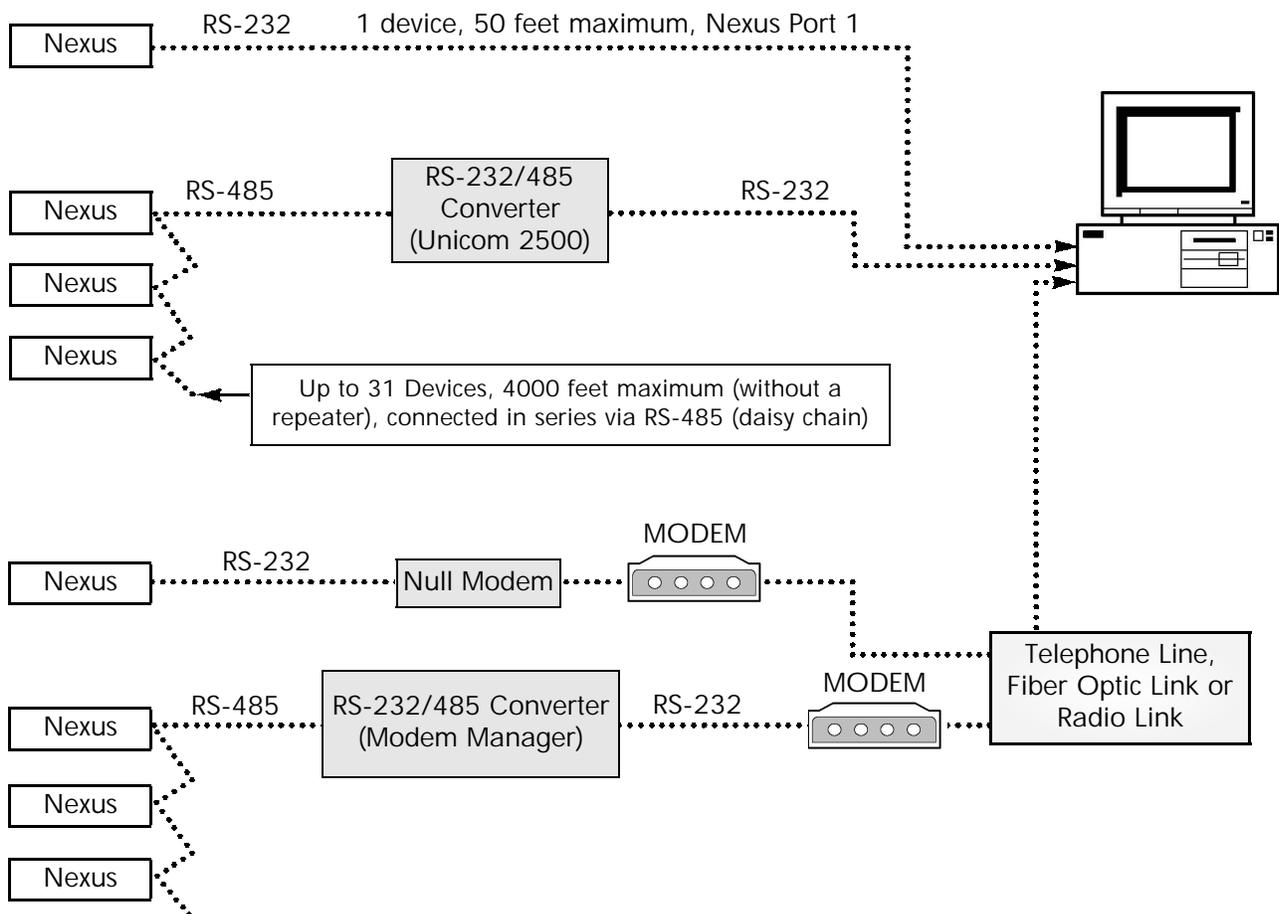


Figure 5.1: Communication Overview

- RJ-11 Telephone Line allows a Nexus Monitor with the Internal Modem Option to communicate with a PC. No other hardware is necessary for this easy-to-use connection. The Nexus Monitor with the Internal Modem Option can connect via RS-485 to other Nexus Monitors in local or remote sites in a daisy chain configuration, as depicted below.

The Nexus Monitor with the Internal Modem Option has a unique label; Port 2 is labeled Modem Gateway. If you are going to use RS-485 to connect multiple Nexus monitors, you MUST use the Modem Gateway. For more details, see *Chapter 10* of this manual.

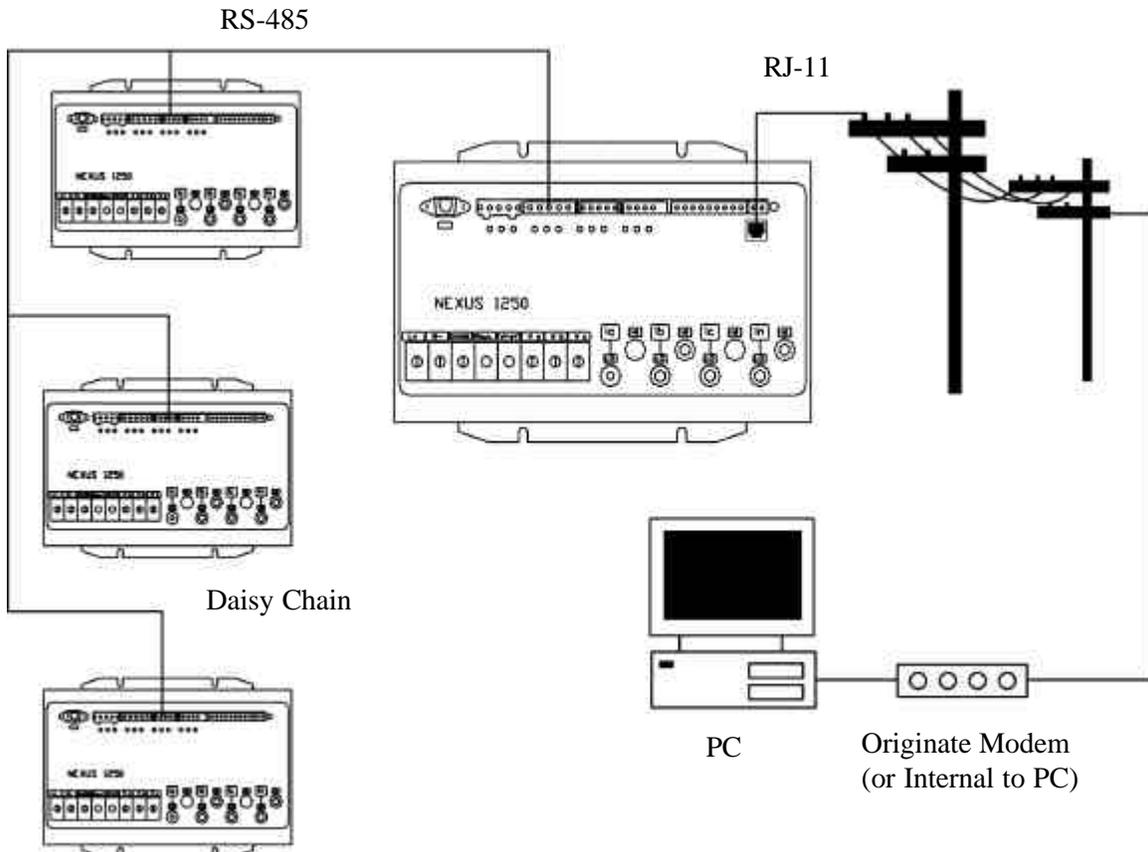


Figure 5.2: RJ-11 Communication with Internal Modem Option

- RJ-45 Network Connection allows a Nexus Monitor with the Internal Network Option to communicate with multiple PC's concurrently. No other hardware is necessary for this easy-to-use connection. The Nexus Monitor with the Internal Network Option can connect via RS-485 to other Nexus Monitors in local or remote sites in a daisy chain configuration, as depicted below.

The Nexus Monitor with the Internal Network Option has a unique label; Port 2 is labeled Ethernet Gateway. If you are going to use RS-485 to connect multiple Nexus monitors via the network, you MUST use the Ethernet Gateway. For more details, see *Chapter 11* of this manual.

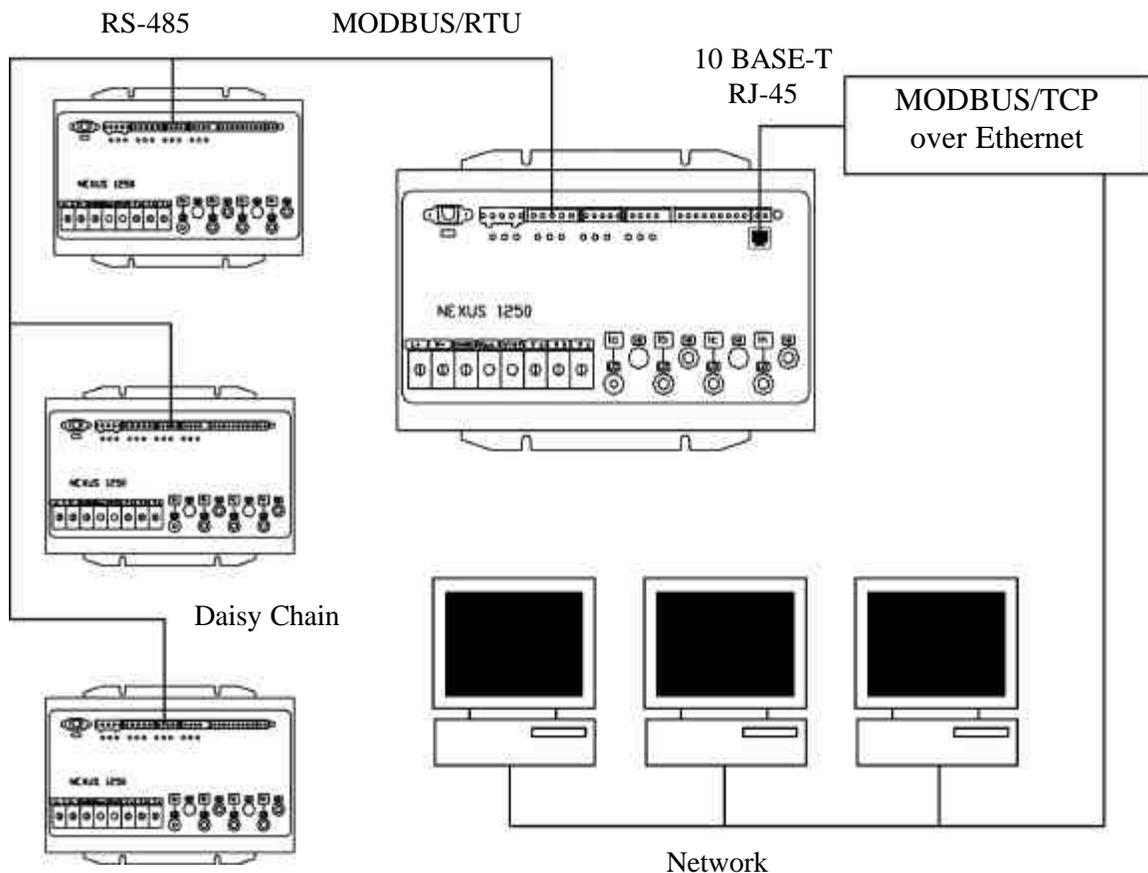
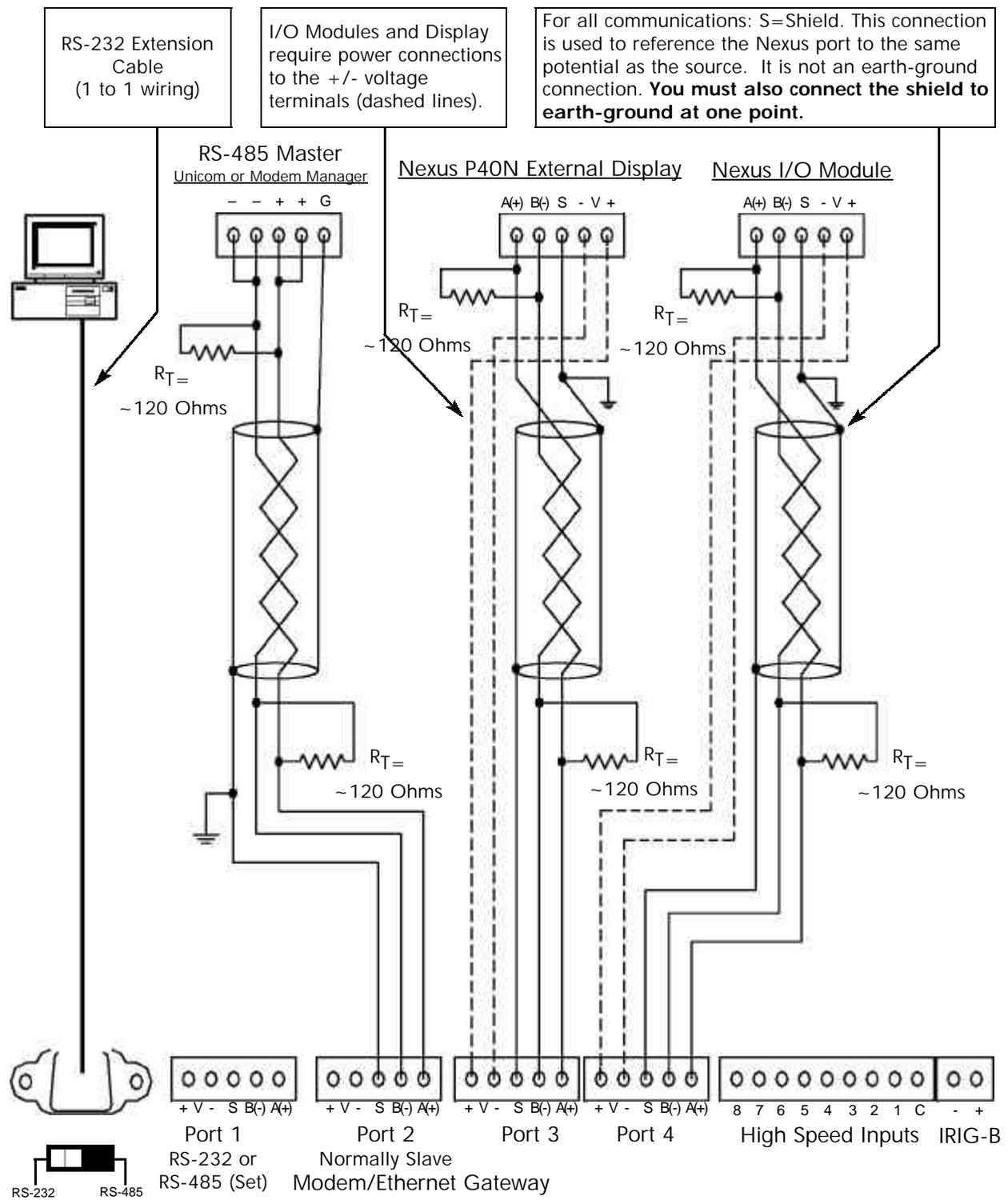


Figure 5.3: RJ-45 Communication with Internal Network Option



NOTE: You may use ANY port to connect a Nexus Display or RS-485 Master. However, if you are using the Internal Modem (or Network) Option, Port 2 is labeled Modem (Ethernet) Gateway. Ports 1, 3 and 4 DO NOT change. The I/O Modules MUST use Port 4 (Port 3 is an alternate). The Nexus P40N Display is shipped programmed to use Port 3—see section 5.7 for details.

Figure 5.4: Communication Wiring

5.2: RS-232 Connection—Nexus Monitor to a Computer

- Use Port 1 for RS-232 communication. Set the selector switch beneath the port to RS-232.
- Insert one end of an RS-232 extension cable into the Nexus Monitor's 9-pin female serial port. Insert the opposite end into a port on the computer.
- The RS-232 standard limits the cable length to 50 feet (15.2m).
- The RS-232 Port is configured as Data Communications Equipment (DCE).

Nexus Monitor Port 1

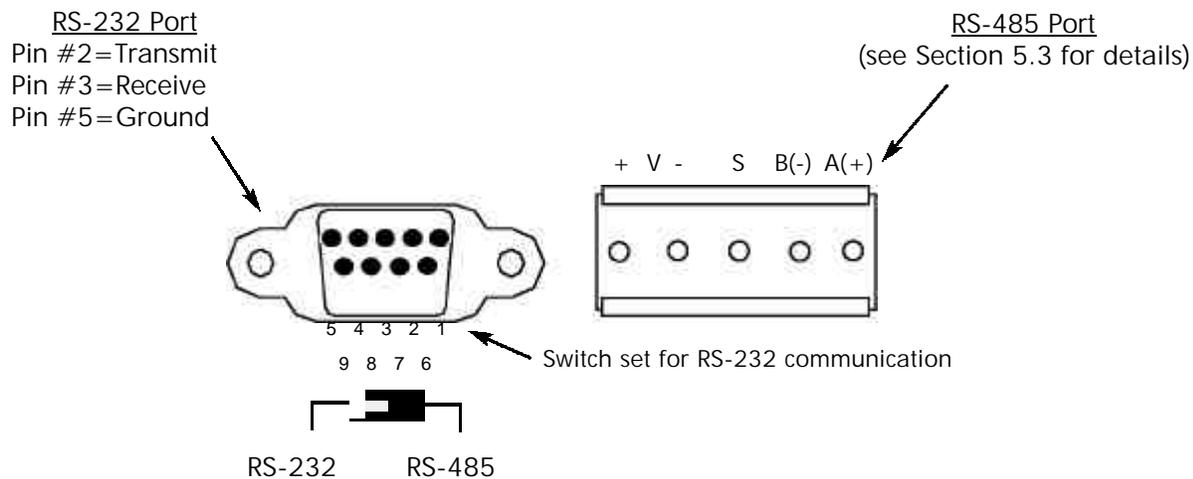


Figure 5.5: Nexus Port 1—RS-232/RS-485 Communication

5.3: Nexus RS-485 Wiring Fundamentals

Nexus RS-485 Ports (Ports 1–4) (see Figure 5.5 above)

- +V-** **Voltage terminals for power connections:** Use with Nexus I/O Modules and the Nexus Displays only. The Nexus Monitor supplies 17 VDC through the +V- terminal connections. Note: Do **not** connect these pins to devices that receive power from another source—ie, a computer—or to devices that do not require power to operate.
- S** **Shield:** The Shield connection is used to reference the Nexus port to the same potential as the source. It is not an earth-ground connection. You must also connect the shield to earth-ground at one point. Do not connect the shield to ground at multiple points; it will interfere with communication.
- A(+)/B(-)** **Two-wire, RS-485 communication terminals:** Connect the A(+) terminal of the Nexus Port to the (+) terminal of the device. Connect the B(-) terminal of the Nexus Port to the (-) terminal of the device.

- RS-485 communication allows multiple devices to communicate on a bus. The Nexus' Ports 1 to 4 are RS-485 terminals, capable for a distance of up to 4000 feet (1219 m). (Nexus' Port 1 can be switched between RS-232 and RS-485.) Below is a detail of a 2-wire RS-485 port.

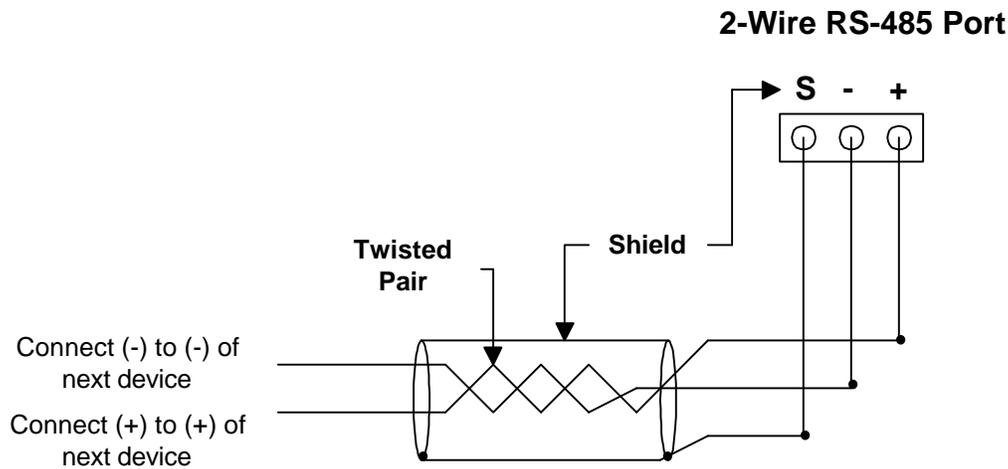


Figure 5.6: 2-Wire RS-485 Port Detail

For All RS-485 Connections:

- Use a shielded twisted pair cable 22 AWG (0.33 mm²) or larger, grounding the shield at one end only.
- Establish point-to-point configurations for each device on a RS-485 bus: Connect (+) terminals to (+) terminals; connect (-) terminals to (-) terminals.
- Protect cables from sources of electrical noise.
- Avoid both “star” and “tee” connections (see Figure 5.6). No more than two cables should be connected at any one point on an RS-485 network, whether the connections are for devices, converters or terminal strips.
- Include all segments when calculating the total cable length of a network. If you are **not** using an RS-485 repeater, the maximum length for cable connecting all devices is 4000 feet (1219 meters).
- Connect devices using the diagrams on the following pages. A **correct connection** requires 1/4 watt resistors connected to the (+) and (-) terminals of each device at the end of a straight-line bus. The line impedance of the cable and the resistor should match. Generally, a 100- or 120-Ohm resistor will work.

