Product Manual and Reference Guide

NeXGen™ GCU Series

Remote Terminal Unit

Version 1.0 Revision B

SAFETY PRECAUTIONS AVOID INJURY

Safeguards are designed into this instrument to protect operators and maintenance personnel from most hazards during instrument operation. However, certain safety precautions must be taken by the operator and all personnel to avoid injury as well as damage to the instrument.

Carefully observe the following safety precautions before and during installation and operation on the instrument. Failure to comply can result in death, severe personal injury, and instrument damage.

- **ALWAYS** follow safety procedures listed in the instructions
- **ALWAYS** follow all locally approved procedures, codes and safety practices when working around high voltages and when testing, installing and/or operating this instrument
- **ALWAYS** wear approved safety gear when operating power equipment.
- **ALWAYS** wear approved ear protection when operating power equipment.
- **ALWAYS** wear approved eye protection when operating power equipment.
- **ALWAYS** insert power plug into properly grounded receptacle to avoid electrical shock
- **NEVER** disconnect any components unless area is know to be nonhazardous
- **NEVER** wear loose clothing or jewelry that may catch moving parts or circuits in the instrument.
- **NEVER** alter, modify or misuse the instrument
- **NEVER** rely on absence or function of LED indicators for presence of high voltages. Always establish a visible disconnect. Failure to follow proper safety practices can result in contact with high voltage which can cause death, or severe personal injury.
- **IMPORTANT** – These instructions are not a substitute for adequate training and experience in safety procedures. These instructions are intended for use by competent personnel who are trained and understanding of proper safety procedures.

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GENERAL INFORMATION

Advanced Control Systems Corporation/Telescada is dedicated to designing, developing and producing the highest quality hardware and software for Gas, Electric and Water Utility applications. Our goal is to provide our customers with reliable products and solutions that simplify and enhance day to day operations. We use state-of-the-art electronics to get the highest performance at the lowest cost. Our principal resources are our people and the support and confidence of our customers.

WARRANTY

Advanced Control Systems Corporation/Telescada warrants its products to operate within specifications under normal use and services for a period of one year from the date of shipment. Components products, spares, replacement parts and repairs are warranted for 90 days. Software is thoroughly tested and thought to be functional. It is supplied "as is" with no warranty of any kind covering detailed performance. Accessory products not manufactured by Advanced Control Systems Corporation/Telescada are covered by the original equipment manufacturer's warranty only. In exercising this warranty, Advanced Control Systems Corporation/Telescada will repair or at its option, replace, any product returned to the customer service department or an authorized service facility within the warranty period, provided that the warrantor's examination discloses that the product is defective due to workmanship or materials and has not been caused by misuse, neglect, accident or abnormal conditions or operations. The purchaser is responsible for the transportation and insurance charges arising from the return of products to the servicing facility. Advanced Control Systems Corporation/Telescada will return all in-warranty products with transportation prepaid. This warranty is in lieu of all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness, or adequacy for any particular purpose or use. Advanced Control Systems Corporation/Telescada shall not be liable for any special, incidental or consequential damages whether in contract, or otherwise.

Revision History

VERSION	REVISION	DATE	AUTHOR	COMMENT
1.0	-	11-02-10	DRC	Original Release
	A	1-04-12	CWM	Technical Specifications Update
	B	5-20-16	CWM	Technical Specifications & Product Revision Update

1. About This Product Manual

Purpose

This User's Manual provides a detailed technical overview of the Telescada NeXGen™GCU. It is to be used to communicate the features, functionality and operation of the NeXGen™GCU.

Additional Reference Documentation

Telescada NeXGen™ GCU Users will also need to refer to the Telescada NeXGen™ NGC (NeXGen™ Configurator) Users Manual to assist with local programming and interrogation of Telescada NeXGen™ instruments

- *Telescada NeXGen™ NGC User's Manual*

Telescada NeXGen™ GCU Modbus Protocol Users will also need to refer to the Telescada NeXGen™ *Link* Users Manual to assist with local interrogation and analog calibration of Telescada NeXGen™ GCU instruments.

- *Telescada NeXGen™ Link User's Manual*

2. Technical Support

Answers to questions concerning the installation, operation, maintenance and use of Advanced Control Systems Corporation/Telescada products is available from our technical service department,

Telescada
35 Corporate Park Drive
Pembroke, Massachusetts, USA 02359
Telephone: 781-829-9228 08:00 to 17:00 Eastern Standard Time
FAX: 781-829-9875
e-mail info.desk@telescada.com

3. Safety Information

When reading this manual, pay particular attention to

Denotes an imminent hazard which may result in moderate or severe injury

Denotes an environment hazard which may result in moderate or severe injury

Denotes a condition which may result in instrument damage

Highlights special or important information

4. Product Overview

The Telescada NeXGen™ GCU Remote Terminal Unit is a powerful, flexible and economical solution for remote monitoring, data recording, alarming and control. The very Low-Power design of the NeXGen™ GCU makes it an instrument well suited for monitoring environments where battery operation, or extended service battery back-up operation is utilized.

The NeXGen™ GCU's flexible design provides users with an I/O core of 4 configurable analogs, 1 dedicated battery power supply analog, 8 digital status points and 3 Digital Outputs. The NeXGen™ GCU can be expanded to add additional I/O though the networking of additional NeXGen™ modules. The

NeXGen™ is an addressable distributed Remote Terminal Unit that can be quickly expanded to meet the specific requirements of the user.