Correct Connection

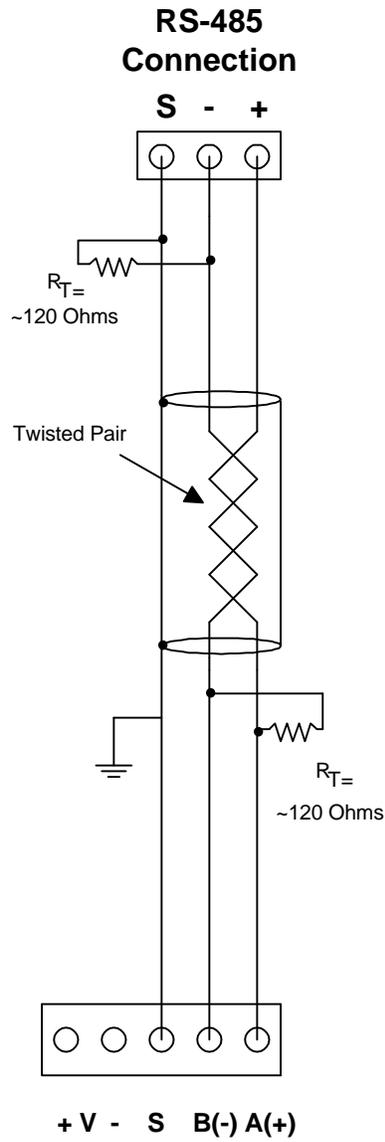
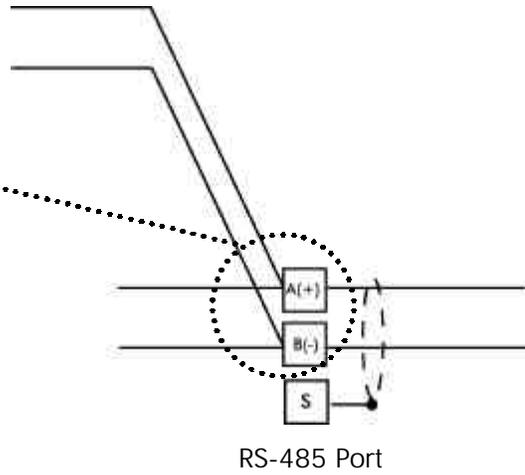


Figure 5.7: 2-Wire RS-485 Connection

Incorrect Connection: "T"



"Tee" Connection Incorrect!
The three wires connected in a "T" shape on both the (+) and (-) terminals will cause interference problems.



Incorrect Connection: "Star"



"Star" Connection Incorrect!
The three wires connected in a "Star" shape on both the (+) and (-) terminals will cause interference problems.

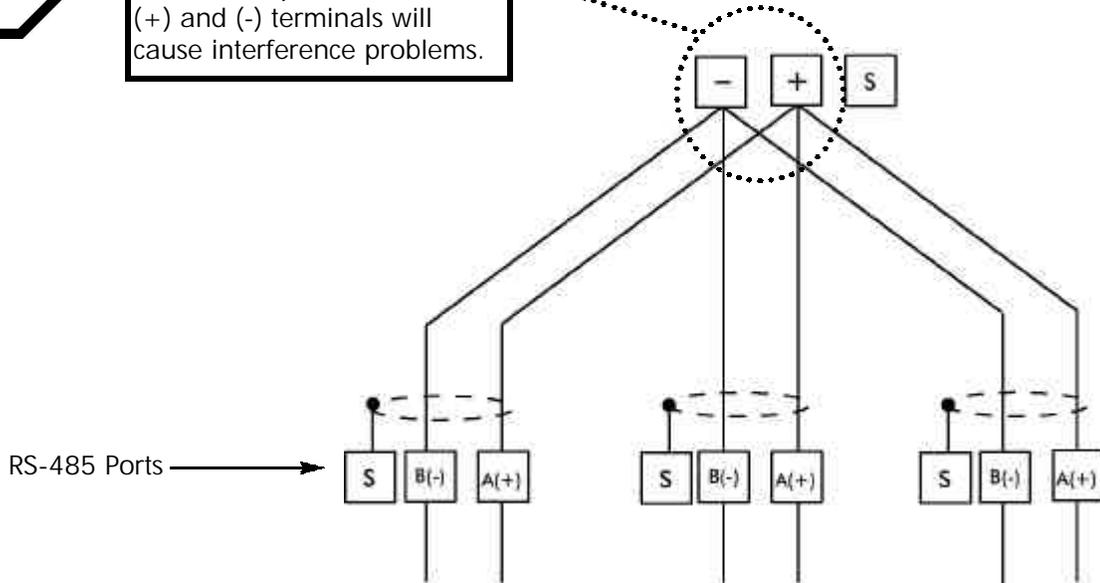


Figure 5.8: Incorrect "T" and "Star" Topologies

5.4: RS-485 Connection—Nexus Monitor to a Computer or PLC

- Use any Port on the Nexus. If you use Port 1, set the selector switch beneath the port to RS-485 (see Figure 5.3).
- The link using RS-485 is capable for up to 4000 feet (1219 meters).
- You **must** use an RS-485 to RS-232 converter, such as EIG's Unicom 2500. See section 5.5.
- For information on connecting the Nexus Monitor to a modem, see sections 5.14–5.16.
- Do not use the V(+)/V(-) pins; they supply power to the Nexus Displays and Nexus I/O Modules.

5.5: RJ-11 (Telephone Line) Connection—Nexus with Internal Modem Option to a PC

- Use RJ-11 Standard Telephone Line to connect with the Nexus. The RJ-11 line is inserted into the RJ-11 Port on the face of the Nexus with Internal Modem Option.
- The length of the connection using RJ-11 into the Nexus is virtually unlimited.
- To connect with other Nexus Monitors in either local or remote locations, you **MUST** use Port 2 as a Master and an RS-485 connection.
- The link using RS-485 is capable for up to 4000 feet (1219 meters).
- For more information on the Nexus Monitor with the Internal Modem Option, see *Chapter 10* of this manual.

5.6: RJ-45 Connection—Nexus with Internal Network Option to multiple PC's

- The Internal Network Option conforms to the IEEE 802.3, 10BaseT specification using unshielded twisted pair (UTP) wiring. This allows the use of inexpensive RJ-45 connectors and CAT 3 or better cabling.
- Using this LAN connection allows multiple PC's to be connected concurrently. The RJ-45 line is inserted into the RJ-45 Port on the face of the Nexus with Internal Network Option.
- The connection using RJ-45 into the Nexus can connect the Nexus to a network using Modbus/TCP protocol over Ethernet.
- To connect with other Nexus Monitors in either local or remote locations, you **MUST** use Port 2 (which is labeled Ethernet Gateway) as a Master and an RS-485 connection. The link using RS-485 is capable for up to 4000 feet (1219 meters).
- For more information on the Nexus Monitor with the Internal Network Option, see *Chapter 11* of this manual.

5.7: RS-485 Connection—Nexus to an RS-485 Master (Unicom or Modem Manager)

- To establish communication between a Nexus Monitor and any RS-485 master, such as EIG's Unicom 2500, Modem Manager or other RS-232–485 converter, use a shielded, twisted pair cable.
- Use an RS-485 port (Ports 1–4) on the Nexus Monitor. If you use Port 1, set the selector switch beneath it to RS-485 (see Figure 5.3). Connect the A(+) and B(-) terminals on the Nexus to the (+) and (-) terminals on the master. Provide jumpers on the master, linking its two (-) terminals and two (+) terminals. RS-485 communication is capable for up to 4000 feet (1219 meters).
- Connect the shield to the Ground (G) terminal on the Master. The (S) terminal on the Nexus is used to reference the Nexus port to the same potential as the source. It is not an earth ground connection. You must also connect the shield to earth-ground at one point.
- Provide resistors at each end, connected to the (+) and (-) lines. R_T is approximately 120 Ohms, but this value may vary based on length of cable run, gauge and the impedance of the wire.

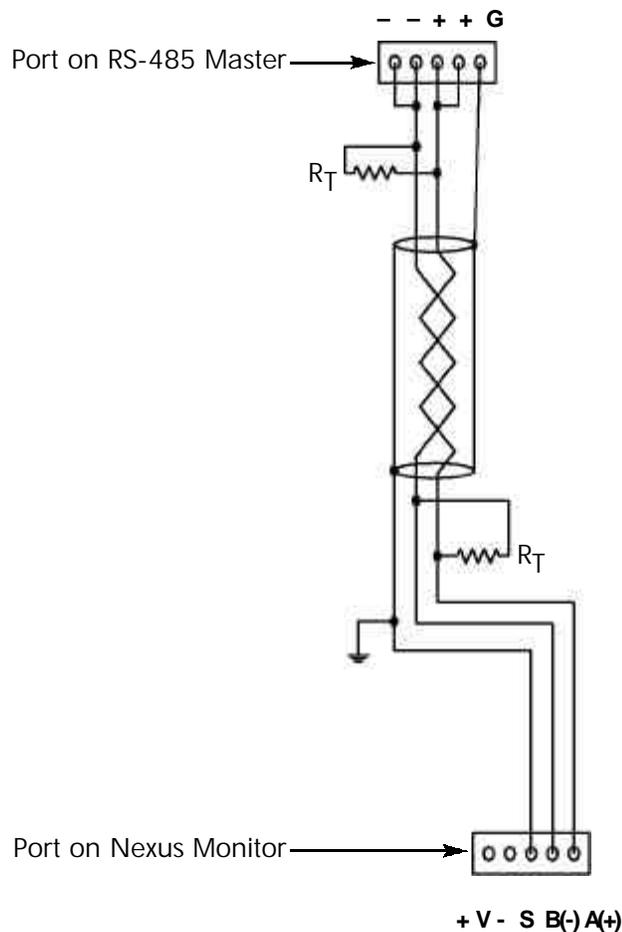


Figure 5.9: Nexus Monitor Connected to an RS-485 Master

5.8: RS-485 Connection—Nexus Monitor to the Nexus P40N External Display

- Insert one end of the supplied RS-485 cable into port 3 of the Nexus Monitor. Port 3 is factory-set to match the Nexus Display's baud rate of 9600. To use a port other than port 3, you must set the port's baud rate to 9600 using the Nexus Communicator software (see the *Nexus Communicator User Manual*). Insert the other end of the cable into the back of the Nexus P40N Display. The connectors fit only one way into the ports.
- The cable harness brings 17 VDC to the displays from the Nexus Monitor, represented by dashed lines in the figure below. RS-485 communication is capable for up to 4000 feet (1219 meters). If your cable length exceeds 200 feet you must use a remote power supply, such as EIG's Power Brick (model # PB1), and:
 - Connect the shield to the shield (S) terminal on the Nexus Display port. The (S) terminal on the Nexus is used to reference the Nexus port to the same potential as the source. It is not an earth-ground connection. You must also connect the shield to earth-ground at one point.
 - Provide termination resistors at each end, connected to the A(+) and B(-) lines. R_T is approximately 120 Ohms.

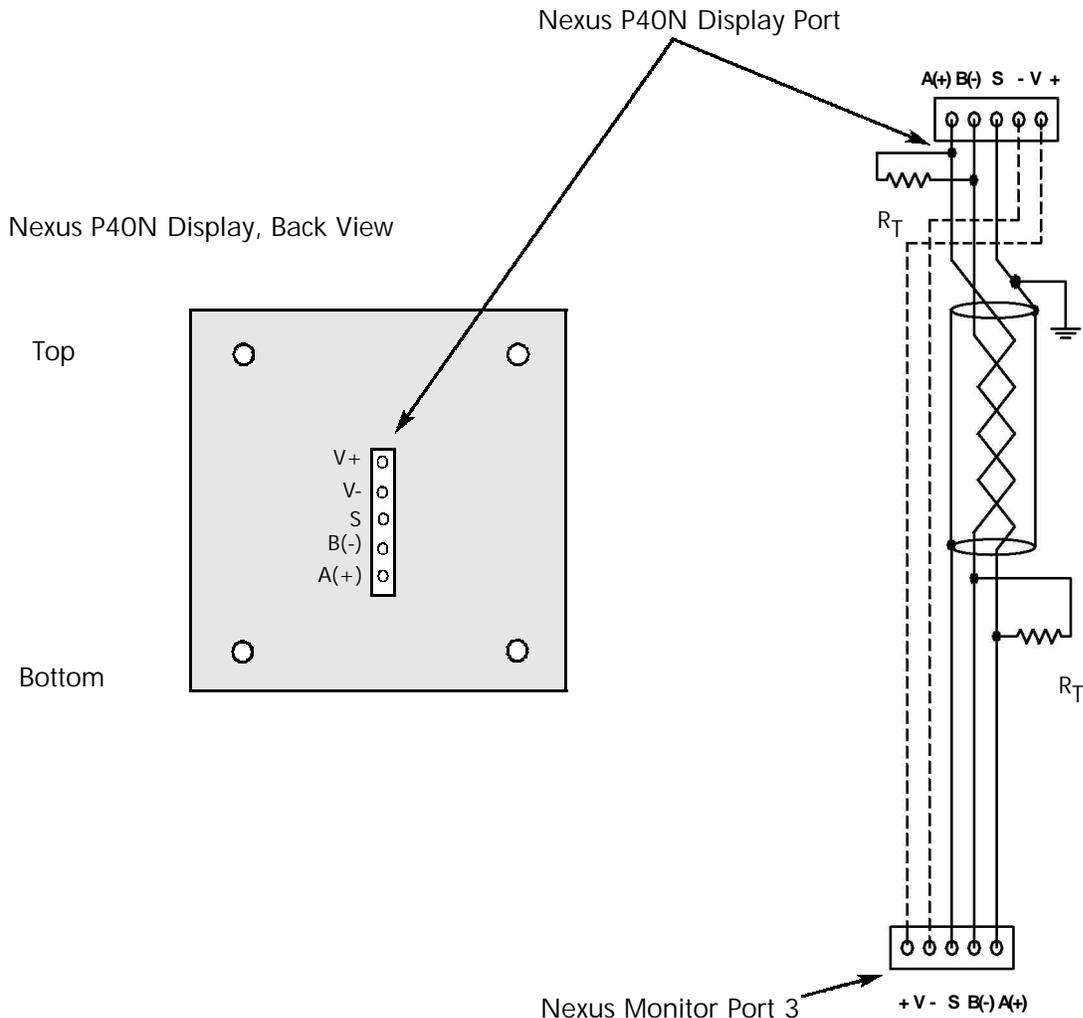


Figure 5.10: Nexus Monitor Connected to Nexus P40N External Display

5.9: RS-485 Connection—Nexus Monitor to the Nexus P60N External Display

- To connect the Nexus P60N Touch Screen External Display, use the Stand Alone Interface Cable provided with the display. The cable is six (6) feet long with 20 AWG conductors (see detail below). Insert one end of the supplied cable into port 3 of the Nexus Monitor. Port 3 is factory-set to match the Nexus Display's baud rate of 9600. To use a port other than port 3, you must set the port's baud rate to 9600 using the Nexus Communicator software (see the *Nexus Communicator User Manual*). Insert the other end of the cable into the back of the Nexus P60N Display. The connectors fit only one way into the ports.

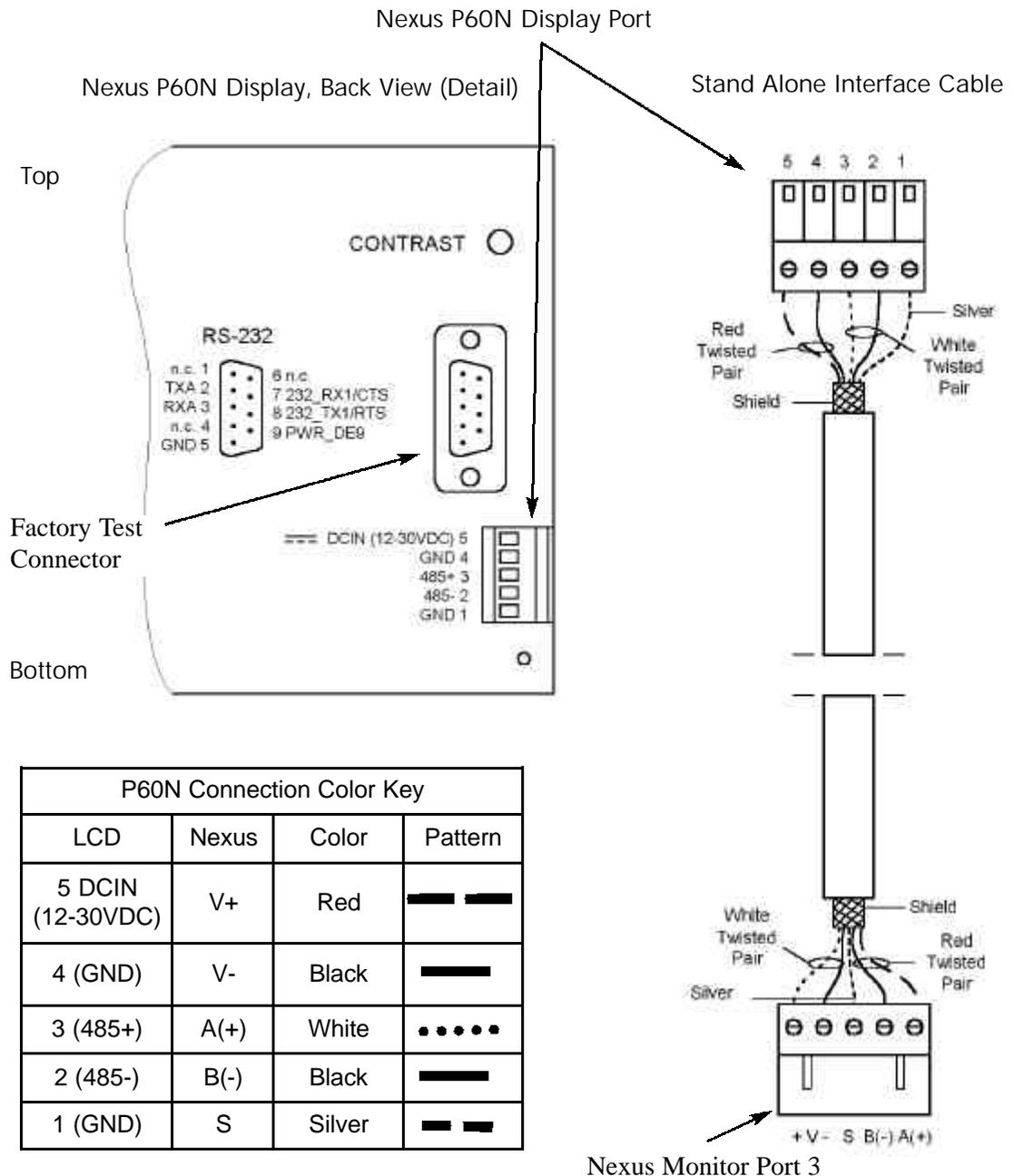


Figure 5.11: Nexus Monitor Connected to Nexus P60N Touch Screen Display

5.10: Communication Ports on the Nexus I/O Modules

- **Female RS-485 Side Port:** use to connect to another module's female RS-485 side port.
- **Male RS-485 Side Port:** use to connect to the Nexus Monitor's port 4 (see section 5.8) or to connect to another module's male RS-485 side port.
- **I/O Port:** use for functions specific to the type of module; size and pin configuration varies depending on type of module. For more detail, refer below to section 5.11 and to Chapter 9 of this manual.

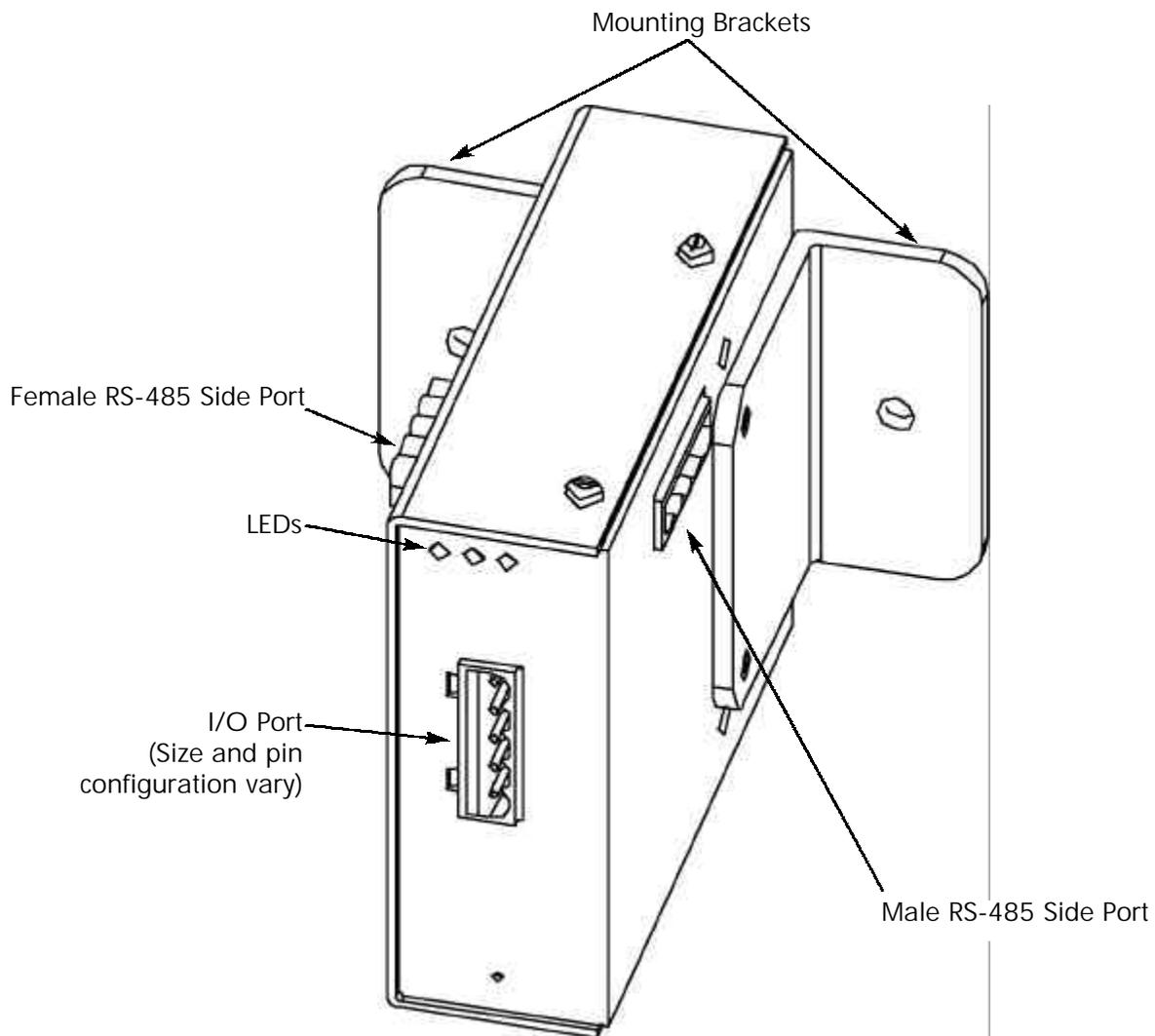


Figure 5.12: Communication Ports on the Nexus I/O Modules

5.11: RS-485 Connection—Nexus Monitor to Nexus I/O Modules

- Six feet of RS-485 cable harness is supplied. Insert one end of the cable into port 4 of the Nexus Monitor.
- Insert the other end of the cable into the I/O module's female RS-485 side port (see Figure 5.9). The connectors fit only one way into the ports.
- Use the male RS-485 side port to attach another I/O module. The Nexus will power up to four connected I/O modules using 15–20 VDC at 50–200mA, represented by dashed lines in the figure below. Use the steps below (section 5.12) to determine if you must use a separate power source (for example, EIG #PB1 - Power Brick) to supply added power to the group. RS-485 communication is capable for up to 4000 feet (1219 meters). However, if your cable length exceeds 200 feet, use the remote power supply and:
 - Connect the A(+) and B(-) terminals on the Nexus to the A(+) and B(-) terminals of the female RS-485 port. Connect the shield to the shield (S) terminal. The (S) terminal on the Nexus is used to reference the Nexus port to the same potential as the source. It is not an earth ground connection. You must also connect the shield to earth-ground at one point.
 - Provide termination resistors at each end, connected to the A(+) and B(-) lines. R_T is approximately 120 Ohms.

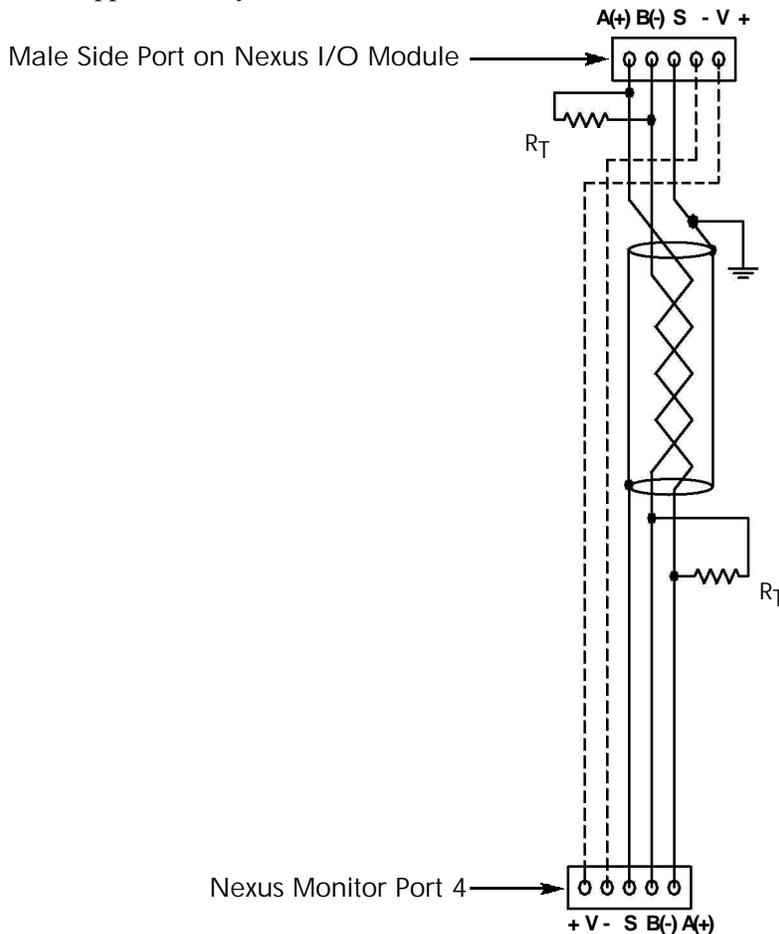


Figure 5.13: Nexus Monitor Connected to Nexus I/O Module

5.12: Steps to Determine Power Needed

- **Available power for All Ports is 12 VA.**
- Refer to the table in the next section (Section 5.13) to determine the VA Ratings for I/O modules and displays.
- **Add together the VA Ratings for I/Os and Displays in use.**
- **Compare Available Power to Power Needed.**

5.13: I/O Modules' Factory Settings and VA Ratings

- All I/Os are shipped pre-programmed with a baud rate of 57600 and addresses. The table below details the factory-set address for each module and the VA Ratings for I/O modules and Nexus displays. Refer to the previous section (section 5.12) for the steps to determine if you must use an additional power source. For programming details, refer to Chapter 8 of the *Nexus Communicator User Manual*.

| I/O MODULES' FACTORY SETTINGS AND VA RATINGS | | | |
|---|----------------------------|---------|-----------|
| MODEL NUMBER | MODULE | ADDRESS | VA RATING |
| 1mAON4 | 0-1mA, 4 Analog Outputs | 128 | 2.7 VA |
| 1mAON8 | 0-1mA, 8 Analog Outputs | 128 | 3.2 VA |
| 20mAON4 | 4-20mA, 4 Analog Outputs | 132 | 5.0 VA |
| 20mAON8 | 4-20mA, 8 Analog Outputs | 132 | 8.5 VA |
| 8A11 | 0-1mA, 8 Analog Outputs | 136 | 2.3 VA |
| 8A12 | 0-20mA, 8 Analog Outputs | 140 | 2.3 VA |
| 8A13 | 0-5 VDC, 8 Analog Outputs | 144 | 2.3 VA |
| 8A14 | 0-10 VDC, 8 Analog Outputs | 148 | 2.3 VA |
| 4RO1 | 4 Latching Relay Outputs | 156 | 2.7 VA |
| 4PO1 | 4 KYZ Pulse Outputs | 160 | 2.7 VA |
| 8D11 | 8 Status Inputs (Wet/Dry) | 164 | 1.0 VA |
| 4RTD1 | 4 RTD Inputs | 168 | 3.6 VA |
| NEXUS DISPLAYS' VA RATINGS | | | |
| P40N | Nexus LED Display | | 8 VA |
| P60N | Nexus Touch Screen Display | | 5 VA |

5.14: Linking Multiple Nexus Devices in Series

- You may connect a total of 31 Nexus Monitors in series on a single bus using RS-485. The cable length may not exceed 4000 feet (1219 meters). Before assembling the bus, each Nexus Monitor **must be assigned a unique address**; see the *Nexus Communicator User Manual*.
- Connect the A(+) and B(-) terminals of each Nexus Monitor. Use jumpers on any RS-485 Master connected at the end of the chain (see section 5.5).
- Connect the shield to the (S) terminal on each Nexus and to the Ground on the RS-485 Master. This connection is used to reference the Nexus port to the same potential as the source. It is not an earth ground connection. You must also connect the shield to earth-ground at one point.
- Provide resistors at each end, connected to the (+) and (-) lines. R_T is approximately 120 Ohms, but this value may vary based on length of cable run, gauge or the impedance of the wire.

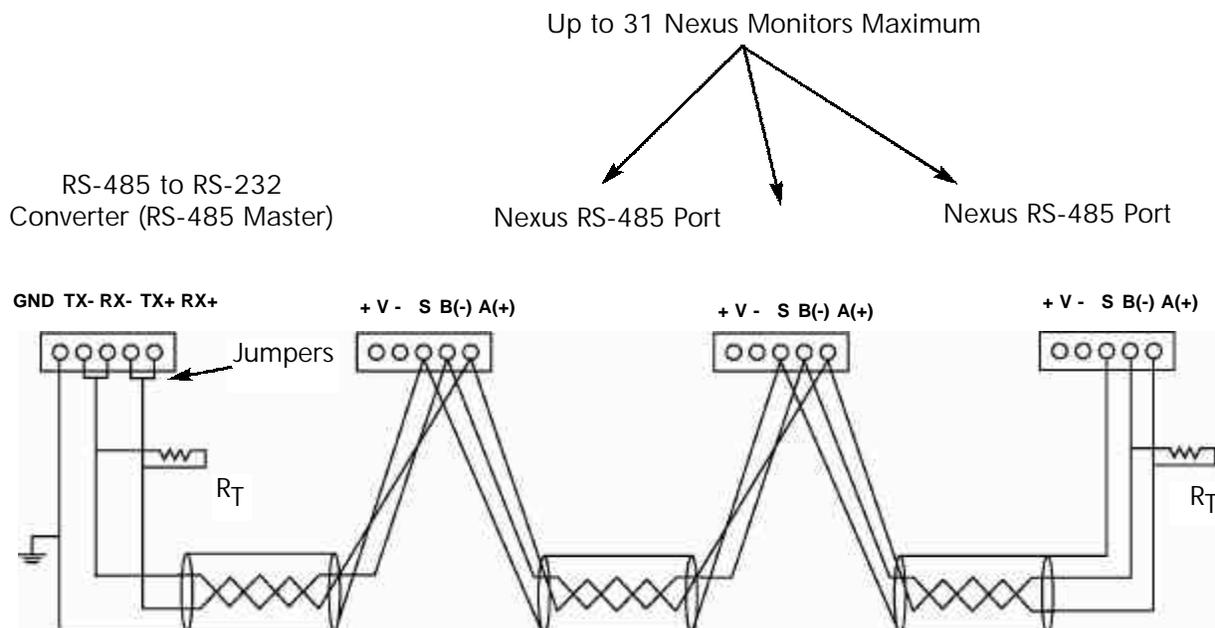


Figure 5.14: Linking Multiple Nexus Devices in Series

5.15: Networking Groups of Nexus Monitors

- You may connect up to 31 Nexus Monitors on the same RS-485 bus. Each one must be assigned a unique address; see the *Nexus Communicator User Manual*. Use an RS-485 repeater to network several links of instruments.
- A maximum number of 31 Nexus Monitors may be connected to one repeater. A maximum number of 31 repeaters may be included on the same network.

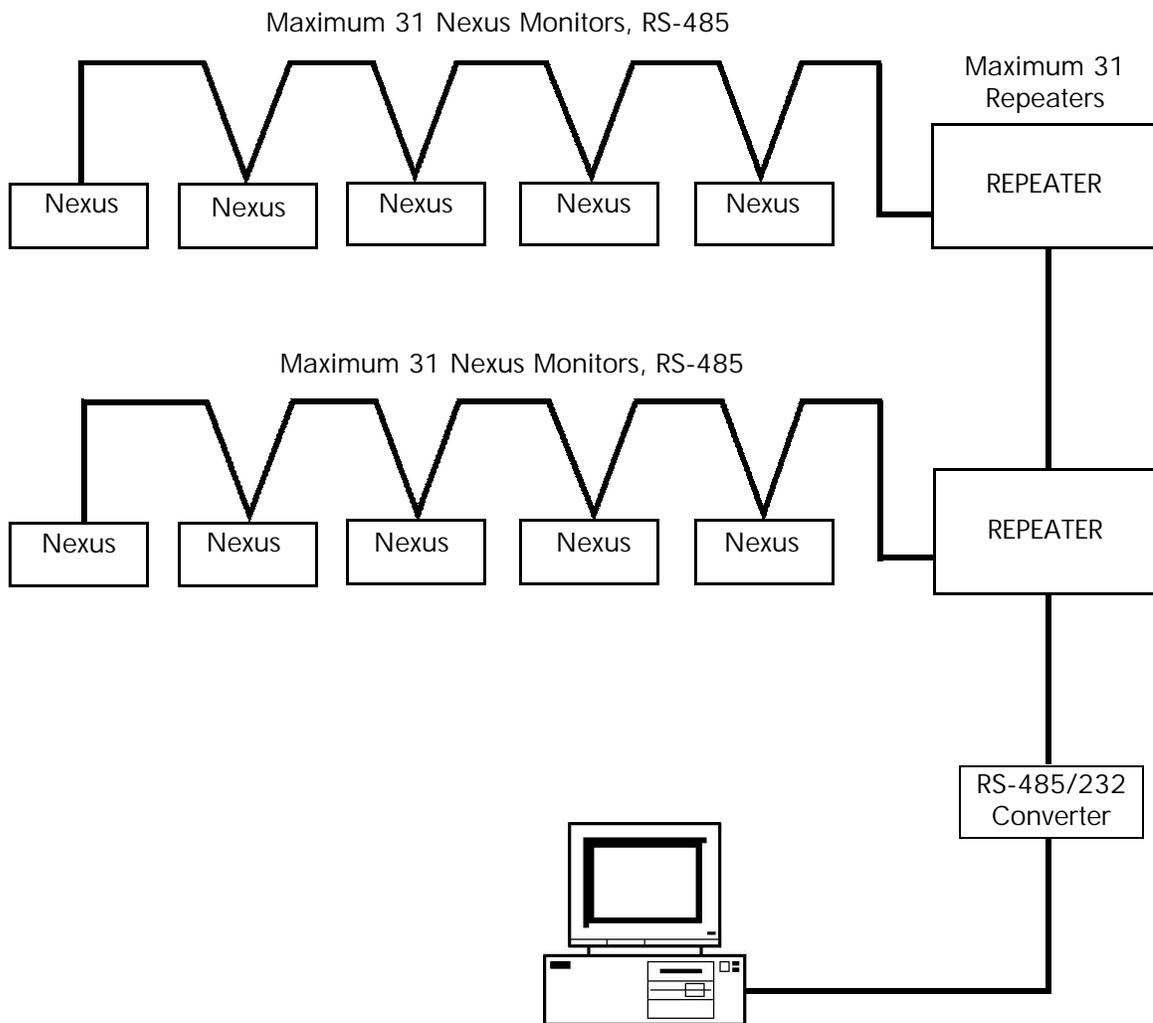


Figure 5.15: Networking Groups of Nexus Monitors

5.16: Remote Communication Overview

- Use modems (dedicated or dial-up) when devices are at great distances. **EIG recommends using RS-485 wiring with a Modem Manager. See section 5.13.**

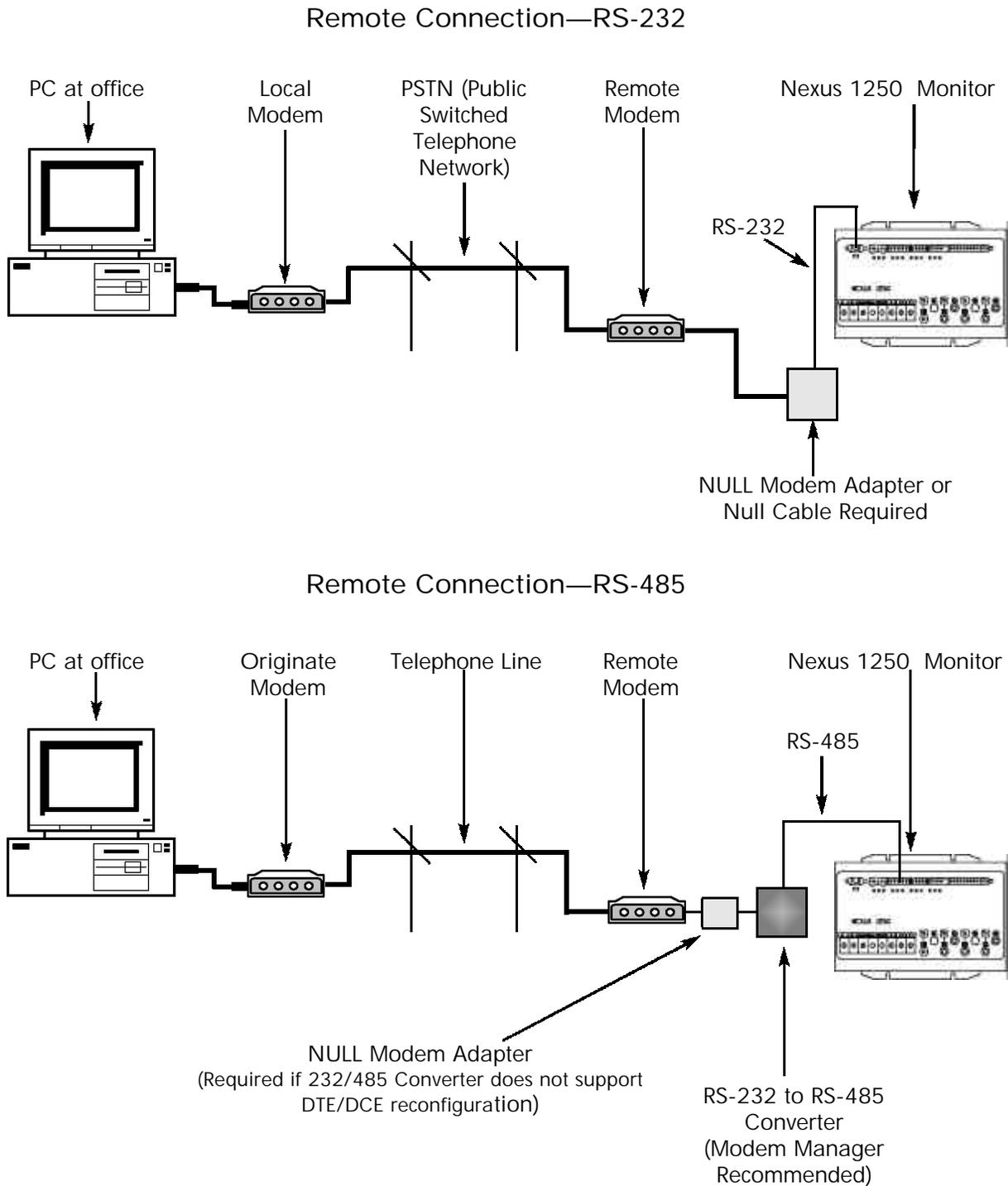


Figure 5.16: Remote Connections—RS-232/RS-485

- Use RJ-11 Telephone Lines when devices are at great distances. Connections are simple, requiring no additional hardware.

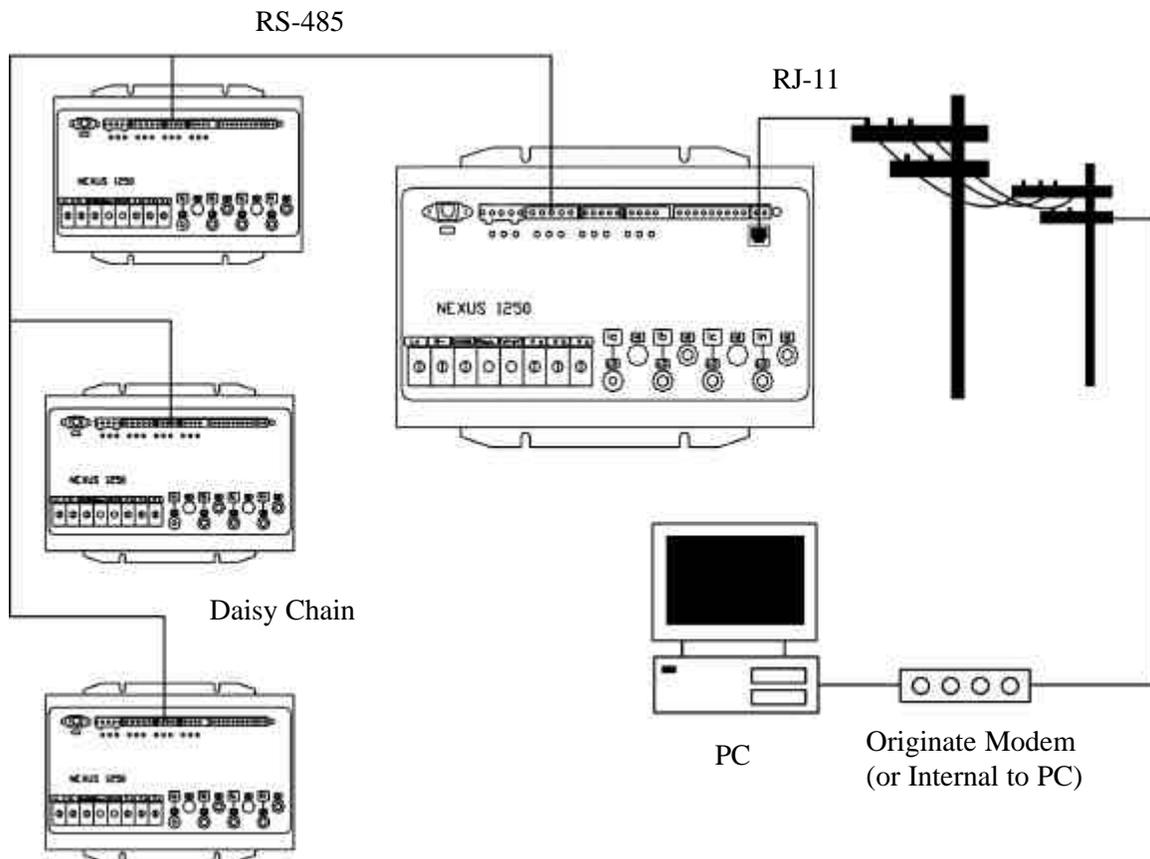


Figure 5.17: Remote Connections with Internal Modem Option

- Standard Telephone wall to phone cabling can be used. This cabling is widely available in many lengths with RJ-11 plugs on each end.
- Plug one end into the Nexus and the other end into the wall jack.

- Or, use RJ-45 Network Connection when devices are at great distances. Connections are simple, requiring no additional hardware.