In additional to configurable I/O, the NeXGen™ GCU serves to consolidate and transmit data from a series of IEDs (intelligent electronic devices) via its RS-232/RS-485 serial communications link. Configurable remote communications ports allow for remote data transmission via radio, dial-up, cellular or fiber optic transceivers. A local maintenance port allows for direct interrogation and programming of the NeXGen™ GCU using the NeXGen™ *NGC* Maintenance Utility Software. DNP3.0 or Modbus standard communications protocols allow the NeXGen™ GCU to communicate with any modern SCADA system.

The NeXGen™ GCU's small footprint allows for quick installation on distribution panels, or mounting within a wall mount or pole top enclosure. The NeXGen™ GCU's 12VDC nominal input voltage makes it ideally suited for being powered by lead acid rechargeable batteries. Complete NeXGen™ GCU, power and communications packages are available from Telescada

5. Feature Set

5.1. Features Overview

- 4 (Four) Configurable Analog Inputs
  - 0-5VDC / 4-20 mA Configurable
  - Data Recording on Each Channel
  - Statistical data recording per channel
  - Event Reporting on Each Channel
  - *Quick-View*™ LED Analog Indicators
- 1 (one) Dedicated Battery Voltage (Power Supply) Analog Input
- 8 (Eight) Configurable Digital Status Inputs
  - Data Recording on Each Channel
  - Event Reporting on Each Channel
  - Can be configured as multiple KYZ inputs
- 3 (Three) Digital Outputs - 2 pull down, 1 pulls up
- 1 (one) RS-232 IED Serial Port with Hardware Handshaking
- 1 (one) RS-485 IED Serial Port
- 1 (one) USB Local Maintenance Port
- 4MB Serial Flash Memory for Data Recording
- DNP3.0 or Modbus Protocol – Software Configurable

5.2. Features Detail

- The low cost of the NeXGen™ GCU allows for economic use of flexible automation throughout the distribution system
- The distributed design of the NeXGen™ platform allows for customized expansion of the NeXGen™ core to meet the specific requirements and budget of the user
- Connectivity for IEDs allows more powerful distributed communications and control. The flexibility of the NeXGen™ programming core allows for integration of IEDs using various IED communications protocols options. DNP3.0 standard.
- Remote Communication serial ports are RS-232 and RS-485 type and configurable for any manner of RF, cellular or dial-up modem.
- Local interrogation and programming of the NeXGen™ GCU via dropdown lists in the Windows® Based NeXGen™ *NGC* Utility software requires no programming knowledge.

6. Technical Specifications

6.1. Analog Inputs

- 4 (four) analog inputs
  - 0-5VDC / 4-20 mA Configurable
  - Data recording on each channel
  - Statistical data recording (min – max – ave)
  - Event reporting on each channel
    - Accuracy – 0.1% of full scale
    - Analog connectors have +5VDC and VBatt+ (13.8VDC) for sensor loop power
    - 20 K ohm input impedance – ESD protected

Analog Sensor Power

The +5 VDC Sensor Power is used to momentarily energize analog transducers. To allow for settling time in most transducers, the sensor power is activated for 400 milli-Seconds before an analog reading is taken. This delayed reading (+5V sensor power pulse width) defaults to 400 mS, but is a programmable parameter. To aid in field troubleshooting the GCU the sensor power will be turned on for a programmable time (default is approximately 5 minutes) after the test button is pushed.

The "SENSOR POWER" LED is illuminated when the +5 VDC sensor power supply is on. If the programmable sample rate is set to 5 seconds (default), the "SENSOR POWER" LED will blink on (for 400 mS) every 5 seconds. If it has been less than 5 minutes since the test push button was pushed, the sensor power in on and the SENSOR POWER LED is illuminated.

The Sensor Power also activates the circuits that drive the LEDs which illuminate when any RX or TX signals occur. These LEDs only work when the sensor power is on (unless the communication is simultaneous with sampling).

Note: The GCU leaves the factory with a removable jumper (W1) installed. If this jumper is removed to save power, the Sensor Power LED will not light up, but sampling data will not be affected.

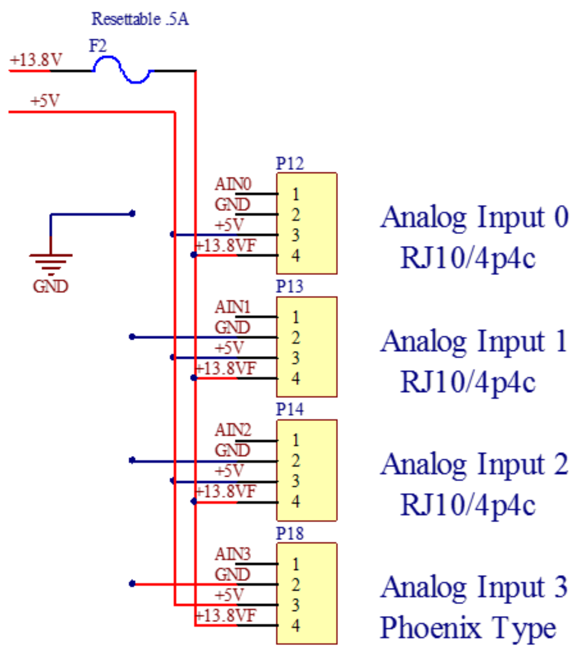


FIG. 1 NeXGen™ GCU Analog Input Connection Overview

Analog Inputs

Analog Inputs use Phoenix type cage clamp connectors. It is a removable plug and stripped wires can easily be attached to it. Pin 1 for this type of connector is located on the left when looking into the connector. The pin numbers shown in the above schematic are correct, but remember to count from pin 1 and left to right. The analog input voltage, (AIN0 thru AIN3), must be between 0 and 5 Volts. The input cannot be negative with respect to ground (pin 2 of each connector).