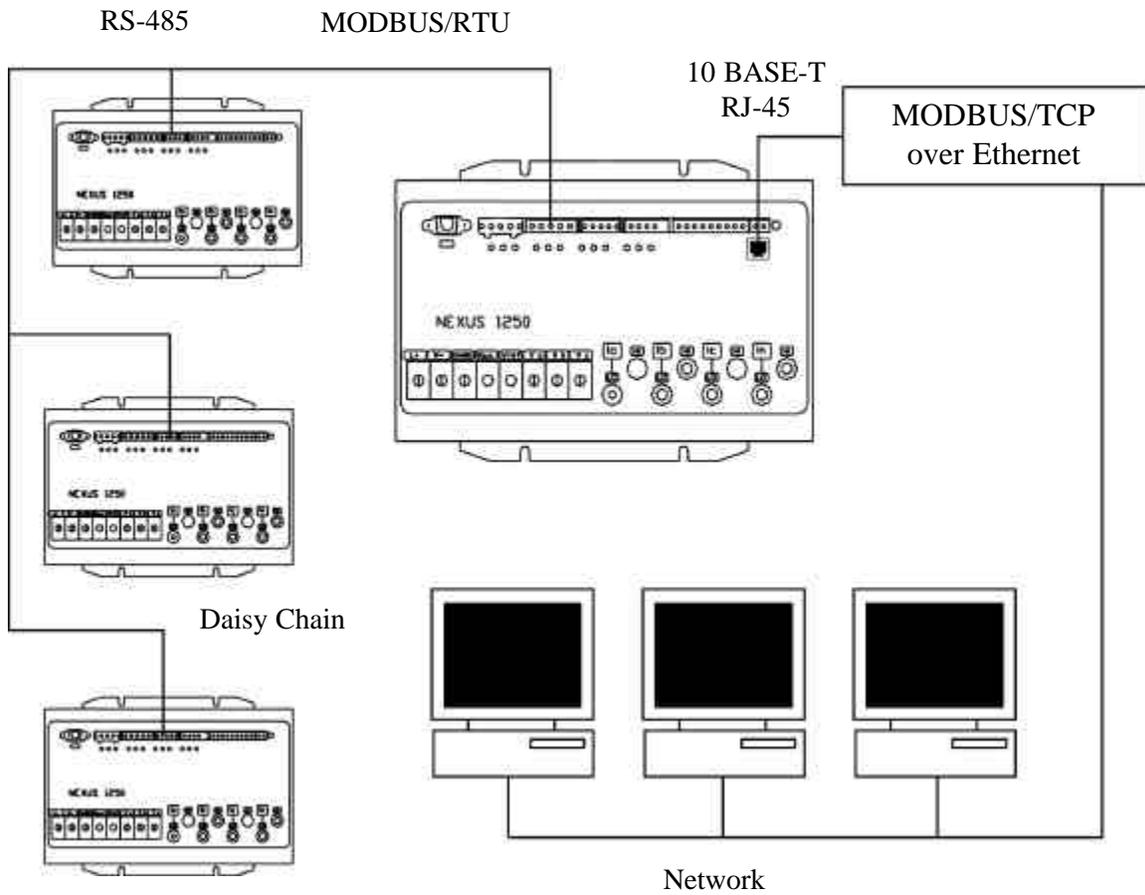


Figure 5.18: Remote Connections with Internal Network Option

5.17: Remote Communication—RS-232

- EIG recommends using RS-485 wiring with a Modem Manager. See section 5.13.
- For RS-232 communication, use Port 1. Set the selector switch under the port to RS-232 (Fig. 5.3).
- Use an RS-232 serial extension cable connected to the 9-pin female serial port of the Nexus Monitor's Port 1. Program this port for Modbus ASCII. See the *Nexus Communicator User Manual* for details.
- The link using RS-232 is capable for up to 50 feet (1219 meters).
- You **must** use a Null Modem or Null Cable between the Nexus Monitor and the remote modem when using RS-232. A Null Modem enables two DCE devices to communicate. The figure below details how a null modem reconfigures the RS-232 pins. **Note: Connecting the Nexus Monitor to a modem via RS-485 protocol with EIG's Modem Manager converter eliminates the need for a Null Modem; see section 5.13.**
- The remote modem must be programmed for auto-answer and set at a fixed baud rate of 9600 with no Flow Control. See section 5.19 and the *Nexus Communicator User Manual* for further details.

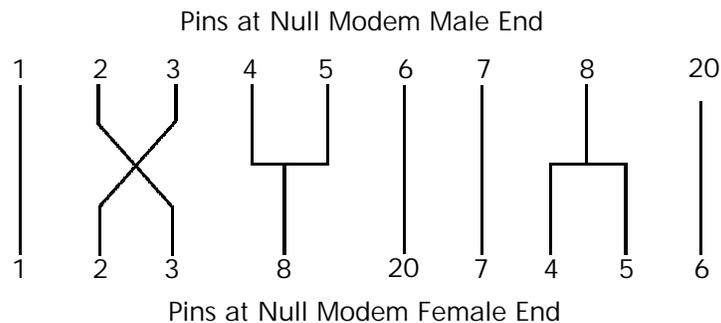


Figure 5.19: Standard Null Modem Configuration

5.18: Remote Communication—RS-485

- Use any Port on the Nexus. If you use Port 1, set the selector switch beneath the port to RS-485 (see Figure 5.3). The link using RS-485 is capable for up to 4000 feet (1219 meters).
- Use Nexus Communicator software to set the port's baud rate to 9600 and enable Modbus ASCII protocol. See the *Nexus Communicator User Manual*.
- You **must** use an RS-485 to RS-232 converter and a NULL Modem. EIG recommends using its **Modem Manager**, a sophisticated RS-232/RS-485 converter that enables devices with different baud rates to communicate. It also eliminates the need for a NULL modem (see section 5.12), and automatically programs the modem to the proper configuration. Also, if the telephone lines are poor, Modem Manager acts as a line buffer, making the communication more reliable.

5.19: Programming Modems for Remote Communication

When a modem speaks to most RS-485 or RS-232-based devices, it must be programmed for the communication to work. This task is often quite complicated because modems are quirky when talking to remote devices.

If you are **not** using a Modem Manager device, you must set the following strings to communicate with the remote Nexus Monitor(s). Consult your modem's manual for the proper string settings or see section 5.15 for a list of selected modem strings.

■ Modem Connected to a Computer (the Originate Modem):

- Restore modem to factory settings. This erases all previously programmed settings.
- Set modem to display Result Codes. The computer will use the result codes.
- Set modem to Verbal Result Codes. The computer will use the verbal result codes.
- Set modem to use DTR Signal. This is necessary for the computer to ensure connection with the originate modem.
- Set modem to enable Flow Control. This is necessary to communicate with remote modem connected to the Nexus.
- Tell modem to write the new settings to activate profile. This places these settings into nonvolatile memory; the setting will take effect after the modem powers up.

■ Modem Connected to the Nexus Monitor (the Remote Modem):

- Restore modem to factory settings. This erases all previously programmed settings.
- Set modem to auto answer on N rings. This sets the remote modem to answer the call after N rings.
- Set modem to ignore DTR Signal. This is necessary for the Nexus to ensure connection with originate modem.
- Set modem to disable Flow Control. Nexus RS-232 communication does not support this feature.
- Tell modem to write the new settings to activate profile. This places these settings into nonvolatile memory; the setting will take effect after the modem powers up.
- When programming the remote modem with a terminal program, make sure the baud rate of the terminal program matches the Nexus Monitor's baud rate.

5.20: Selected Modem Strings

| Modem | String/Setting |
|-------------------------------------|-------------------------------|
| Cardinal modem: | AT&FE0F8&K0N0S37=9 |
| Zoom/Faxmodem VFX V.32BIS(14.4K): | AT&F0&K0S0=1&W0&Y0 |
| Zoom/Faxmodem 56Kx Dual Mode: | AT&F0&K0&C0S0=1&W0&Y0 |
| USRobotics Sportster 33.6 Faxmodem: | AT&F0&N6&W0Y0 (for 9600 baud) |
| DIP switch setting: | Up Up Down Down Up Up Up Down |
| USRobotics Sportster 56K Faxmodem: | AT&F0&W0Y0 |
| DIP switch setting: | Up Up Down Down Up Up Up Down |

5.21: High Speed Inputs Connection

- The Nexus High Speed Inputs can be used in many ways:

Attach the KYZ HS Outputs from other meters for totalizing.
 Attach relaying contacts for breaker status or initiated logging.

- Refer to the Nexus Communicator User Manual for information on programming the functionality of these versatile inputs.
- The High Speed Inputs can be used with either dry or wet field contacts. For WET contacts, the common rides on a unit-generated 15VDC. No user programming is necessary to use either wet or dry field contacts.

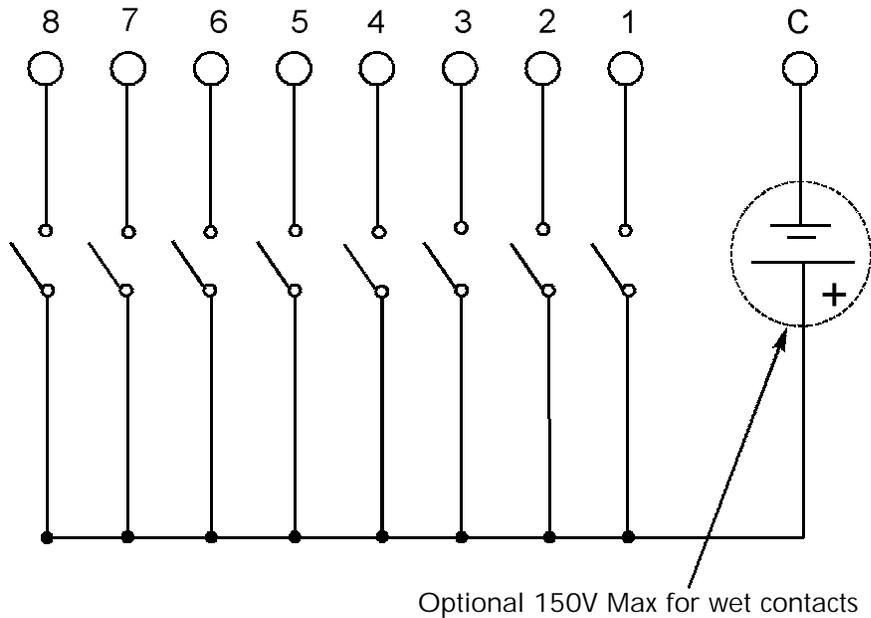


Figure 5.20: High Speed Inputs Connection

5.22: IRIG-B Connections

- IRIG-B is a standard time code format that synchronizes event timestamping to within 1 millisecond. An IRIG-B signal-generating device connected to the GPS satellite system will synchronize Nexus Monitors located at different geographic locations.
- Connect the (+) terminal of the Nexus Monitor to the (+) terminal of the signal generating device; connect the (-) terminal of the Nexus Monitor to the (-) terminal of the signal generating device.

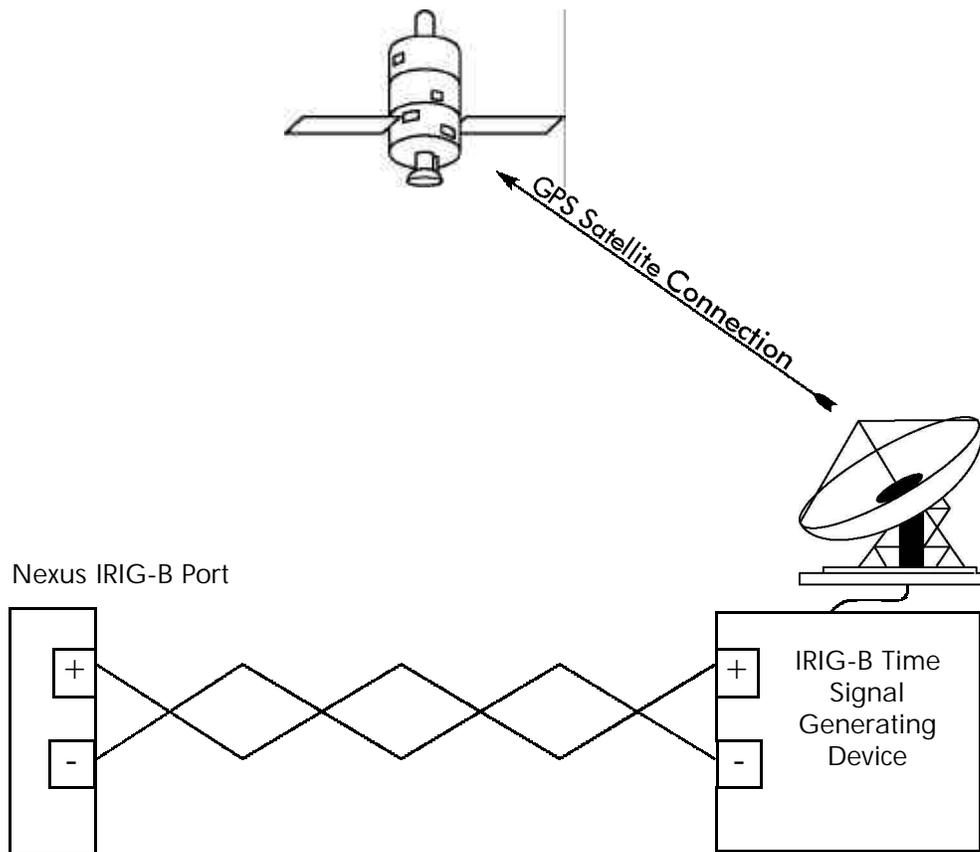


Figure 5.21: IRIG-B Connection

Chapter 6

Using the Nexus External Displays

6.1: Overview

- Electro Industries offers two external displays for use with the Nexus. The P40N is our LED display, which provides easy-to-use access to the information stored in the Nexus. The P60N is our Touch Screen Display, which provides easy access to Nexus readings and information combined with a graphical touch screen presentation.
- Plug one of the Nexus External Displays into port 3 on the Nexus Monitor, using the RS-485 cable supplied. The Displays operate at 9600 baud; port 3 is factory-set to 9600 baud (see Chapter 5 for communication details). To use the Displays on another port, configure that port to operate at 9600 baud, using the Nexus Communicator Software; see the *Nexus Communicator User Manual*.

6.2: Nexus P40N LED External Display

- The Nexus P40N LED External Display has three modes:
 - **Dynamic Readings Mode** (section 6.3 and 6.4)
 - **Nexus Information Mode** (section 6.5 and 6.6)
 - **Display Features Mode** (section 6.7 and 6.8)
- Each Mode is divided into Groups. Most Groups are further broken down into Readings.
 - Use the **MODE** button to scroll between Modes.
 - Use the **UP/DOWN** arrows to scroll from Group to Group within each Mode.
 - Use the **LEFT/RIGHT** arrows to scroll from Reading to Reading within each Group.
- Use the Nexus Communicator software to Flash Update the P40N External Display.

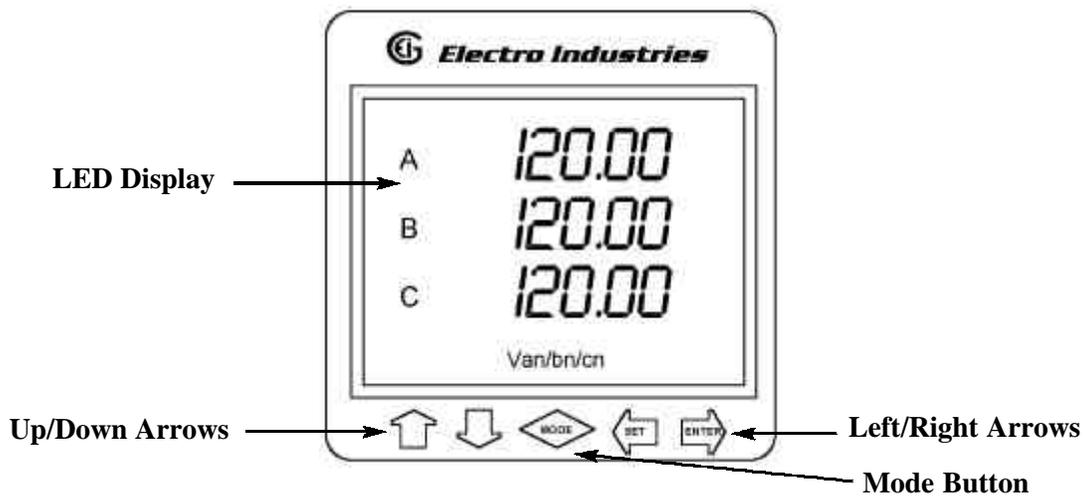


Figure 6.1: Nexus P40N LED External Display

6.3: Dynamic Readings Mode

- The External Display puts itself in the Dynamic Readings Mode upon power-up. Use the **MODE** button to access the Dynamic Readings from other Modes. Use the **UP/DOWN** arrows to navigate from Group to Group within this Mode. See section 6.4 for a navigational map of the Dynamic Readings Mode.

- **Group 1: Phase to Neutral Voltages** (Use the LEFT/RIGHT arrows to access the following readings, in order.)
 - Volts AN/BN/CN
 - Maximum Volts AN/BN/CN
 - Minimum Volts AN/BN/CN
 - Volts AN/BN/CN %THD
 - Volts AN/BN/CN Maximum %THD
 - Volts AN/BN/CN Minimum %THD

- **Group 2: Phase to Phase Voltages** (Use the LEFT/RIGHT arrows to access the following readings, in order.)
 - Volts AB/BC/CA
 - Maximum Volts AB/BC/CA
 - Minimum Volts AB/BC/CA

- **Group 3: Current** (Use the LEFT/RIGHT arrows to access the following readings, in order.)
 - Current A/B/C
 - Maximum Current
 - Minimum Current
 - Current %THD
 - Current Maximum %THD
 - Current Minimum %THD
 - Current Calculated N/Measured N
 - Maximum Current Calculated N/Measured N

- **Group 4: Watt/VAR** (Use the LEFT/RIGHT arrows to access the following readings, in order.)
 - kWatt/kVAR
 - Maximum +kWatt/+kVAR/CoIn kVAR
 - Maximum -kWatt/-kVAR/CoIn kVAR
 - Fixed Window Average Maximum +kWatt/+kVAR/CoIn kVAR
 - Predictive Sliding Window Maximum +kWatt/+kVAR/CoIn kVAR

- **Group 5: VA/PF/Frequency** (Use the LEFT/RIGHT arrows to access the following readings, in order.)
 - kVA/PF lag/Hz
 - Maximum kVA/Hz
 - Minimum kVA/Hz

- Maximum Quadrant 1 Total PF
- Minimum Quadrant 1 Total PF
- Maximum Quadrant 2 Total PF
- Minimum Quadrant 2 Total PF
- Maximum Quadrant 3 Total PF
- Minimum Quadrant 3 Total PF
- Maximum Quadrant 4 Total PF
- Minimum Quadrant 4 Total PF

■ **Group 6: Delivered Energy** (Use the LEFT/RIGHT arrows to access the following readings, in order.)

- +kWatthr Quadrant 1+Quadrant 4 (Primary)
- +kVAhr Quadrant 1 (Primary)
- +kVARhr Quadrant 1 (Primary)
- +kVAhr Quadrant 4 (Primary)
- -kVARhr Quadrant 4 (Primary)

■ **Group 7: Received Energy** (Use the LEFT/RIGHT arrows to access the following readings, in order.)

- -kWatthr Quadrant 2+Quadrant 3 (Primary)
- +kVAhr Quadrant 2 (Primary)
- +kVARhr Quadrant 2 (Primary)
- +kVAhr Quadrant 3 (Primary)
- -kVARhr Quadrant 3 (Primary)

■ **Group 8: Accumulations** (Use the LEFT/RIGHT arrows to access the following readings, in order.)

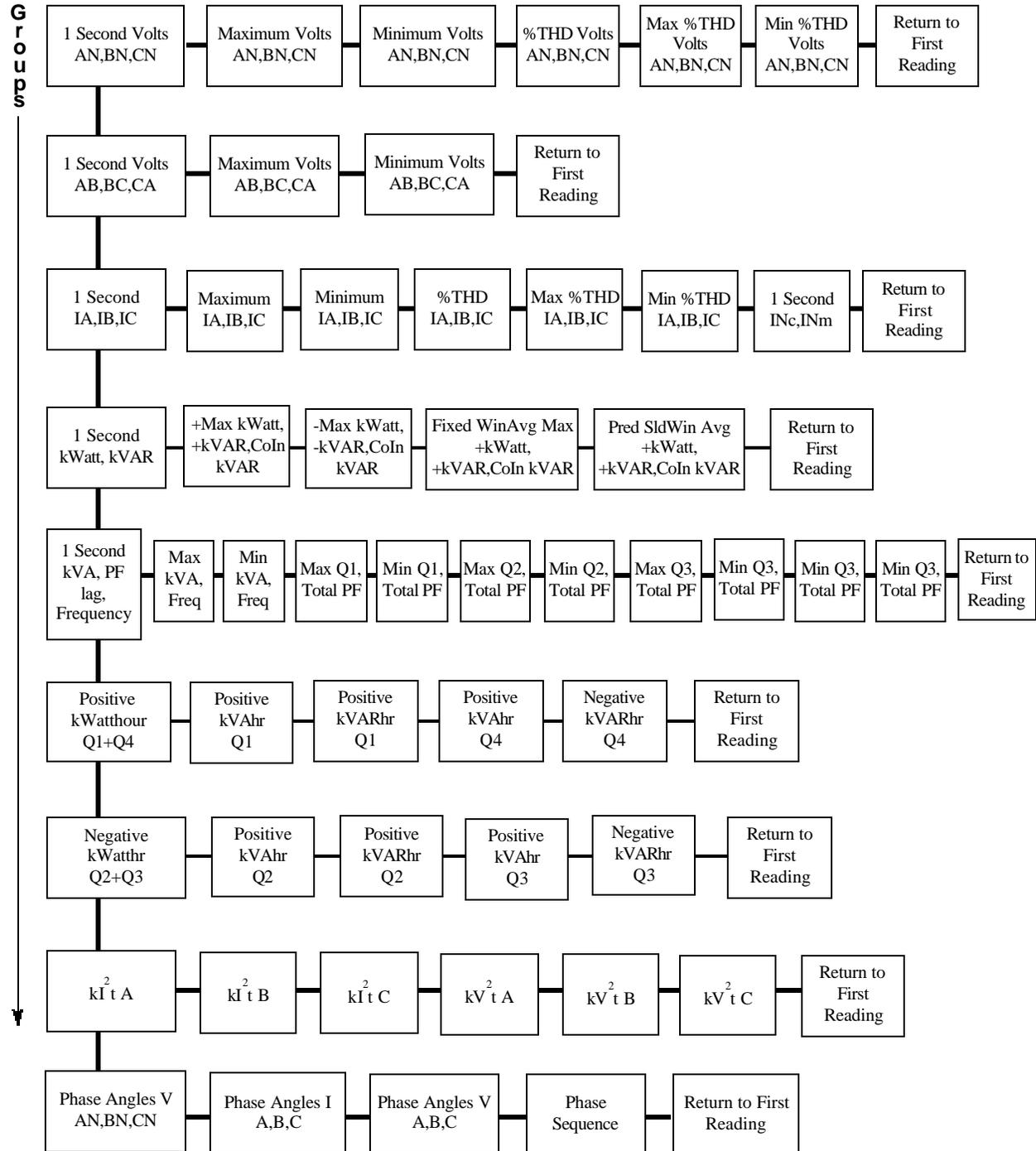
- kI^2t A
- kI^2t B
- kI^2t C
- kV^2t A
- kV^2t B
- kV^2t C

■ **Group 9: Phase Angles** (Use the LEFT/RIGHT arrows to access the following readings, in order.)