Typically this signal is derived from a transducer that is powered by the 5 VDC located on pin 3 of the same connector. All measurements are taken with respect to ground which is found on pin 2 of these connectors. The battery input voltage is also brought out to pin 4 of the analog connectors so that transmitters requiring 12 VDC can be powered.

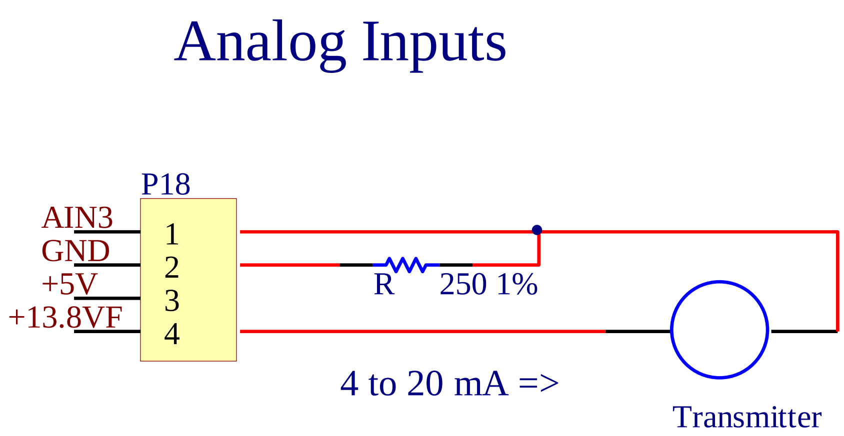


FIG. 2 NeXGen™ GCU Analog Input Connection Detail

Use of Analog Inputs as Current Inputs:

4 to 20 mA current signals from transmitters can be measured by powering the transmitters from the battery voltage brought out to pin 4 of the analog input connectors. This battery voltage, labeled VB+ and connected to the + VBATT (power input), is protected from overloads by a small (1/2 amp) resettable fuse. The resettable fuse will reset itself after the short circuit is removed. Resetting should occur in about 10 minutes, but it could take as long as 30 minutes on hot days.

A typical 4 to 20 mA transmitter can use the 250 ohm resistors internal to the GCU to develop the voltage that will be measured by the analog input. Or the signal can be developed by an external 250 ohm resistor. Using the internal resistor requires the cover be removed and jumpers to be installed on W2.

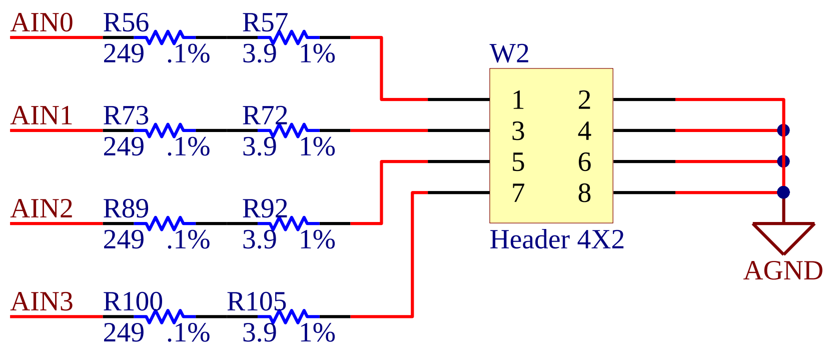


FIG. 3 NeXGen™ GCU Analog 4-20mA Input Jumper Overview

6.2. Digital (Status) Inputs

- 8 Digital Inputs
    - Data recording on each channel
    - Event reporting on each channel
- 0 and 5 VDC nominal Input Voltage
- Wetted (pulled up to Vbatt by 22K ohms) - Appropriate for dry relay contacts
- 4 DI channels configurable for KYZ inputs
- Per point configurable for Form A, B, C or transition accumulators
- Digital timing input accuracy of +/-1 ms
- Report limiting for the accumulators
- Digital Inputs are internally pulled up to Vbatt via 22K ohms
- Digital inputs are ESD protected

External Digital Inputs
Connector pins labeled D10 through D17 are external digital inputs. These 8 inputs are protected from surges, pulled up to +Vbatt by 22K ohm resistors, and filtered (with a time constant of about 50 micro seconds). The GCU uses these inputs as state indicators, and in pairs as KYZ inputs for pulse counters. Inputs DI4-Z, DI5-Y and GND-K form a KYZ input. Inputs DI6-Z, DI7-Y and GND-K combine to form a second KYZ input. KYZ inputs count only when Z is pulled low followed by Y being pulled low and Z is back to high. KYZ inputs are used to connect meter pulse outputs to the GCU.

Note: To insure a state change is counted each status input must pull down below 1 volt with respect to the “K” (GND) input. A closed set of relay contacts with less than 200 feet 22 AWG of wire will create this condition.

6.3. Digital (Control) Outputs

- 3 Digital Outputs
    - OUT0 – PNP Output Transistor
        - PNP General Purpose Amplifier
            - V_{CEO} Collector-Emitter Voltage 40 V
            - V_{CBO} Collector-Base Voltage 40 V
            - V_{EBO} Emitter-Base Voltage 5.0 V
            - I_C Collector Current - Continuous 300 mA
    - OUT1&2 – FET Transistor
        - Output Device Absolute Maximum Ratings
            - V_{DSS} Drain-Source Voltage 50 V
            - V_{GSS} Gate-Source Voltage □20 V
            - I_D Drain Current – Continuous (Note 1) 0.22 A – Pulsed 0.88
            - P_D Maximum Power Dissipation (Note 1) 0.36 W
            - Derate Above 25□C 2.8 mW/□C

Digital Output OUT0 (Pull Up)

OUT0 is an output that pulls up when the associated processor pin is set. When operated the output is connected to +K (nominally +13.8 VDC) through a small bipolar transistor who's maximum current rating is 250 mA. This output does not have an internal pull down resistor. For protection this output is connected through a reverse diode to +K and reverse diode to ground. Consequently these outputs cannot be connected to a voltage that is higher than +K or a negative voltage. In the GCU the +K voltage will typically be connected to the battery, which will be nominally +13.8 VDC, but could be as high as 15 VDC during solar charging or as low as 11.5 VDC for a discharged battery. +13.8 Volts is the voltage that should be applied to the battery when it is being float charged.

Digital Outputs OUT1 & 2 (Pull Down)

When the digital outputs labeled **OUT1** and **OUT2** are set (activated) or activated momentarily, they pull down (to ground). These outputs are "pulled down", or switched to ground, by turning on a small FET (Field Effect Transistor) internal to the GCU that connects these outputs to ground. Each of these outputs can "sink" as much as 200 milli-Amps. These outputs do not have an internal pull up resistor. For protection each output is connected through a reverse diode to +K and reverse diode to ground. Consequently these outputs cannot be connected to a voltage that is higher than +K or a negative voltage. In the GCU the +K voltage will typically be connected to the battery, which will be nominally +13.8 VDC, but could be as high as 15 VDC during solar charging or as low as 11.5 volts for a very discharged battery. +13.8 Volts is the voltage that should be applied to the battery when it is being float charged.

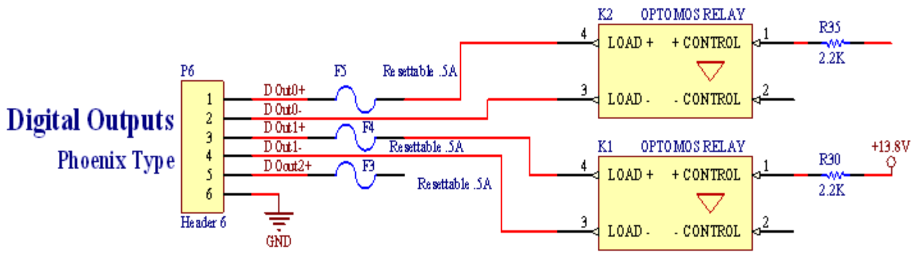


FIG. 4 NeXGen™ GCU Digital Output Connection Detail

6.4. Communications

• Remote Communications

- 2 (two) serial communication ports configurable for RS-232 or RS-485
- 3 wire RS232 (hardware handshaking available)
- Configurable baud rates up to 38.4kbps
- Connectors for serial communications ports are RJ-12 type
- DNP3.0, Modbus RTU / ASCII Protocol Configurable

• Local Communications

- Server assignable ports – 2 servers can operate simultaneously
- RS-232 serial maintenance port for “LOCAL” interrogation, programming and data transfer.
- Configurable baud rates up to 38.4kbps
- Connectors for serial communications ports are RJ-12 type
- Interrogation, programming and data transfer via the maintenance port is achieved using Telescada NeXGen™ *NGC* Utility Software

• Distributed Communications

- 2 (two) RS-485 ports for networking multiple NeXGen™ modules
- Individually Addressable by parameters

6.5. Power Supply

- The NeXGen GCU Core Module is powered by an internal DC/DC converter
- Input power – 6-18 VDC (12VDC Nominal)
- Always on when powered
- Short circuit protection
- Reverse polarity protection
- Resettable fused power input
- 7 W maximum input supply draw

6.6. Processor and Memory

- The Core module processor is the R3000 operating at 8 MHz.
- Memory:
  - FLASH: 512k
  - SRAM: 512k
  - Serial Flash Memory: 4MB
  - Battery Backed RTC (Real Time Clock)
  - Watchdog timer

6.7. Physical & Environmental

- ### Physical Specifications

- The NeXGen GCU is housed in a protective thermoformed high impact ABS plastic enclosure 7" x 6.0" x 1.25
- Panel Mountable Design
- LED status indications for
  - Communication port line status (RX/TX)
  - IED port line status (RX/TX)
  - Analog Sensor Power
  - Analog Level Status – (levels set in GCU database)
- Standard RJ-12 connectors are provided for serial communications
- Standard RJ-12 connectors are provided for IED communications
- #14 Compression Terminal Blocks provided for field terminations -analogs, status inputs, control outputs and DC power.
- Input and Output removable Phoenix connectors
- All connections are made without removing the protective cover
- All field termination locations are clearly labeled on the PCB and enclosure cover