- Phase Angle Van/bn/cn
- Phase Angle Ia/b/c
- Phase Angle Vab/bc/ca
- Phase Sequence

6.4: Navigational Map of Dynamic Readings Mode

- Use LEFT/RIGHT arrow keys to navigate Readings
- Use UP/DOWN arrows to scroll between groups.



6.5: Nexus Information Mode

- Use the **MODE** button to access the Nexus Information Mode from other Modes. Use the **UP/DOWN** arrows to navigate from Group to Group within this Mode. See section 6.6 for a navigational map of the Nexus Information Mode.

- **Group 1: Device Time**
 - Meter Time

- **Group 2: Communication Settings** (Use the LEFT/RIGHT arrows to access the following readings, in order.)
 - Communication Settings Port 1: Baud/Addr/Protocol
 - Communication Settings Port 2: Baud/Addr/Protocol
 - Communication Settings Port 3: Baud/Addr/Protocol
 - Communication Settings Port 4: Baud/Addr/Protocol

- **Group 3: PT, CT Ratios** (Use the LEFT/RIGHT arrows to access the following readings, in order.)
 - PT Ratio
 - CT Ratio

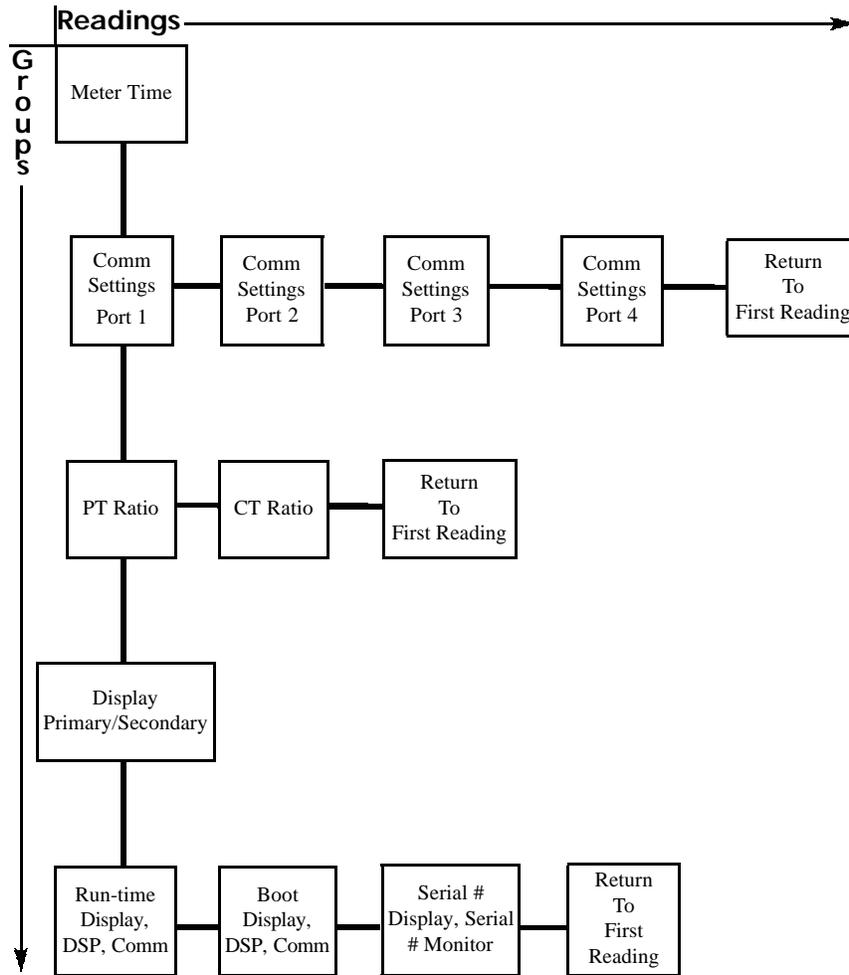
- **Group 4: External Display Units**
 - Primary/Secondary

 - Select either Primary or Secondary units for the External Display using the Nexus Communicator software (see the *Nexus Communicator User Manual*). When Primary is selected, the Display shows all readings in Primary units based on the user programmed PT and CT Ratios. When Secondary is selected, the Display shows all readings in Secondary units.

- **Group 5: Firmware Versions and Serial Numbers** (Use the LEFT/RIGHT arrows to access the following readings, in order.)
 - RunTime External Display/RunTime DSP/RunTime Comm
 - Boot External Display/Boot DSP/Boot Comm
 - Serial Number External Display; Serial Number Nexus Monitor

6.6: Navigational Map of Nexus Information Mode

- Use UP/DOWN arrows to scroll between groups.
- Use LEFT/RIGHT arrows to scroll between readings.



6.7: Display Features Mode

- Use the **MODE** button to access the Display Features Mode from other Modes. Use the **UP/DOWN** arrows to navigate from Group to Group within this Mode. See section 6.8 for a navigational map of the Display Features mode.

■ Group 1: Reset Max/Min

- **Note:** If the **password protection** feature has been enabled with the Nexus Communicator software, you will need to enter a password to reset the max/min readings. To do this, first press the Enter button. Then enter the password, one character at a time, by pressing on the UP or DOWN arrows. Each password character begins as an “A”. Press the UP arrow to increment the character from “A–Z” and then from “0–9”. Press the DOWN arrow to decrement the character from “A” to “9–0” and then from “Z–A”. Press SET to enter each character the password. When the entire password is shown on the Display screen, press ENTER. If the password is correct you may then press Enter again to Reset the Energy readings.
- Press the **Enter** button to reset the Max and Min values.

■ Group 2: Reset Energy

- **Note:** If the **password protection** feature has been enabled with the Nexus Communicator software, you will need to enter a password to reset the energy. To do this, first press the Enter button. Then enter the password, one character at a time, by pressing on the UP or DOWN arrows. Each password character begins as an “A”. Press the UP arrow to increment the character from “A–Z” and then from “0–9”. Press the DOWN arrow to decrement the character from “A” to “9–0” and then from “Z–A”. Press SET to enter each character the password. When the entire password is shown on the Display screen, press ENTER. If the password is correct you may then press Enter again to Reset the Energy readings.
- Press **Enter** button to reset the Max and Min values.

■ Group 3: Display Baud Rate/Address

■ Group 4: Display Communication Protocol

■ Group 5: EIG Use Only

■ Group 6: EIG Use Only

■ Group 7: Lamp Test

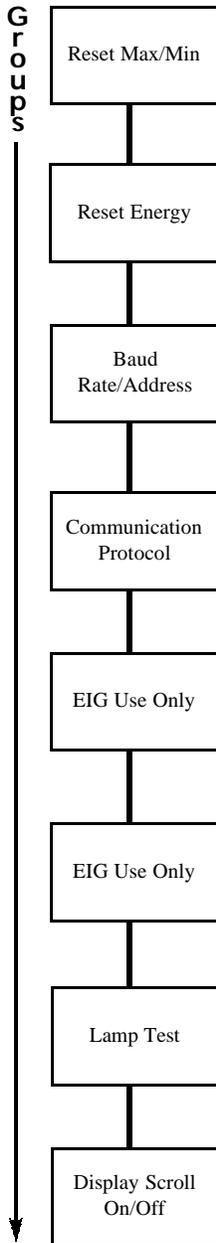
- Press **Enter** to conduct an LED test.

■ Group 8: Display Scroll ON/OFF

- Press **Enter** to turn the scroll feature on or off. When the scroll feature is on, the P40N External Display will scroll through the first reading of each group in the Dynamic Readings Mode. If a button is pressed during the scroll, scrolling pauses for one minute.

6.8: Navigational Map of Display Features Mode

- Use UP/DOWN arrows to scroll between groups.



6.9: Nexus P60N Touch Screen External Display

- The P60N Touch Screen External Display is ready to use upon power-up. Touching the “buttons” at the top of the screen will take you to the **Groups of Readings** listed below. With the “buttons” at the bottom of the screen, you can use the touch screen to review **Limits** and review and/or change **Settings** on the Display and the Nexus Monitor. Also, you can Reset Max/Min and Demand, Hour, I²T and V²T Counters, All Logs and TOU for Current Session and Month using the **Reset Button**.
- All screens have a **Main** button that will take you back to the Main screen. All screens also have a **Next** button that will take you to the next group of readings. Some of the screens have additional navigation buttons to take you to complimentary readings. See section 6.10 for a navigational map.

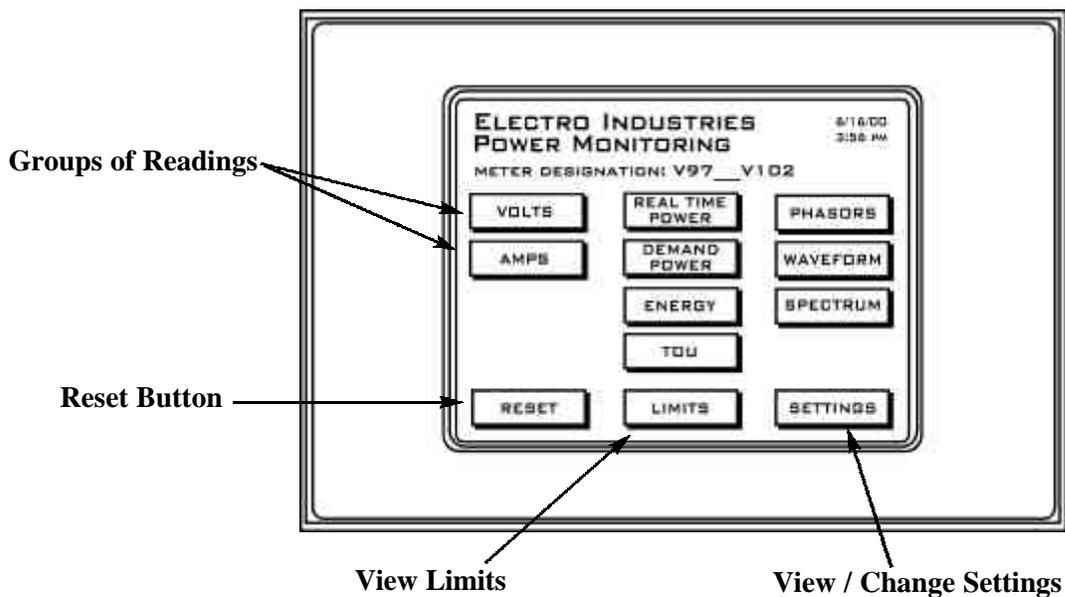


Figure 6.2: Nexus P60N Touch Screen External Display

■ VOLTS: Voltage Readings Details

- Volts AN/BN/CN/AB/BC/CA
- Maximum Volts AN/BN/CN/AB/BC/CA
- Minimum Volts AN/BN/CN/AB/BC/CA

| VOLTAGE | | | | 8/16/00 |
|------------------|-----------|--------|--------|---------|
| READINGS DETAILS | | | | 3:58 PM |
| | REAL TIME | MAX | MIN | |
| | VOLTS | VOLTS | VOLTS | |
| A-N | 120.44 | 122.86 | 114.30 | |
| B-N | 120.05 | 122.84 | 114.30 | |
| C-N | 120.05 | 122.84 | 114.29 | |
| A-B | 0.00 | 0.00 | 0.00 | |
| B-C | 0.00 | 0.00 | 0.00 | |
| C-A | 0.00 | 0.00 | 0.00 | |
| POLLING | | | | |
| MAIN | | NEXT | | |

■ **AMPS: Current Readings Details**

- Real Time Current A/B/C
- Maximum Current A/B/C
- Minimum Current A/B/C
- Current Calculated N/Measured N
- Maximum Current Calculated N/Measured N

| CURRENT READINGS DETAILS | | | |
|---------------------------------|--------------------------|--------------------|--------------------|
| | REAL TIME CURRENT | MAX CURRENT | MIN CURRENT |
| A | 49.04 | 53.67 | 35.91 |
| B | 49.05 | 53.63 | 35.91 |
| C | 49.08 | 53.63 | 35.93 |
| Meas N | 48.70 | 53.65 | 35.92 |
| Calc N | 148.01 | 160.89 | 107.58 |

POLLING

■ **REAL TIME POWER: Real Time Power Readings Details** (Demand button goes to Demand Power screen.)

- Instant kWatt/kVAR/VA/PF
- Average kWatt/kVAR/VA/PF
- Predicted kWatt/kVAR/VA/PF

| REAL TIME POWER READINGS DETAILS | | | |
|---|----------------|----------------|------------------|
| | INSTANT | AVERAGE | PREDICTED |
| WATTS | 9290. | 9290. | 9079. |
| VARS | -14858. | -14858. | -14731. |
| VA | 11732. | 11732. | 11635. |
| PF | -0.536 | -0.536 | |
| LEAD | | LEAD | |

POLLING

■ **DEMAND POWER: Demand Power Readings Details** (R/T button goes to Real Time Power screen.)

- Thermal Window Average Maximum +kWatt/+kVAR/CoIn kVAR
- Fixed Window Average Maximum +kWatt/+kVAR/CoIn kVAR
- Predictive Sliding Window Maximum +kWatt/+kVAR/CoIn kVAR

| DEMAND POWER READINGS DETAILS | | | |
|--------------------------------------|----------------|--------------|----------------|
| | THERMAL | FIXED | SLIDING |
| +KWATTS | 9.8 | 9.8 | 9.1 |
| - KWATTS | 6553.6 | 6553.6 | 6553.6 |
| + WATTS | -14.7 | -14.7 | -12.1 |
| CoIn KVars | | | |
| - WATTS | 0.0 | 0.0 | 0.0 |
| CoIn KVars | | | |
| + KVARs | -6553.6 | -6553.6 | -6553.6 |
| - KVARs | -16.9 | -16.9 | -14.9 |

POLLING

■ **ENERGY: Accumulated Energy Information/Delivered Energy/Received Energy** (TOU button goes to TOU Register Accumulations screen.)

- -kWatthr Quadrant 2+Quadrant 3 (Primary)
- +kVAhr Quadrant 2 (Primary)
- +kVARhr Quadrant 2 (Primary)
- +kVAhr Quadrant 3 (Primary)
- -kVARhr Quadrant 3 (Primary)
- +kWatthr Quadrant 1+Quadrant 4 (Primary)
- +kVAhr for all Quadrants (Primary)

| ACCUMULATED ENERGY INFORMATION | | | |
|---------------------------------------|------------------|----|-----------------------|
| VAR 0000000000000000 | Q2 | Q1 | REC WATT |
| VA 0000000000000000 | Q3 | Q4 | 000000088070247 |
| DEL WATT | 0000000000000000 | | |
| VA 0000000000000000 | | | VA 00000000061221713 |
| VAR 0000000000000000 | | | VAR 00000000012217891 |

POLLING

■ **TOU: Time of Use Readings Register Accumulations/ Registers 1 - 8** (Demand button goes to TOU Register Demand screen.) (Next Reg button displays Registers 1 - 8.) (Next Group button displays Prior Season, Month, Current Season, Month.)

- -kWatthr Quadrant 2+Quadrant 3 (Primary)
- +kVAhr Quadrant 2 (Primary)
- +kVARhr Quadrant 2 (Primary)
- +kVAhr Quadrant 3 (Primary)
- -kVARhr Quadrant 3 (Primary)
- +kWatthr Quadrant 1+Quadrant 4 (Primary)
- +kVAhr Quadrants 1 & 4 (Primary)
- -kVARhr Quadrant 4 (Primary)

Register Demand/ Register 1 - 8 (Accum button goes to TOU Register Accumulation screen.) Next Reg button displays Registers 1 - 8.) (Next Group button displays Prior Season, Month, Current Season, Month.)

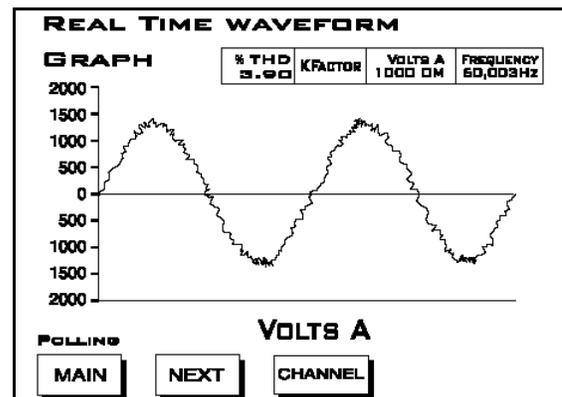
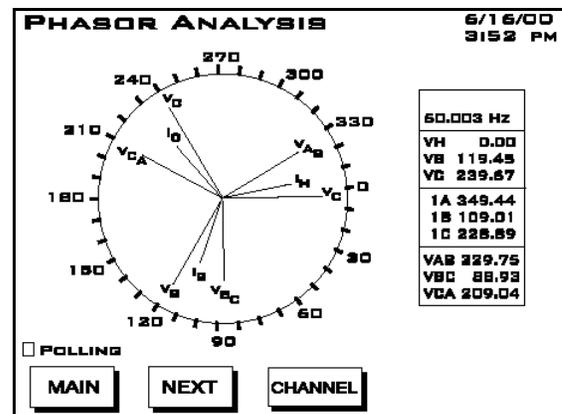
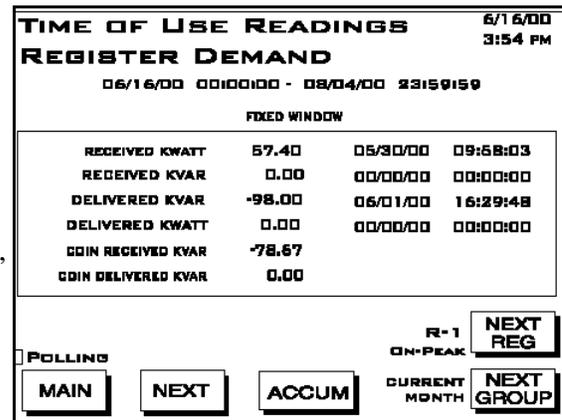
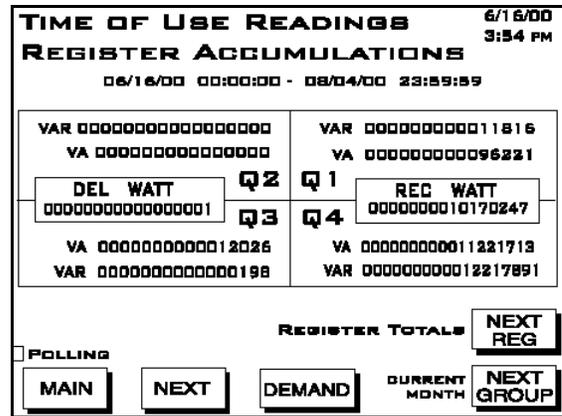
- Fixed Window +kWatth, +kVARhr, -kWatth, -kVARh, Coin +kVARh, Coin -kVARh

■ **PHASORS: Phasor Analysis**

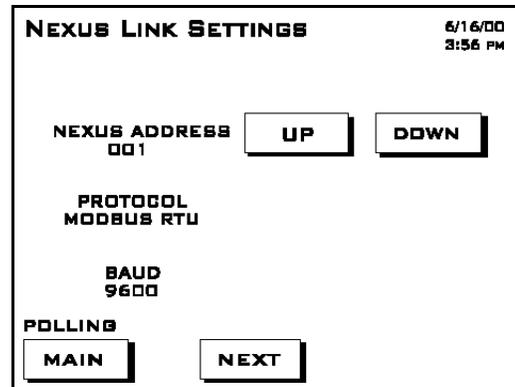
- Phase Angle Van/bn/cn
- Phase Angle Ia/b/c
- Phase Angle Vab/bc/ca

■ **WAVEFORM: Real Time Waveform Graph.** Use Channel button to view graphs and readings:

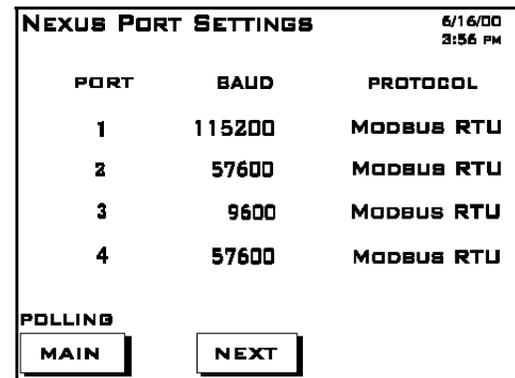
- Channel Van/bn/cn
- Channel Ia/b/c
- % THD, KFactor, Frequency for selected channel



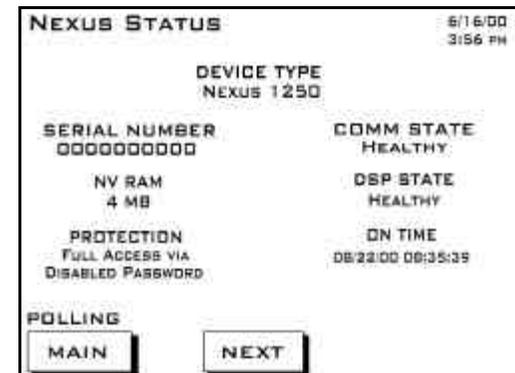
- Nexus Link Settings:**
 Nexus Address (000 - 255).
 Touch Up/Down buttons to increase/decrease settings.
 Protocol (selected).
 Baud (selected).



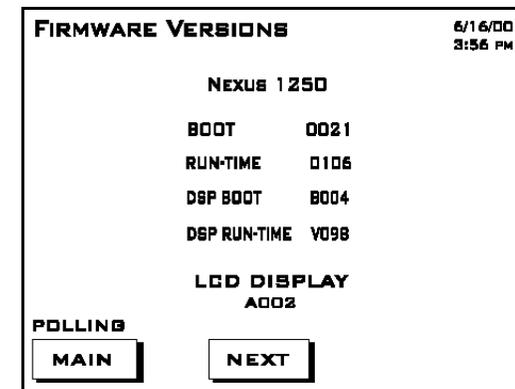
- Nexus Port Settings:**
 Port 1 (Baud and Protocol selected).
 Port 2 (Baud and Protocol selected).
 Port 3 (Baud and Protocol selected).
 Port 4 (Baud and Protocol selected).