- **Module Outside Dimensions and Baseplate Mounting Detail**

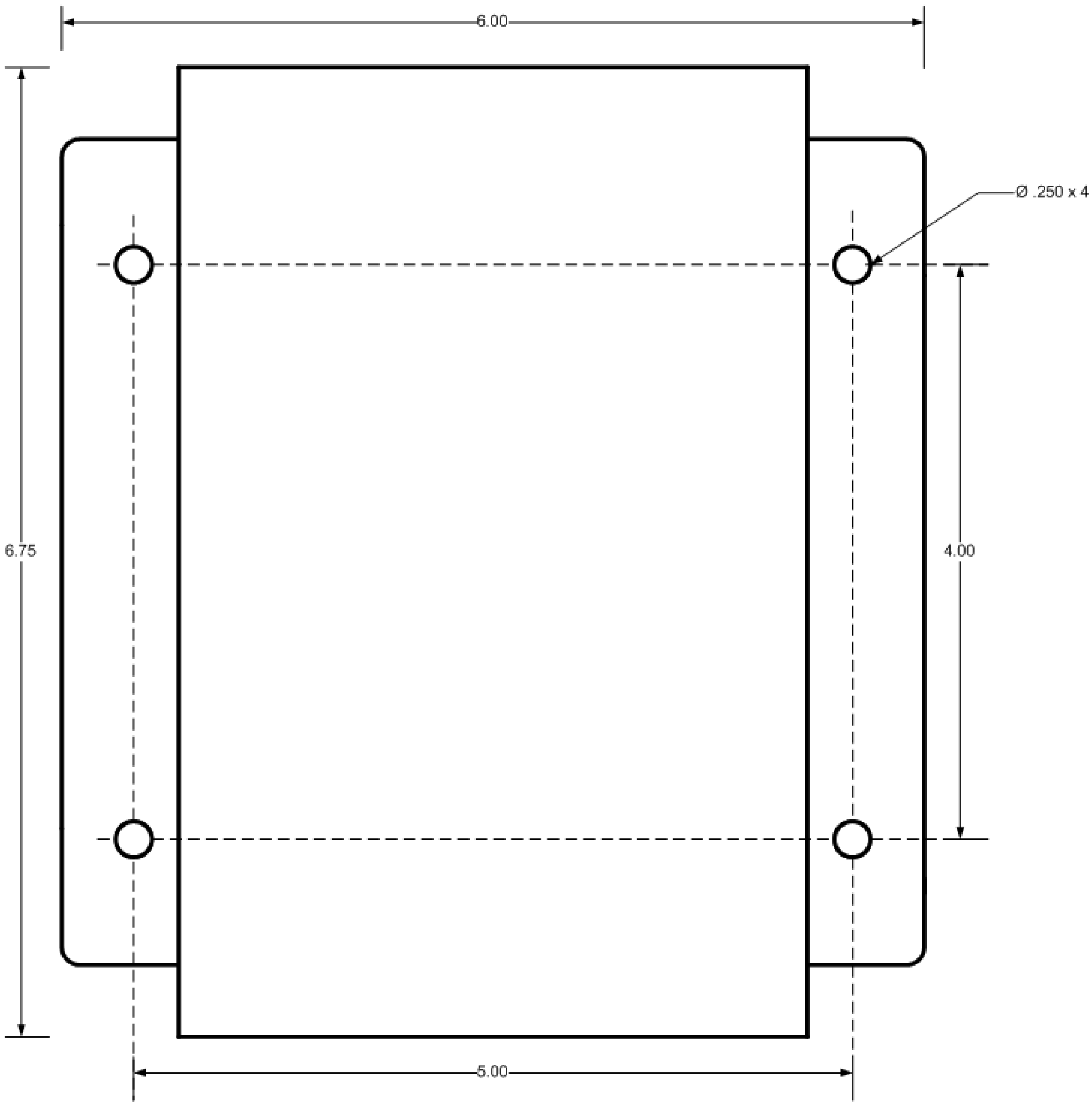


FIG. 5 NeXGen™ GCU Baseplate Mounting Detail

• Environmental Operating Conditions

- Operating Temperature range: -40° to +60°C
- Storage Temperature: -40° to +60°C
- Humidity: 5% to 95% Non-condensing

6.8. Expansion Capability

The distributed design of the NeXGen™ platform allows for expansion of the NeXGen™ GCU core to meet the specific requirements and budget of the user. Expansion is achieved through the networking of additional NeXGen™ GCU modules via isolated connection at the NeXGen™ GCU RS-485 port. Each distributed NeXGen™ GCU module is addressable.

7. Installation and Power-Up

ATTENTION For accurate and reliable operation of your NeXGen™ GCU the following practices and recommendations must be considered at all times. The instrument warranty may be null and void if you do not follow these practices and recommendations. If you have any concerns, do not hesitate to contact Telescada.

CAUTION Do not attempt the installation of your NeXGen™ GCU if it has been dropped, damaged or the packaging indicates it may have been dropped or damaged.