- Nexus Status:**
 Device Type: Nexus 1250
 Serial Number (10 digit number)
 Comm State: Healthy or Unhealthy
 Nv Ram: 4 MB
 DSP State: Healthy or Unhealthy
 Protection: Password Enabled or Disabled
 On Time: Current Date and Time

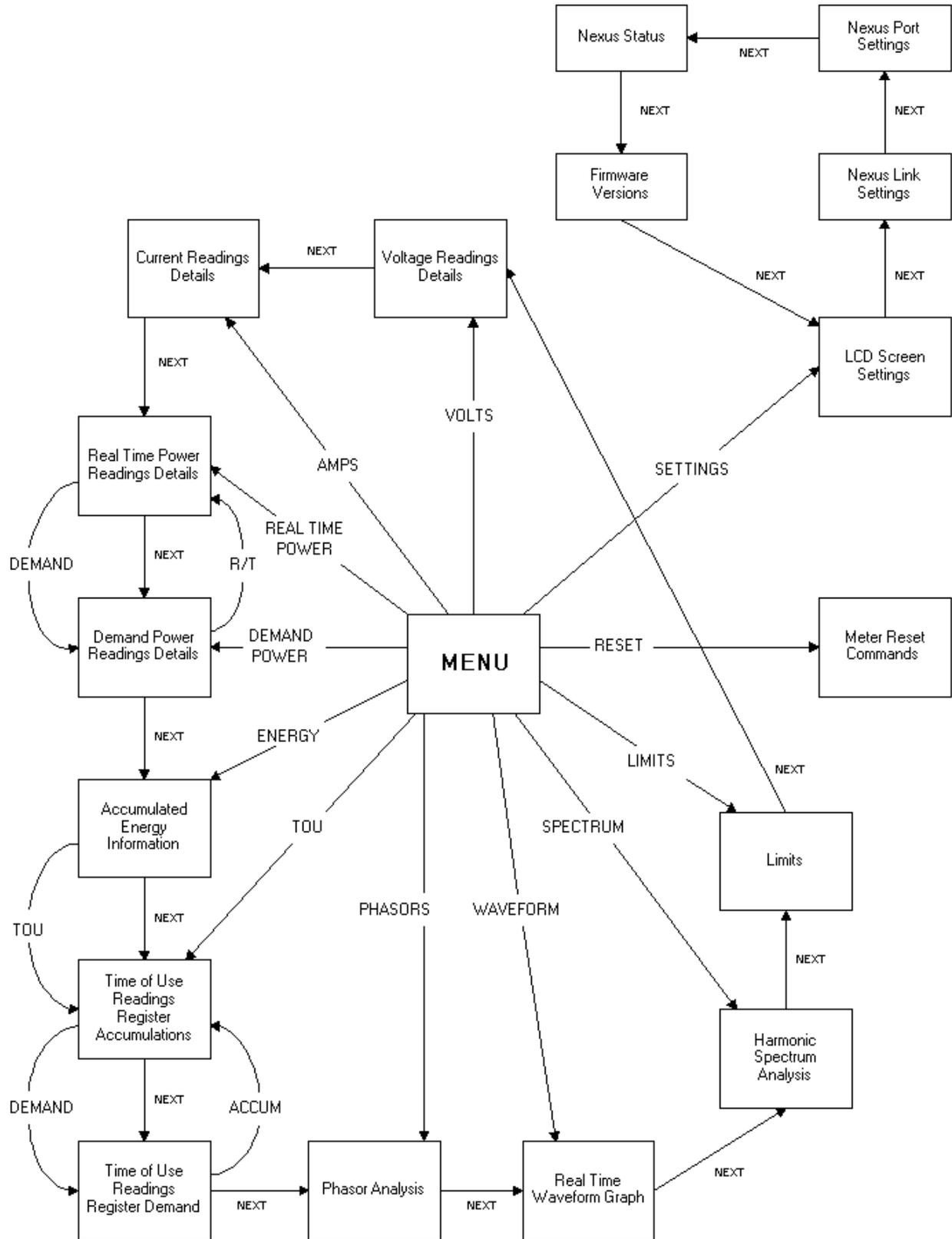


- Firmware Versions:**
 Nexus 1250
 Boot:
 Run-time:
 DSP Boot:
 DSP Run-time:
 LCD Display:



This screen displays the current firmware version for the Nexus and the display.

6.10: Navigational Map for P60N Touch Screen External Display



Chapter 7

Transformer Loss Compensation

7.1: Introduction

- The Edison Electric Institute's *Handbook for Electricity Metering, Ninth Edition* defines Loss Compensation as:

A means for correcting the reading of a meter when the metering point and point of service are physically separated, resulting in measurable losses including I²R losses in conductors and transformers and iron-core losses. These losses may be added to or subtracted from the meter registration.

- Typically, meters connected to secondary circuits cannot measure power dissipated in transmission lines and in the cores of transformers. Transformer Loss Compensation (TLC) is a technique that electrically or computationally accounts for the lost active and reactive power. These calculations are based on the formulas below. These equations describe the amount of active (Watts) and reactive (Vars) power lost due to both iron and copper effects (reflected to the secondary).

- Vars Compensation =
$$((\text{Measured Voltage}/\text{Cal point Voltage})^4 \times \%LVFE \times \text{Secondary VA}) + ((\text{Measured Current}/\text{Cal Point Current})^2 \times \%LVCU \times \text{Secondary VA})$$
- Watts Compensation =
$$((\text{Measured Voltage}/\text{Cal point Voltage})^2 \times \%LWFE \times \text{Secondary VA}) + ((\text{Measured Current}/\text{Cal Point Current})^2 \times \%LWCU \times \text{Secondary VA})$$

- These compensation values are added to the measured Watts and Vars for delivered power and subtracted from the same quantities for received power. The Values for %LWFE, %LWCU, %LVFE, %LVCU are derived from the transformer and meter information, as demonstrated in following sections.

7.2: Nexus 1250 Transformer Loss Compensation

- The Nexus 1250 provides compensation for all metered and derived quantities by performing the numerical calculations described in section 7.5, Calculating Transformer Loss Compensation Percentages (Work Sheet). Enter the derived values in the Device Profile screen of the Nexus Communicator software. Transformer Loss Compensation applies to the following values:
 - 1 second and average Watt/Vars totals.
 - All thermal fixed sliding average Watts/Vars.
 - All energy accumulation registers.
 - KYZ output quantities.
- The Nexus Communicator software allows you to enable Transformer Loss Compensation for Copper, Iron, both or neither. You can enable it to add/subtract from delivered/received quantities.
- Nexus 1250 Transformer Loss Compensation:
 - Performs calculations on each phase of the meter for every measurement taken. Unbalanced loads are accurately handled.
 - Calculates numerically, eliminating the environmental effects that cause inaccuracies in electromechanical compensators.
 - Performs Bi-directional Loss Compensation.
 - Requires no additional wiring; the compensation occurs internally.
 - Imposes no additional electrical burden when performing Loss Compensation.

7.3: Loss Compensation Percentages

- **Loss compensation percentages** are values that describe the percentage Watt and Var losses due to Iron and Copper at the loss calibration point of the Nexus Monitor. Losses due to Iron manifest themselves in changes to the measured voltage. Losses due to Copper manifest themselves in changes to the measured current.

- **Transformer characteristics** are published in the documentation accompanying individual transformers. Manufacturers determine the following characteristics when testing transformers for proper operation:
 - Transformer Bank Rating (Self Cooled)
 - Test Phase Voltage (Low Side)
 - No Load Loss Watts
 - Load Loss Watts
 - % Exciting Current
 - % Impedance

- **Meter characteristics** specify the type of meter type, class, etc., as ordered by the customer. The information is published in documentation accompanying individual meters. The different characteristics are:
 - Voltage Transformer Ratio (VTR)
 - Current Transformer Ratio (CTR)
 - Meter Secondary Voltage (always 120V for Nexus Transformer Loss Compensation)
 - Meter Secondary Phase Current (always 5A for Nexus Transformer Loss Compensation)

- **Derivation equations** detail the calculation of Loss Compensation Percentages from the Transformer and Meter characteristics. The following symbols represent Loss Compensation Percentages:
 - %LWFE—Percent Loss of Watts due to Iron
 - %LWCU—Percent Loss of Watts due to Copper
 - %LVFE—Percent Loss of Vars due to Iron
 - %LVCU—Percent Loss of Vars due to Copper

■ The following derivation equations give the above values in terms of known transformer and meter parameters:

- %LWFE (%) = $100 \times (\text{Watt Losses Iron (KW)}/\text{Primary KW})$
- %LWCU (%) = $100 \times (\text{Watt Losses Copper (KW)}/\text{Primary KW})$
- %LVFE (%) = $100 \times (\text{Var Losses Iron (KW)}/\text{Primary KVAR})$
- %LVCU (%) = $100 \times (\text{Var Losses Copper (KW)}/\text{Primary KVAR})$

■ The loss values of LWFE, LVFE, LWCU and LVCU are the actual losses used in computing the percentages above. The equation for Primary KVA is:

- Primary KVA = $(\text{Meter Secondary Voltage} \times \text{VTR}) \times (\text{Meter Secondary Current} \times \text{CTR}) \times \text{No. Elements (3)}$

■ The equation for Watt losses due to iron is:

- $\text{LWFE} = ((\text{Meter Secondary Volts} \times \text{VTR})/\text{Rated Transformer Volts})^2 \times \text{No Load Loss Watts}$

■ The equation for Var losses due to iron is:

- $\text{LVFE} = ((\text{Meter Secondary Volts} \times \text{VTR})/\text{Rated Transformer Volts})^4 \times \text{No Load Loss Vars}$

■ The equation for Watt losses due to copper is:

- $\text{LWCU} = ((\text{Meter Secondary Current} \times \text{CTR})/\text{Primary Current at Rated Bank KVA and Test Phase Volts})^2 \times \text{Load Loss Watts}$

■ The equation for Var losses due to copper is:

- $\text{LVCU} = ((\text{Meter Secondary Current} \times \text{CTR})/\text{Primary Current at Rated Bank KVA and Test Phase Volts})^2 \times \text{Load Loss Vars}$

■ Test Phase Voltage and the Load and No Load Watts are provided by the transformer manufacturer. All other information must be derived using the following equations, which are derived from the information provided by the transformer manufacturer and from the Nexus Monitor specified by the customer.

■ The following equation gives Primary Current at Rated Bank KVA and Test Phase Voltage. This value is used in calculating Copper Watt and Var losses, above.

- Primary Current at Rated Bank KVA and Test Phase Voltage = $(\text{Bank KVA Rating}/\text{Test Phase Voltage}) \times \text{SQRT (3)}$

■ Load and no Load Loss Watts information generally accompanies the transformer. However, Load and No Load Loss Vars must be calculated from other information. The following equations are for Load and No Load Loss Vars:

- $\text{Load Loss Vars} = \text{SQRT} ((\text{Load Loss VA})^2 - (\text{Load Loss Watts}^2))$

- $\text{No Load Loss Vars} = \text{SQRT} ((\text{No Load Loss VA})^2 - (\text{No Load Loss Watts}^2))$

■ Load and No Load Loss VA must be calculated from transformer parameters. The equations are given below:

- $\text{Load Loss KVA} = \% \text{Impedance} \times \text{Bank KVA Rating}$

- $\text{No Load Loss KVA} = (\text{Exciting Current} \times \text{Bank KVA Rating})$

■ At this point, by working backwards from the Transformer and Nexus Monitor information, it is possible to derive values for %LWFE, %LWCU, %LVFE AND %LVCU.

7.4: Application of Load Loss Compensation Percentages

- Use the following work sheet, section 7.5, to calculate Transformer Loss Compensation Percentages. Program the percentages into the Nexus Monitor by selecting the Device Profile screen of the Nexus Communicator software and entering the appropriate percentages and operating parameters. These factors are used to compute the losses on a secondary per phase basis using the meter voltage and current readings. The 1 second Watt and Var Totals are updated to reflect the computed losses, which are carried forward to all registers and energy accumulation values. These are reflected back to the primary by uses of the CTR and VTR ratios. The equations implemented in the meter are given below.

- $\text{Loss WCU} = (\%LWCU \times (I/\text{Meter Secondary Current})^2 \times \text{Meter VA Rating})/100$
- $\text{Loss WFE} = (\%LWFE \times (V/\text{Meter Secondary Voltage})^2 \times \text{Meter VA Rating})/100$
- $\text{Loss VCU} = (\%LVCU \times (I/\text{Meter Secondary Current})^2 \times \text{Meter VA Rating})/100$
- $\text{Loss VFE} = (\%LVFE \times (V/\text{Monitor Secondary Voltage})^4 \times \text{Monitor VA Rating})/100$
 - Nexus Secondary Voltage = 120V
 - Nexus Secondary Current = 5A
 - Nexus VA Rating = Secondary Voltage x Monitor Secondary Current = 600VA

- The losses are applied (additive for the example) as follows:

- $\text{Total 1 Sec Watts} = \text{Total 1 Sec Watts} + \text{Loss WCU} + \text{Loss WFE}$
- $\text{Total 1 Sec Vars} = \text{Total 1 Sec Vars} + \text{Loss VCU} + \text{Loss VFE}$

7.5: Calculating Transformer Loss Compensation Percentages (Work Sheet)

Company: _____
 Date: _____
 Transformer Serial Number _____

Required Data

Transformer Data

Transformer Bank Rating (Self Cooled) = _____
 Test Phase Voltage (Low Side) = _____
 No Load Loss Watts = _____
 Load Loss Watts = _____
 % Exciting current = _____
 % Impedance = _____

Nexus Monitor Information

Voltage Transformer Ratio (VTR) = _____
 Current Transformer Ratio (CTR) = _____
 Meter Secondary Voltage (always 120V for Nexus TLC) = 120V
 Meter Secondary Phase Current (always 5A for Nexus TLC) = 5A

Losses Due to Iron

No Load KVA Losses = (Exciting Current) x (Bank KVA Rating)

$$= \text{_____} \times \text{_____}$$

No Load Loss Vars = $\text{SQRT}((\text{No Load VA Losses})^2 - (\text{No Load Watt Losses})^2)$

$$= \text{SQRT}((\text{_____})^2 - ((\text{_____})^2))$$

Adjust No Load Losses to the Nexus Meter Secondary Voltage:

Watt Losses (FE) = $((120 \times \text{VTR})/\text{Test Phase Voltage})^2 \times \text{No Load Loss Watts}$

$$= ((120 \times \text{_____})/\text{_____})^2 \times \text{_____}$$

Var Losses (FE) = $((120 \times \text{VTR})/\text{Test Phase Voltage})^4 \times \text{No Load Loss Vars}$

$$= ((120 \times \text{_____})/\text{_____})^4 \times \text{_____}$$

Losses Due to Copper

KVA Load Losses = (Impedance) x (Bank KVA Rating)

KW = _____ x _____

Load Loss Vars = SQRT((Load VA Losses)² - (Load Watt Losses)²)

= SQRT((_____)² - (_____)²)

It (Primary) at Rated Bank KVA and Test Phase Voltage

= (Bank KVA Rating/Test Voltage,Phase to Phase) x SQRT (3)

= (_____/_____) x SQRT (3)

Adjust Load Losses due to current to the Nexus Monitor Secondary Current:

Watt Losses (CU) = ((5 x CTR)/It (Primary)² x Load Loss Watts

KW = ((5 x ___)/_____)² x _____

Var Losses (CU) = ((5 x CTR)/It (Primary)² x Load Loss Vars

KVA = ((5 x ___)/_____)² x _____

PERCENT COMPENSATION FACTORS

Nominal Primary KVA = (120V x VTR) x (5A x CTR) x 3

KVA = (120V x _____) x (5A x _____) x 3

%LWFE = (Watt Losses (FE) (KW) x 100)/Nominal Primary KVA

% = (_____ x 100)/_____

%LVFE = (VAR Losses (FE) (KW) x 100)/Nominal Primary KVA

% = (_____ x 100)/_____

%LWCU = (Watt Losses (CU) (KW) x 100)/Nominal Primary KVA

% = (_____ x 100)/_____

%LVCU = (VAR Losses (CU) (KW) x 100)/Nominal Primary KVA

% = (_____ x 100)/_____

Chapter 8

Nexus Time-of-Use

8.1: Introduction

- A Time-of-Use (TOU) usage structure takes into account the quantity of energy used *and* the time at which it was consumed. The Nexus 1250 TOU function, available with the Nexus Communicator software, is designed to accommodate a variety of programmable rate structures. Nexus TOU accumulates data based on the time-scheme programmed into the Nexus Monitor.
- See the *Nexus Communicator User Manual* for details on programming the Nexus 1250 TOU calendar and retrieving TOU data.

8.2: The Nexus TOU Calendar

- A Nexus TOU calendar sets the parameters for TOU data accumulation. You may store up to twenty calendars in the Nexus Monitor and an unlimited amount of calendar files on your computer.
- The Nexus TOU calendar profile allows you to assign a programmable usage **schedule**—eg, “Weekday,” “Weekend,” “Holiday”—to each day of the calendar year. You may create up to 16 different TOU schedules.
- Each TOU schedule divides the 24-hour day into fifteen-minute intervals from 00:00:00 to 23:59:59. You may apply one of eight different programmable **registers**—eg “Peak,” “Off Peak,” “Shoulder Peak”— to each fifteen-minute interval.
- The Nexus Monitor stores:
 - accumulations on a seasonal basis, up to four seasons per year;
 - accumulations on a monthly basis.
- Seasonal and monthly accumulations may span one year into the next. Each season and month is defined by a programmable start/billing date, which is also the end-date of the prior season or month.
 - A season ends at midnight of the day before the start of the next season.
 - A month ends at midnight of the month’s billing day.
- If the year ends and there is no new calendar, TOU accumulations will stop. If a calendar is present for the following year, TOU accumulations continue until the next monthly bill date or next start-of-season is reached. Accumulation can span into the following year.
- If no following year is present, the last accumulation for the year will end on 12:31:23:59:59.

8.3: TOU Prior Season and Month

- The Nexus Monitor stores accumulations for the prior season and the prior month. When the end of a billing period is reached, the current season or month becomes stored as the prior. The registers are then cleared and accumulations resume, using the next set of TOU schedules and register assignments from the stored calendar.
- Prior and current accumulations to date are always available.

8.4: Updating, Retrieving and Replacing TOU Calendars

- Nexus Communicator software retrieves TOU calendars from the Nexus Monitor or from the computer's hard drive for review and edit.
- Up to a maximum of twenty yearly calendars can be stored in the Nexus Monitor at any given time. You may retrieve them one at a time; a new calendar can be stored while a current calendar is in use.
- Accumulations do not stop during calendar updates. If a calendar is replaced while in use, the accumulations for the current period will continue until the set end date. At that point, the current time will become the new start time and the settings of the new calendar will be used.
- Reset the current accumulations, if you replace a calendar in use. A reset clears only the current accumulation registers. This causes the current accumulations to use the present date as the start and accumulate to the next new end date, which will be taken from the new calendar. Once stored, prior accumulations are always available and can not be reset. See the *Nexus Communicator User Manual* for how to reset TOU accumulations.
- At the end of a defined period, current accumulations are stored, the registers are cleared and accumulations for the next period begin. When the year boundary is crossed, the second calendar, if present, is used. To retain continuity, you have up to one year to replace the old calendar with one for the following year.

8.5: Daylight Savings and Demand

- To use Daylight Savings Time, you must enable it in the Nexus Monitor's Device Profile and enter the associated dates or use the default dates of the first Sunday in April at 1:59:59 (to 3:00:00) and the last Sunday in October at 1:59:59 (to 1:00:00). See the *Nexus Communicator User Manual*. Or, you can use **Auto DST**, which sets Daylight Savings Time automatically (for the United States ONLY).
- You must also select a fixed or sliding window average method for the accumulation values.

Chapter 9

Nexus External I/O Modules

9.1: Hardware Overview

- All Nexus External I/O modules have the following components:
 - **Female RS-485 Side Port:** use to connect to another module's female RS-485 side port.
 - **Male RS-485 Side Port:** use to connect to the Nexus Monitor's port 4 or to another module's male RS-485 side port.
 - **I/O Port:** used for functions specific to the type of module; **size and pin configuration vary depending on type of module.**
 - **Reset Button:** Press and hold for three seconds to reset the module's **baud rate to 57600** and its **address to 247** for 30 seconds.
 - **LEDs:** when flashing, signal that the module is functioning.
 - **Mounting Brackets (MBIO):** used to secure one or more modules to a flat surface.

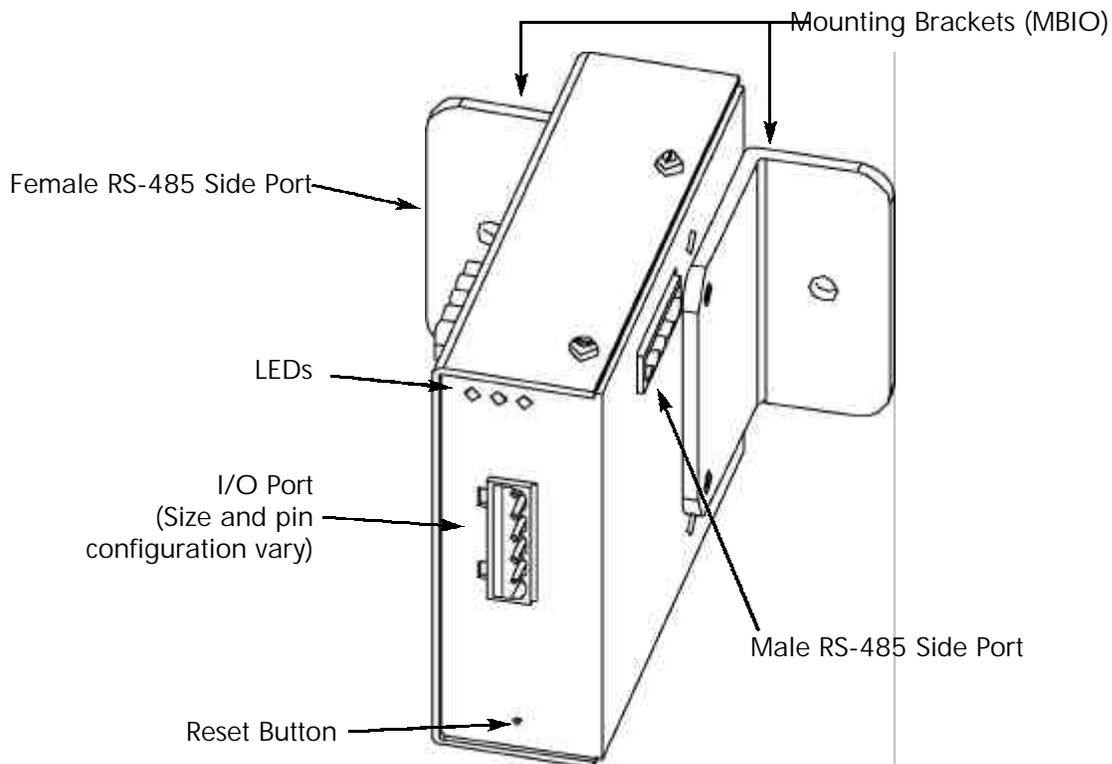


Figure 9.1: I/O Module Components

9.2: Installing Nexus External I/O Modules

- I/O modules must use the Nexus Monitor's port 4. Port 4 allows the Nexus Monitor, normally a slave, to become a Master (Port 3 can be used as an alternate). Six feet of RS-485 cable harness is supplied. Insert one end of the cable into port 4; insert the other end into the module's Male RS-485 Side Port. The connectors fit only one way into the ports. See section 9.3 for details on using multiple I/O modules.
- The Nexus Monitor will power up to four modules (**two** Analog Output Modules) using 15–20 VDC at 50–200 mA, represented by dashed lines in the figure below. Refer to sections 5.12 - 5.13 for the steps to determine if you must use an **additional power source**, such as the EIG Power Brick (model #PB1, 12V). RS-485 communication is capable for up to 4000 feet (1219 meters). However, if your cable length exceeds 200 feet, use the additional power supply and:
 - Connect the A(+) and B(-) terminals on the Nexus to the A(+) and B(-) terminals of the male RS-485 port. Connect the shield to the shield (S) terminal. The (S) terminal on the Nexus is used to reference the Nexus port to the same potential as the source. It is not an earth ground connection. You must also connect the shield to earth-ground at one point.
 - Provide termination resistors at each end, connected to the A(+) and B(-) lines. R_T is approximately 120 Ohms.

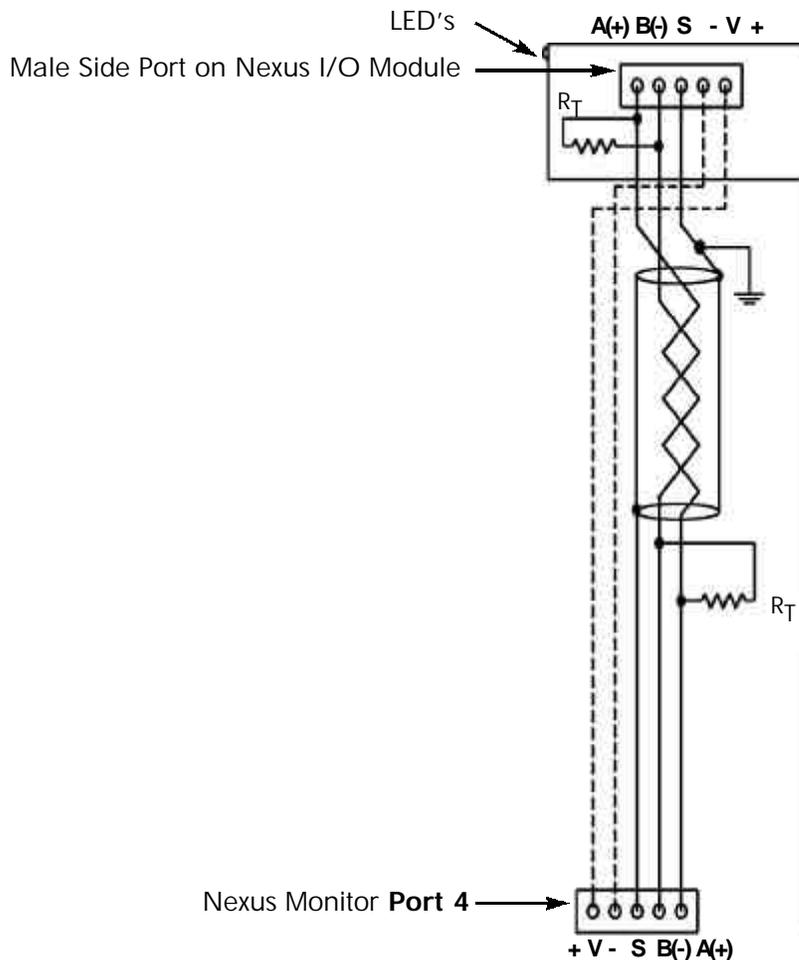
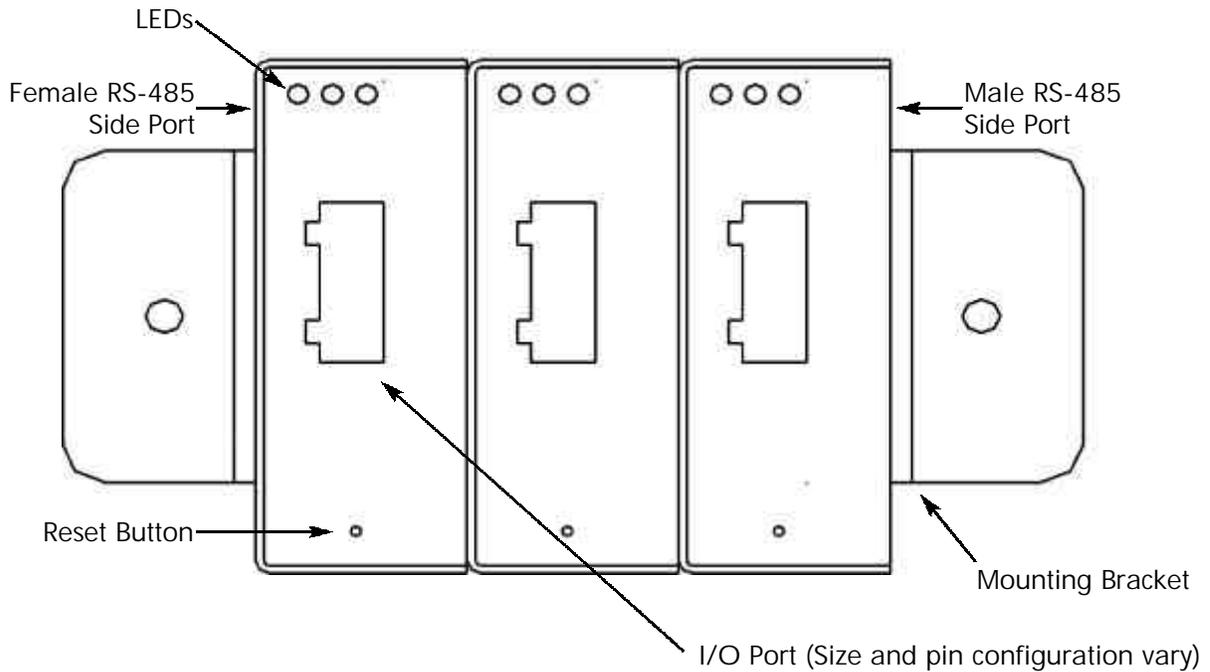


Figure 9.2: Nexus Monitor Connected to I/O Module

9.3: Using Multiple I/O Modules



I/Os must use the Nexus Monitor's Port 4.
Set the port to 57600 Baud, Master.

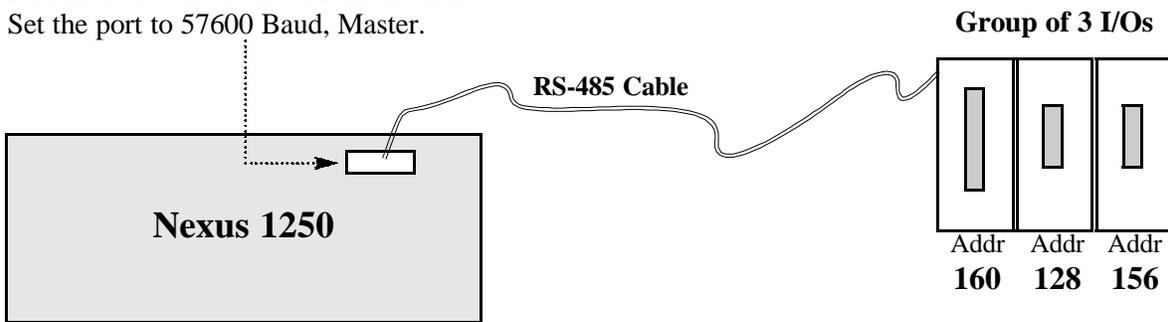


Figure 9.3: Multiple I/Os

- Each I/O module in a group **must be assigned a unique address**. See the *Nexus Communicator User Manual* for details on configuring and programming the I/O Modules.
- Use the male and female RS-485 side ports to attach I/O modules together. Screw the modules together, using the integrated fastening system. Attach the mounting brackets to each side of the group to ensure all modules are securely connected.

9.4: Factory Settings and Reset Button

■ Factory Settings:

All Nexus I/O Modules are shipped with a preset address and a baud rate of 57600.

■ Reset Button:

If there is a communication problem or if you are unsure of a module's address and baud rate, press and hold the RESET button for 3 seconds; the module will reset to a default address of **247 at 57600 baud for 30-seconds**. This will enable you to interrogate the I/O using the Nexus Communicator software; see the *Nexus Communicator User Manual*.

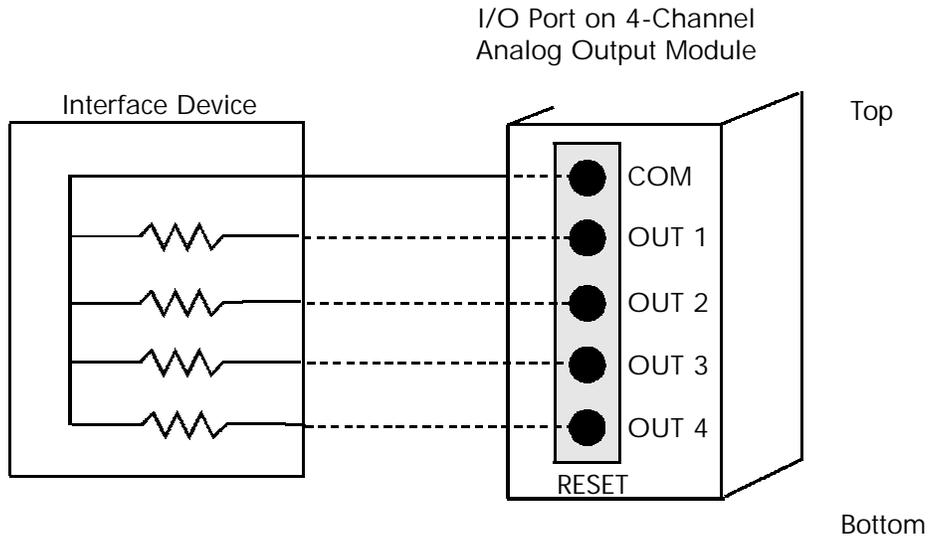
| <u>Model #</u> | <u>Module</u> | <u>Factory-Set Address</u> |
|----------------|-----------------------------------|----------------------------|
| 1mAON4 | 0–1mA, 4-Channel Analog Output | 128 |
| 1mAON8 | 0–1mA, 8-Channel Analog Output | 128 |
| 20mAON4 | 4–20mA, 4-Channel Analog Output | 132 |
| 20mAON8 | 4–20mA, 8-Channel Analog Output | 132 |
| 8AI1 | 0–1mA, 8-Channel Analog Input | 136 |
| 8AI2 | 0–20mA, 8-Channel Analog Input | 140 |
| 8AI3 | 0–5 VDC, 8-Channel Analog Input | 144 |
| 8AI4 | 0–10 VDC, 8-Channel Analog Input | 148 |
| 4RO1 | 4 Latching Relay Outputs | 156 |
| 4PO1 | 4 KYZ Pulse Outputs | 160 |
| 8DI1 | 8 Digital Status Inputs (Wet/Dry) | 164 |
| 4RTD1 | 4 RTD Inputs | 168 |

9.5: Analog Transducer Signal Output Modules

| Analog Transducer Signal Output Modules Specifications | |
|---|--|
| Model Numbers | 1mAON4: 4-Channel Analog Output, 0–1mA |
| | 1mAON8: 8-Channel Analog Output, 0–1mA |
| | 20mAON4: 4-Channel Analog Output, 4–20mA |
| | 20mAON8: 8-Channel Analog Output, 4–20mA |
| Accuracy | 0.1% of Full Scale |
| Scaling | Programmable |
| Communication | RS-485, Modbus RTU |
| | Programmable Baud Rates: 4800 to 57500 Baud |
| Power Requirement | 15–20 VDC at 50–200mA; Nexus Monitor will support up to two modules. |
| Operating Temperature | -20°C to 70°C / -4°F to +158°F |
| Maximum Load Impedance | 0–1mA: 10k Ω; 4–20mA: 500 Ω |
| Factory Settings | Modbus Address: 1mAON4,0–1mA: 128; 1mAON8, 0-1mA: 128 20mAON4,4–20mA: 132, 20mAON8,4-20mA: 132 |
| | Baud Rate: 57600 |
| Default Settings (Reset Button) | Modbus Address: 247 |
| | Baud Rate: 57600 |

- The Analog Transducer Signal Output Modules (0–1mA or 4–20mA) are available in either a 4- or 8-channel configuration.
- The Nexus Monitor supplies power for up to two connected Analog Output modules. See section 9.2 for power and communication details. See sections 5.12 and 5.13 for the steps to determine if you must use an additional power source.
- All outputs share a single common point. This is also an isolated connection (from ground).
- The figure on the next page shows the configuration of the Analog Output Module's I/O Port, which is used for connection to an interface device.

4-Channel Analog Output Module (0-1mA or 4-20mA)



NOTE: Dashed lines indicate customer wiring.

8-Channel Analog Output Module (0-1mA or 4-20mA)

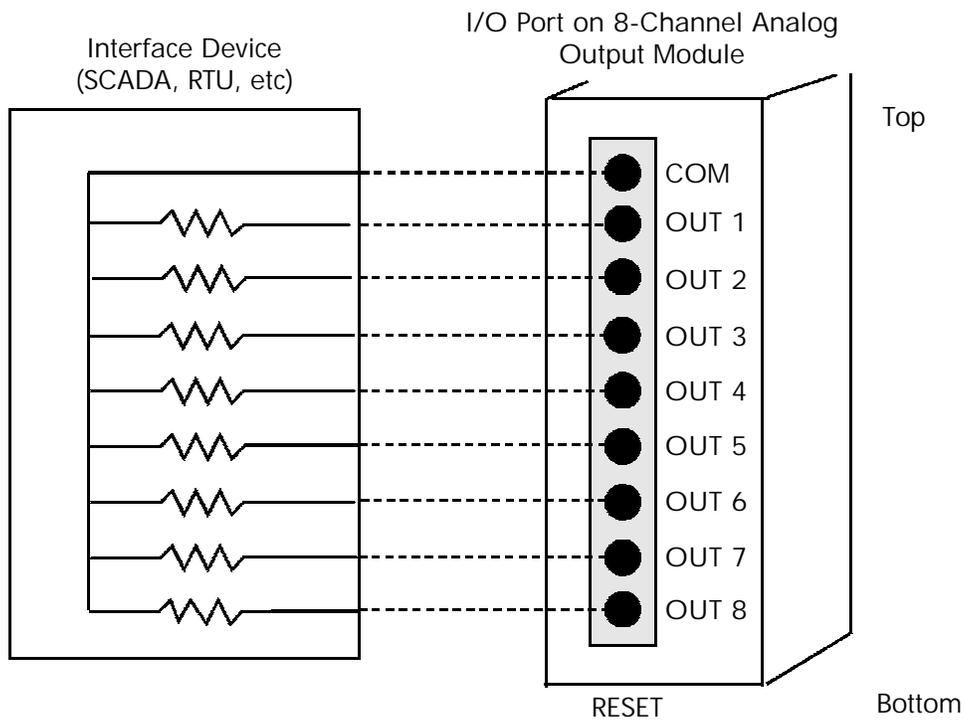


Figure 9.4

9.6: Analog Input Modules

| Analog Input Modules Specifications | |
|--|---|
| Model Numbers | 8AI1: 8-Channel Analog Input, 0-1mA |
| | 8AI2: 8-Channel Analog Input, 0-20mA |
| | 8AI3: 8-Channel Analog Input, 0-5VDC |
| | 8AI4: 8-Channel Analog Input, 0-10VDC |
| Accuracy | 0.1% of Full Scale |
| Scaling | Programmable |
| Communication | RS-485, Modbus RTU |
| | Programmable Baud Rates: 4800 to 57600 Baud |
| Power Requirement | 15-20 VDC at 50-200mA; Nexus Module will support up to 4 modules |
| Operating Temperature | -20°C to 70°C / -4°F to +158°F |
| Input Impedance | 8AI1, 0-1mA: 1k Ω; 8AI2, 0-20mA: 100 Ω 8AI3, 0-5VDC: >1M Ω; 8AI4, 0-10VDC: >1MΩ |
| Factory Settings | Modbus Address: 8AI1, 0-1mA: 136; 8AI2, 0-20mA: 140 8AI3, 0-5VDC: 144, 8AI4, 0-10VDC: 148 |
| | Baud Rate: 57600 |
| Default Settings (Reset Button) | Modbus Address: 247 |
| | Baud Rate: 57600 |

- The Analog Input Modules (0–1mA, 0–20mA, 0-5 VDC and 0-10 VDC) are available in 8-channel format.
- The Nexus Monitor supplies power for up to four connected modules. See section 9.2 for power and communication details. Refer to sections 5.12 - 5.13 for the steps to determine if you must use an additional power source.
- All inputs share a single common point. This is also an isolated connection (from ground).
- The figure on the next page shows the configuration of the Analog Input Module’s I/O Port, which is used for connection to an interface device.

8-Channel Analog Input Module (0-1mA, 0-20mA, 0-5 VDC or 0-10 VDC)

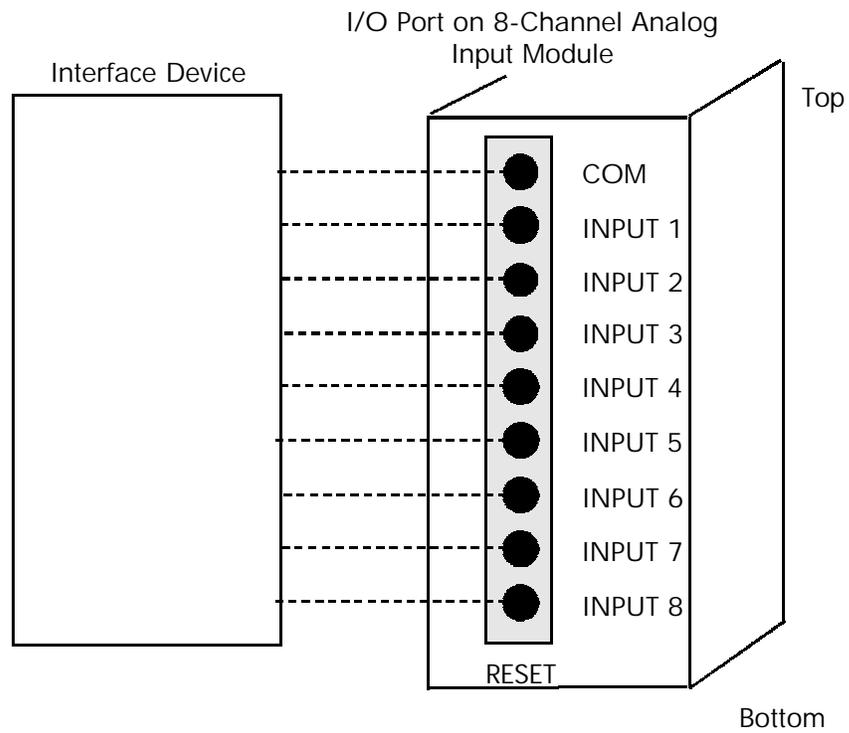


Figure 9.5

NOTE: Dashed lines indicate customer wiring.

9.7: Digital Dry Contact Relay Output (Form C) Module

| Digital Dry Contact Relay Output (Form C) Module Specifications | |
|--|--|
| Model Number | 4RO1: 4 Latching Relay Outputs |
| Communication | RS-485, Modbus RTU |
| | Programmable Baud Rates from 4800 to 57600 Baud |
| Power | 15–20 VDC at 50–200 mA; Nexus Monitor will support up to four modules. |
| Operating Temperature | -20°C to 70°C / -4°F to +158°F |
| Maximum Switch Current | 5Arms@240VAC, 3A@125VDC |
| Maximum Switch Voltage | 240VAC or 125VDC |
| Contact Type on each output | SPDT |
| Factory Settings | Modbus Address: 156 |
| | Baud Rate: 57600 |
| | Delay: 0 |
| Default Settings (Reset Button) | Modbus Address: 247 |
| | Baud Rate: 57600 |

- Relay output modules are triggered by limits programmed with the Nexus Communicator software. See the *Nexus Communicator User Manual* for details on programming limits.
- The Nexus Monitor supplies power for up to four connected modules. See section 9.2 for power and communication details. See sections 5.12 - 5.13 for the steps to determine if you must use an additional power source.
- The figure on the next page shows the configuration of the Output Module's I/O Port, which is used for connection to an interface device.
- Each latching relay will hold its state in the event of a power loss.