DO NOT Connect or Disconnect any components unless the installation area is known to be non-hazardous. **DO NOT** power up the instrument unless the installation area is known to be non-hazardous

7.1. Instrument Connection Overview

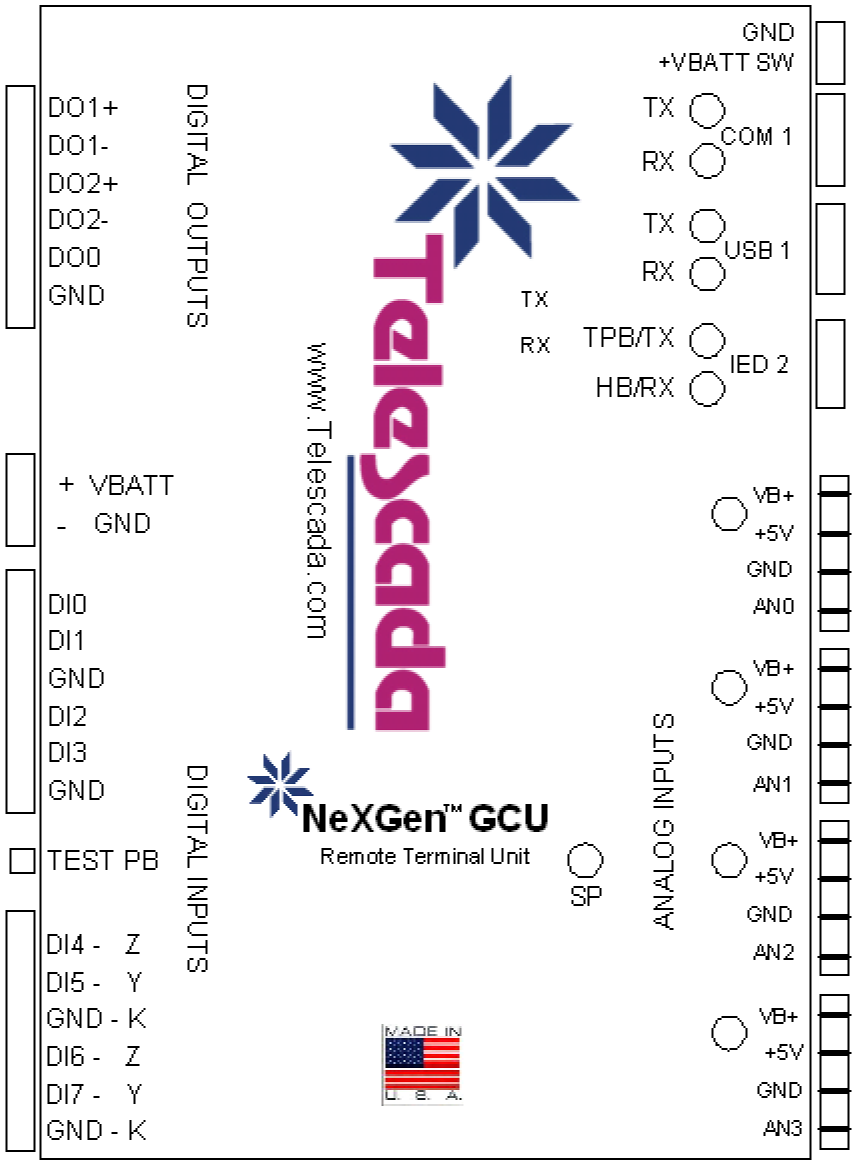


FIG. 6 NeXGen™ GCU Circuit Board Interconnect Overview

7.2. Installation Environment

The NeXGen™ GCU installation must be acceptable to the regulatory authority having legal jurisdiction over the installation. The NeXGen™ GCU ABS enclosure IS NOT intended for outdoor use. The NeXGen™ GCU should be mounted in an appropriate NEMA enclosure to provide protection against the environment and accidental contact with the instrument circuit board and input voltages for outdoor installations.

The NeXGen™ GCU employs spring based compression terminals for all inputs.

CAUTION Ensure that all input wires are securely contained in the appropriate spring clamps prior to powering up the instrument.

DO NOT Connect or Disconnect any components unless the installation area is known to be non-hazardous. **DO NOT** power up the instrument unless the installation area is known to be non-hazardous

7.3. Input Power Supply

• Input Power Configuration

The NeXGen™ GCU is powered by an internal DC/DC converters. Input voltage for the GCU is 9 – 18 VDC (13.8 VDC nominal). The NeXGen™ GCU is always-on when powered. The input voltage is connected to the internal power supplies through a resettable fuse. If the input current exceeds the fuse current rating (1A), the fuse will open. Resettable fuses take some time to recover. Remove the input voltage and allow 30 minutes for fuse recovery.

CAUTION Make sure that the external DC power supply is within the proper range for the instrument and polarity of the wiring matches that indicated on the terminal block

• Input Power Fusing

The NeXGen™ GCU control circuit board is protected by a resettable fuse located on the GCU printed circuit board.

The input voltage is connected to the internal power supplies through a resettable fuse. If the input current exceeds the fuse current rating (1A), the fuse will open. Resettable fuses take some time to recover. Remove the input voltage and allow 30 minutes for fuse recovery.

DO NOT Connect or Disconnect any components unless the installation area is known to be non-hazardous. **DO NOT** power up the instrument unless the installation area is known to be non-hazardous

- **Grounding**

To ensure safe operations, you must connect the NeXGen™ GCU enclosure to earth ground using a braided cable or heavy solid copper conductor. When making ground connections ensure that all grounding surfaces are free of dirt, residue and corrosion. The ground wire must be the largest gauge of all wires used for field termination. A 12 AWG green and yellow wire is recommended. For spring based compression terminals the maximum wire gauge is 12 AWG.

8. Communications

8.1. Serial Connections

The NeXGen™ GCU has 3 serial interfaces for local and remote communications. Serial interfaces are USB and RS-232 type. Both serial interfaces are configured using the Telescada NeXGen™ NGC Configuration Software.

The Local, IED1 and IED2 serial interfaces on the NeXGen™ GCU printed circuit board are standard 6 position modular jacks. The mating 6 position modular plug: Tyco Electronics P/N 5-555176-3, or equal. The pin out of comm. Ports IED1 and IED2 changes as the ports are programmed as 2 or 4 wire RS-485 ports.

ATTENTION When using remote serial communications, such as digital radio, digital cellular, digital fiber optic transceivers communications devices may be plugged into the Local Port or IED ports. Serial communications is programmed using the configuration software, NGC. Although it may seem inappropriately named, most remote communications devices are plugged in to the LOCAL port.

- ## Local/Programming/Serial Port

The USB Local Port for the NeXGen™ GCU is a virtual serial port. It is a standard four wire implementation using a USB type B connector on the NeXGen™ GCU. This port defaults to 9600 baud. The baud rate can be changed using NGC (Telescada's GCU programming tool) or GCU-Link.

ATTENTION The USB port requires a "virtual serial port driver" which will automatically load if the laptop is connected to the internet. It only needs to be loaded once. The virtual serial port does not exist until the laptop is plugged into a USB port.

In earlier revision of the NeXGen™ GCU (PCB revisions C and earlier) serial port programming functions are completed using the Telescada NeXGen™ NGC Configuration Software and a corresponding TAC-01 series programming cable The TAC-01 cable is terminated with a 6 pin modular plug (RJ-12) on one end and a DB9 connector on the other. The NeXGen™ GCU Local/Programming Port is located at LOCAL label on the Enclosure Front Cover.

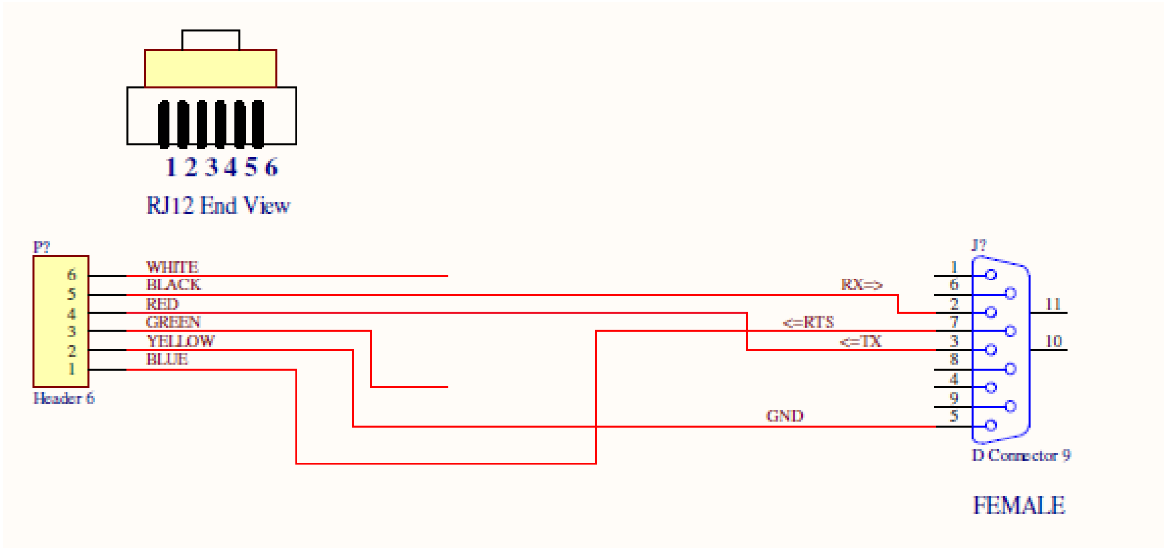


FIG. 7 NeXGen™ TAC-01 Series Local Cable

The NeXGen™ GCU Local port is a three wire implementation using a modular RJ-12 jack with RS-232 signal levels. This port defaults to 9600 baud 8,N,1. A local programming terminal, (a.k.a. laptop computer), is typically connected here. This port can also be used as the radio interface or a modem port if the modem is programmed so that it does not require AT commands or hardware handshaking lines. Note: Looking into the connector, Pin 1 is on the right.

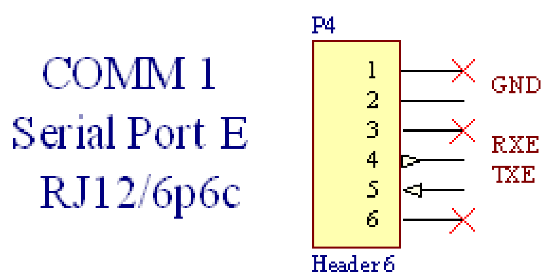


FIG. 8 NeXGen™ GCU Local Port Pin-Out

IED Communications

8.1..1. IED 1 Port – RS-232

The IED 1 port is a five wire implementation using a modular RJ-12 jack with RS-232 signal levels. Two hand shaking lines are added to accommodate IED ports that require hardware handshaking. Because of the extra lines, a parameter has been created that sets the ports handshaking status. IED 1 Port defaults to 9600 baud, and no hardware handshaking, but parameters to change its baud rate and handshaking status can be set using Telescada NeXGen™ NGC Configuration Software. The handshaking lines are implemented by the processor under firmware control (pins PC2 and PC3). These lines can be used as DTR or RTS as outputs and CTS or DSR as inputs. Note: Looking into the connector, Pin 1 is on the right.