Digital Dry Contact Relay Module (I/O Port)

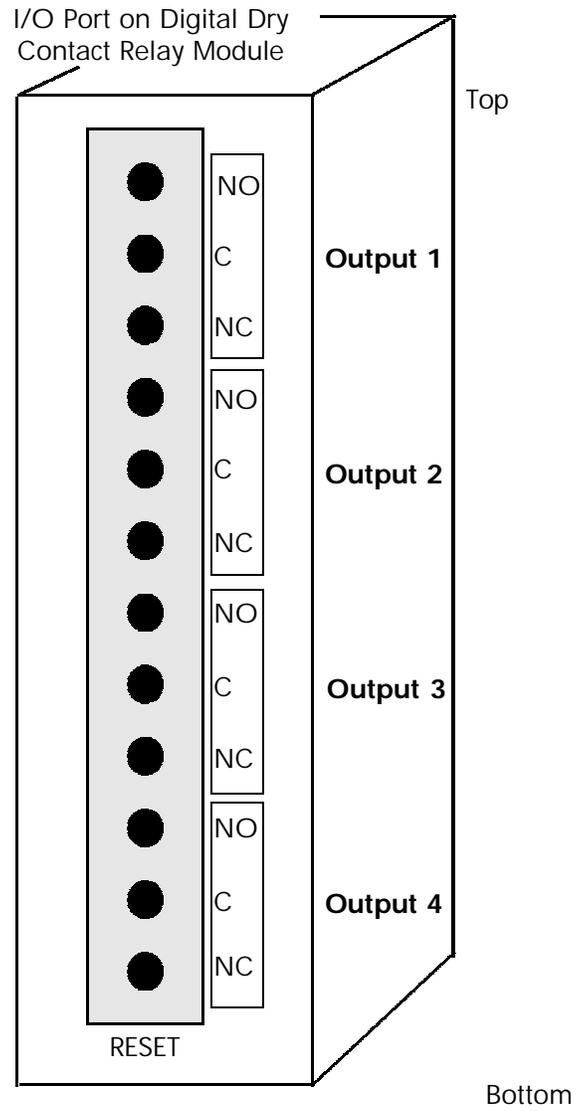


Figure 9.6

9.8: Digital Solid State Pulse Output (KYZ) Module

| Digital Solid State Pulse Output (KYZ) Module Specifications | |
|---|--|
| Model Number | 4PO1 |
| Communication | RS-485, Modbus RTU |
| | Programmable Baud Rates from 4800 to 57600 Baud |
| Power | 15–20 VDC at 50–200 mA; Nexus Monitor will support up to four modules. |
| Operating Temperature | -20°C to 70°C / -4°F to +158°F |
| Maximum Pulse Speed | 20 Pulses Per Second |
| Factory Settings | Modbus Address: 160 |
| | Baud Rate: 57600 |
| | Delay: 0 |
| Default Settings (Reset Button) | Modbus Address: 247 |
| | Baud Rate: 57600 |

- The Digital Solid State Pulse Output (KYZ) Modules are user programmed to reflect VAR-hours, WATT-hours, or VA-hours. See the *Nexus Communicator User Manual* for details on programming the module.
- The Nexus Monitor supplies power for up to four connected modules. See section 9.2 for power and communication details. See sections 5.12 - 5.13 for the steps to determine if you must use an additional power supply.
- The figure on the next page shows the configuration of the KYZ Pulse Module's I/O Port, which is used for connection to an interface device.
- NC = Normally Closed; NO = Normally Open; C = Common.

Digital Solid State Pulse Output (KYZ) Module

I/O Port on Digital Solid
State Pulse Output
(KYZ) Module

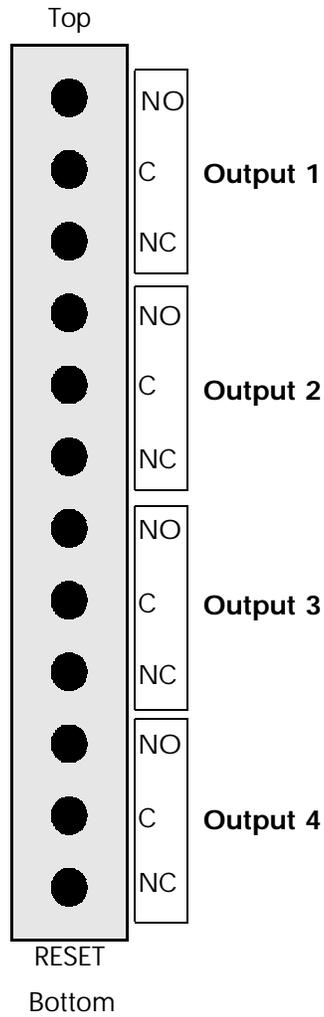


Figure 9.7

NOTE: Relay contact positions are shown in shelf (de-energized) state.

9.9: Digital Status Input Module

| Digital Status Input Module Specifications | |
|--|--|
| Model Number | 8DI1 |
| Communication | RS-485, Modbus RTU |
| | Programmable Baud Rates from 4800 to 57600 Baud |
| Power | 15–20 VDC at 50–200 mA; Nexus Monitor will support up to four modules. |
| Operating Temperature | -20°C to 70°C / -4°F to +158°F |
| Voltage Rating | Up to 300 VDC |
| Detection | Wet/Dry, Auto Detect |
| Factory Settings | Modbus Address: 164 |
| | Baud Rate: 57600 |
| | Delay: 0 |
| Default Settings (Reset Button) | Modbus Address: 247 |
| | Baud Rate: 57600 |

- The Nexus Monitor supplies power to up to four connected modules. See section 9.2 for power and communication details. See sections 5.12 and 5.13 for the steps to determine if you must use an additional power source.
- The figure on the next page shows the configuration of the Digital Status Input Module's I/O Port, which is used for connection to an interface device. This module is used for either additional **status detect** or for **accumulating pulses from external equipment**, such as power meters, water meters, etc. A user programmable address and functionality afford versatility.

Digital Status Input Module, I/O Port

I/O Port on Digital
Status Input Module

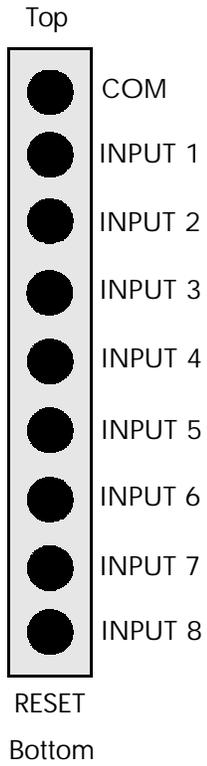


Figure 9.8

Chapter 10

Nexus Monitor with Internal Modem Option

10.1: Hardware Overview

- The Nexus Monitor with the Internal Modem has all the components of the standard Nexus Monitor **PLUS** the capability of connecting to a PC via standard phone line. No additional hardware is required to establish a virtually unlimited connection from a PC to a Nexus with Internal Modem Option.

If desired, the internal expansion port of the Nexus can be configured with an internal 56K bps modem. This gives Nexus dial-in capability without additional hardware. This is ideal for small remote applications.

When the device is configured with a modem card, Port 2 becomes a gateway allowing other Modbus-based serial devices access to the phone line. Additional connections can include a daisy chain of standard Nexus Monitors. A Daisy Chain can have up to 31 meters. If more are desired, the installation of a repeater allows additional meters. (See section 5-14 for repeater details.)

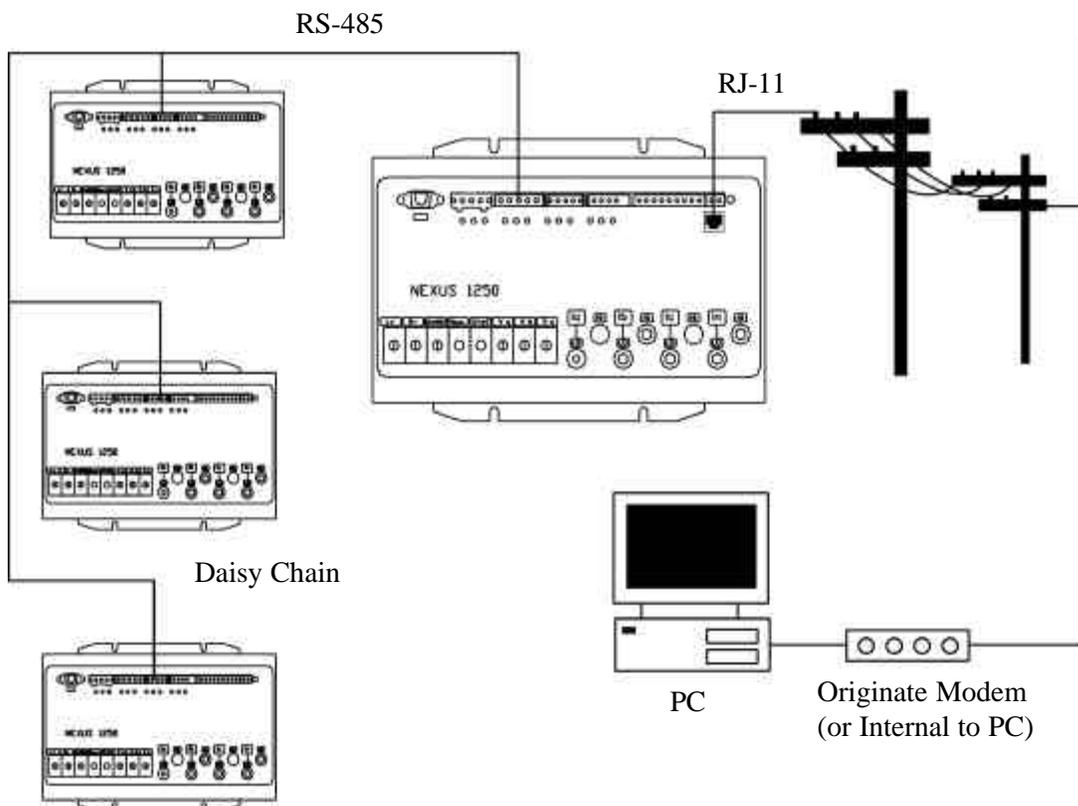


Figure 10.1: Nexus with Internal Modem Option

10.2: Hardware Connection

- Use RJ-11 Standard Telephone Line to connect with the Nexus. The RJ-11 line is inserted into the RJ-11 Port on the face of the Nexus with Internal Modem Option.
- The connection using RJ-11 into the Nexus is virtually unlimited, since it utilizes a PSTN (Public Switched Telephone Network).
- To connect with other Nexus Monitors in either local or remote locations, you **MUST** use **Port 2** as a Master and an RS-485 connection to **any port** on the remote Nexus.
- The Address of the remote Nexus **MUST** be something other than “1”.
- The link using RS-485 is capable for up to 4000 feet (1219 meters).

Chapter 11

Nexus Monitor with Internal Network Option

11.1: Hardware Overview

- The Nexus Monitor with the Internal Network Option has all the components of the standard Nexus Monitor **PLUS** the capability of connecting to a multiple PC's via Modbus/TCP over Ethernet. Additional hardware is not required to establish a connection from a network to a Nexus with Internal Network Option.

With the Internal Network Option, the Nexus provides an Ethernet Gateway, allowing access to other Modbus/RTU devices. Additional connections can include a daisy chain of standard Nexus Monitors. A daisy chain can have up to 31 meters. If more are desired, the installation of a repeater allows additional meters. (See section 5-14 for repeater details.)

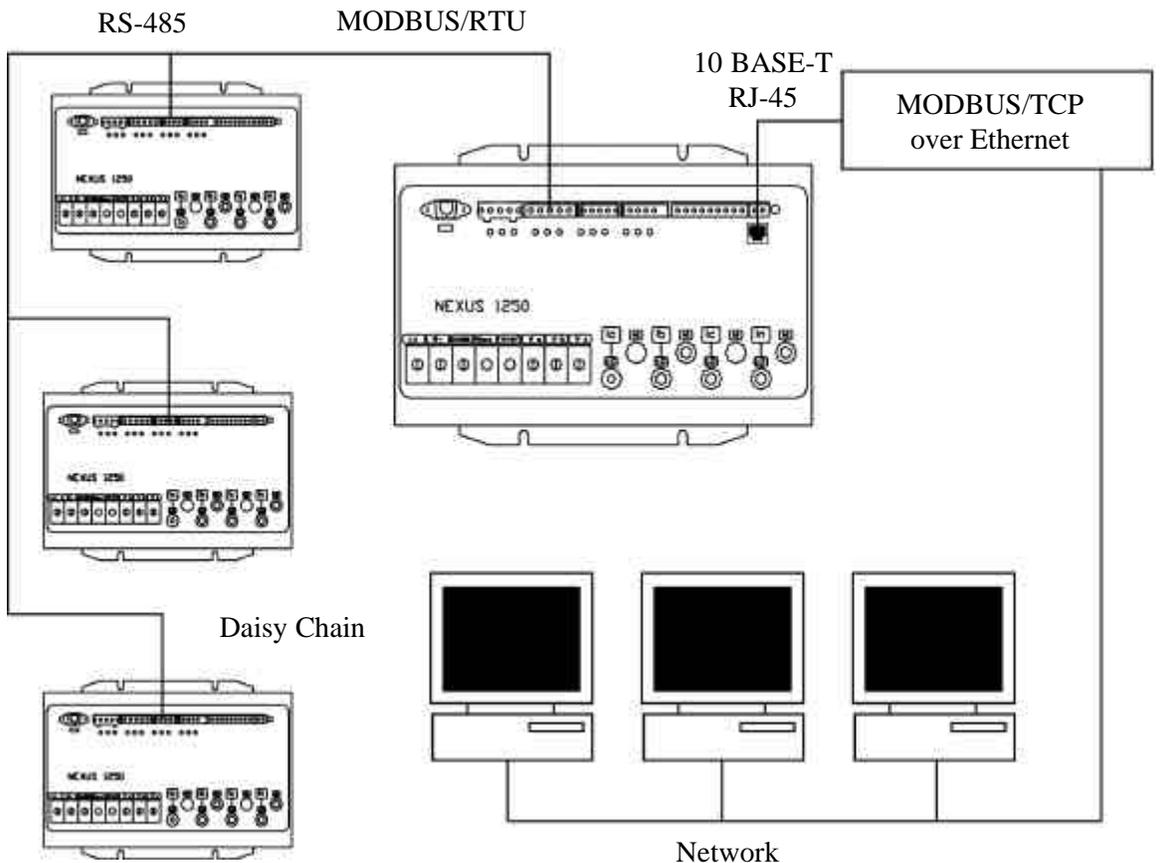


Figure 11.1: Nexus with Internal Network Option

- The Internal Network Option of the Nexus Monitor is an extremely versatile communications tool.
 - Adheres to IEEE 802.3 ethernet standard using TCP/IP.
 - Utilizes simple and inexpensive 10BaseT wiring and connections.
 - Plugs right into your network using built-in RJ-45 jack.
 - Programmable to any IP address, subnet mask and gateway requirements.
 - Communicates using the industry standard Modbus/TCP protocol.
- With the Internal Network Option, the standard Port 2 on the Nexus becomes a “gateway” to allow additional Nexus Monitors access via the LAN. Simply connect a daisy chain of Nexus Monitors together via RS-485, each with its own device address and using the same baud rates. With this option, you can access any of those instruments via the single LAN connection.
- The Internal Network Option allows multiple simultaneous connections (via LAN) to the Nexus. You can access the Nexus with SCADA, MV90 and RTU all at the same time.
- The Internal Network Option allows multiple users running Nexus Communicator software to access the meter concurrently.

11.2: Hardware Connection

- Use Standard RJ-45 10 Base-T cable to connect with the Nexus. The RJ-45 line is inserted into the RJ-45 Port on the face of the Nexus with Internal Network Option.
- Set the IP Address using the following steps:
(Refer to Section 3.5 of the *Nexus Communicator User Manual* for more details).

1. From the Device Profile screen, double-click on the Communications Ports line, then double-click on any of the ports. The Device Profile Communications Settings screen appears.
2. In the Network Settings section, enter data provided by your systems manager:

| | | |
|------------------|---------------|-----------|
| IP Address: | 135.15.173.99 | (Example) |
| Subnet Mask: | 255.255.255.0 | (Example) |
| Default Gateway: | 0.0.0.0 | (Example) |
| Computer Name: | NETWORK | (Example) |
| Baud Rate: | 115200 | (Example) |

NOTE: DO NOT check Obtain IP Address using DHCP Server, if you have an IP Address.

- After the above parameters are set, Nexus Communicator will connect via the network using a Device Address of “1” and the assigned IP Address using the following steps:
 1. Double click on Nexus Communicator icon to open.
 2. Click the Connect icon in the icon tool bar. The Connect screen will appear.
 3. Click the Network button at the top of the screen. The screen will change to one requesting the following information:

| | |
|-----------------|--|
| Device Address: | 1 |
| Host: | IP Address (per your network administrator). Example: 135.15.173.99 |
| Network Port: | 502 |
| Protocol: | Modbus TCP |

4. Click the Connect button at the bottom of the screen. Nexus Communicator connects to the Nexus with the Host IP Address via the Network.
- To connect with other Nexus Monitors in either local or remote locations, you **MUST** use the **Ethernet Gateway** as a Master and an RS-485 connection to **any port** on the remote Nexus.
 - The Address of the remote Nexus **MUST** be something other than “1”. “1” is reserved for the Nexus connected to the network via its RJ-45.
 - The link using RS-485 is capable for up to 4000 feet (1219 meters).

GLOSSARY OF TERMS

| Term | Definition |
|-------------------------------------|---|
| 0.1 Second Values | These values are the RMS values of the indicated quantity as calculated after approximately 50 milliseconds (3 cycles) of sampling. |
| 1 Second Values | These values are the RMS values of the indicated quantity as calculated after one second (60 cycles) of sampling. |
| Average (Current) | When applied to current values (amps) the average is a calculated value that corresponds to the thermal average over a specified time interval. The interval is specified by the user in the meter profile. The interval is typically 15 minutes. So, Average Amps is the thermal average of amps over the previous 15-minute interval. The thermal average rises to 90% of the actual value in each time interval. For example, if a constant 100amp load is applied, the thermal average will indicate 90 amps after one time interval, 99 amps after two time intervals and 99.9 amps after three time intervals. |
| Average (Input Pulse Accumulations) | When applied to Input Pulse Accumulations, the label "Average" refers to the fixed window average value of the input pulses. |
| Average (Power) | When applied to power values (watts, VARs, VA) the average is a calculated value that corresponds to the thermal average over a specified time interval. The interval is specified by the user in the meter profile. The interval is typically 15 minutes. So, the Average Watts is the thermal average of watts over the previous 15-minute interval. The thermal average rises to 90% of the actual value in each time interval. For example, is a constant 100kw load is applied, the thermal average will indicate 90kw after one time interval, 99kw after two time intervals and 99.9kw after three time intervals. |
| CBEMA Curve | A voltage quality curve established originally by the Computer Business Equipment Manufacturers Association. The CBEMA Curve defines voltage disturbances that could cause malfunction or damage in microprocessor devices. The curve is characterized by voltage magnitude and the duration during which the voltage is outside of tolerance. (See ITIC Curve also.) |

| Term | Definition |
|------------------------------|---|
| DNP 3.0 | A common protocol used in electric utility substations and SCADA systems. |
| Ethernet | A type of LAN network connection that connects two or more devices on a common communications backbone. An Ethernet LAN consists of at least one hub device (the network backbone) with multiple devices connected to it in a star configuration. The most common versions of Ethernet in use are 10BaseT or 100BaseT as defined in IEEE standards. However, several other versions of Ethernet are also available. |
| Fixed Window Average (Power) | The Fixed Window Average is the average power calculated over a user-set time interval, typically 15 minutes. This calculated average corresponds to the demand calculations performed by most electric utilities in monitoring user power demand. (See Sliding Window Average also.) |
| ITIC Curve | An updated version of the CBEMA Curve that reflects further study into the performance of microprocessor devices. The curve consists of a series of steps but still defines combinations of voltage magnitude and duration that will cause malfunction or damage. |
| Modbus ASCII | Alternate version of the Modbus protocol that utilizes a different data transfer format. This version is not dependent upon strict timing, as is the RTU version. This is the best choice for telecommunications applications (via modems). |
| Modbus RTU | The most common form of Modbus protocol. Modbus RTU is an open protocol spoken by many field devices to enable devices from multiple vendors to communicate in a common language. Data is transmitted in a timed binary format, providing increased throughput and therefore, increased performance. |
| Network | A communications connection between two or more devices to enable those devices to send and receive data to one another. In most applications the network will be either a serial type or a LAN type. |

| Term | Definition |
|--|---|
| NVRAM | NVRAM (Non-volatile Random Access Memory) is able to keep the stored values in memory even with the loss of circuit or control power. High speed NVRAM is used in the Nexus to gather measured information and to insure that no information is lost. |
| Protocol | The language that will be spoken between two or more devices connected on the network. |
| Quadrant (Programmable Values and Factors on the Nexus) | Watt and VAR flow is typically represented using an X-Y coordinate system. The four corners of the X-Y plane are referred to as a quadrants. Most power applications label the upper right hand corner as the first quadrant and number the remaining quadrants in a counter-clockwise rotation. Following are the positions of the quadrants: 1st - upper right, 2nd - upper left, 3rd - lower left and 4th - lower right. Power flow is generally positive in quadrants 1 and 4. VAR flow is positive in quadrants 1 and 2. The most common load conditions are: Quadrant 1 - power flow positive, VAR flow positive, inductive load, lagging or positive power factor; and Quadrant 2 - power flow negative, VAR flow positive, capacitive load, leading or negative power factor. |
| RS-232 | A type of serial network connection that connects two devices to enable communications between devices. An RS-232 connection connects only two pints. Distance between devices is typically limited to fairly short runs. Current standards recommend a maximum of 50 feet but some users have had success with runs up to 100 feet. Communications speed is typically in the range of 1200 bits per second to 57,600 bits per second. |
| RS-485 | A type of serial network connection that connects two or more devices to enable communications between the devices. An RS-485 connection will allow multi-drop communications from one to many points. Distance between devices is typically limited to around 2,000 to 3,000 wire feet. Communications speed is typically in the range of 120 bits per second to 115,000 bits per second. |

| Term | Definition |
|--------------------------------|--|
| Sliding Window Average (Power) | The Sliding Window Average is the average power calculated over a user-set time interval that is derived from a specified number of sub-intervals, each of a specified time. For example, the average is calculated over a 15-minute interval by calculating the sum of the average of three consecutive 5-minute intervals. This demand calculation methodology has been adopted by several utilities to prevent customer manipulation of kw demand by simply spreading peak demand across two intervals. |
| THD | THD (Total Harmonic Distortion) is the combined effect of all harmonics measured in a voltage or current. The THD number is expressed as a percent of the fundamental. For example, a 3% THD indicates that the magnitude of all harmonic distortion measured equals 3% of the magnitude of the fundamental 60 Hz quantity. |
| Voltage, Vab | Vab, Vbc, Vca are all phase to phase voltage measurements. These voltages are measured between the three phase voltage inputs to the meter. |
| Voltage, Van | Van, Vbn, Vcn are all phase to neutral voltages applied to the monitor. These voltages are measured between the phase voltage inputs and Vref input to the meter. Technologically, these voltages can be "measured" even when the meter is in a Delta configuration and there is no connection to the Vref input. However, in this configuration, these voltages have limited meaning and are typically not reported. |
| Voltage, Vaux | This is a fourth voltage input measured from between the Vaux and Vref inputs. This input can be scaled to any value. However, the actual input voltage to the meter should be of the same magnitude as the voltages applied to the Va, Vb and Vc terminals. |