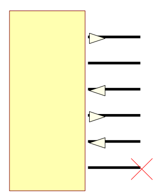


FIG. 9 NeXGen™ GCU IED Port 1 Pin-Out

8.1..2. IED 2 Port – RS-485

The IED 2 port is a two-wire RS-485 port. It is a three wire implementation, (two signals (+, plus and -, minus) and a ground wire), using a modular RJ-12 jack and RS-485 signal levels. This port can only be an RS-485 port, and is not programmable. The baud rate is variable but defaults to 9600.

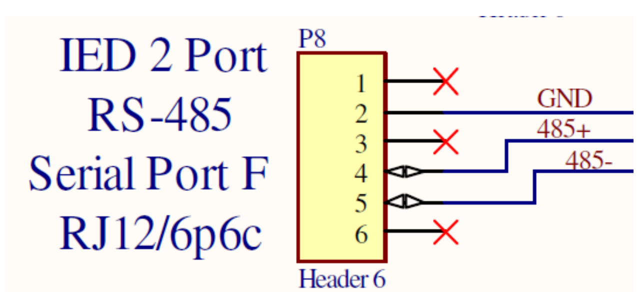
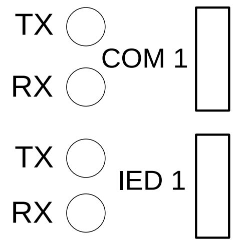
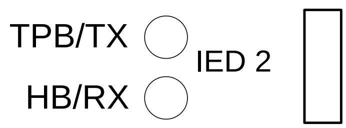


FIG. 10 NeXGen™ GCU IED 2 port wiring pinout

8.1..3. LED Indicators with Power Saving Time-Out Functionality



The circuits that drive the Local Port and IED 1 indicators are powered by the +5VDC sampling power supply. The sampling power supply can be turned on for 5 minutes by pushing the test button. If the supply is on, the TX and RX LEDs will flash when the GCU is polled. The TX and RX indicators will not flash if the sensor power has timed out. The sensor power supply times out and is turned off 10 minutes after the test push button has been pressed.



IED 2 port is an RS-485 port with an RX and TX indicator lights. These LEDs associated with IED2 are dual purpose. The LED labeled HB/RX (Heartbeat/Receive) flashes once per second and indicates that the firmware is operating properly. The same LED flashes if an RS-485 signal is received.

The TPB/TX LED also has a dual purpose. It is illuminated as long as the test push button is depressed or flashes briefly if an RS-485 signal is transmitted. Like the other LEDs in this product, these indicators stop working 5 minutes after the test button is pushed

ATTENTION To activate the LED indicator lights once they have expired after the 5 minute time-out, press the TEST PB once briefly and release. Holding the TEST PB for more than 10 seconds will default all parameters.

- ## Test and Reset Push Buttons

The NeXGen™ GCU Test pushbutton is used for remote field diagnostics, instrument configuration and activating the LED indicator lights after they time-out. The NeXGen™ GCU Test Pushbutton is located at “TEST PB” label on the left side of the GCU Enclosure.

The NeXGen™ GCU Processor Reset Pushbutton is located at under the plastic enclosure cover on the GCU printed circuit board. You must remove the NeXGen™ GCU ABS enclosure cover to access the NeXGen™ GCU Processor Reset Pushbutton. This pushbutton is not generally used by end users.

ATTENTION When reinstalling the GCU ABS enclosure cover after accessing the NeXGen™ GCU Processor Reset Pushbutton, take care to carefully align the LED lamp holders with the corresponding recess on the enclosure cover.

Test Pushbutton Functionality

The NeXGen™ GCU Test Pushbutton is the small white button located at TEST PB on the left side of the NeXGen™ GCU. When depressed momentarily, the Test PB sends a message from the NeXGen™ core processor, to the Local/Serial Port. This message can be used to identify the GCU address.

When the Test Pushbutton is pressed momentarily, the Test LED labeled “TPB/TX” on the enclosure front panel will light, along with the LOCAL TX and RX LEDs indicating the message sent to the Local/Serial Port.

If the NeXGen™ GCU is connected to a PC or Laptop running the NGC configuration software, the NeXGen™ core processor will send a message to NGC with the instrument’s programmed address and some configuration information.

If there is a remote transceiver connected to the Local/Serial Port, this message will go out the transceiver to the host SCADA system.

ATTENTION Holding down the Test Pushbutton for 10 (ten) seconds or longer will default the NeXGen™ core processor and reset the instrument to local address #1, and set all parameters to their default settings.

8.1..1. Reset Pushbutton Functionality

The NeXGen™ GCU Processor Reset Pushbutton is the small white button located under the GCU core module. When depressed momentarily, the Reset PB resets the NeXGen™ core processor. (This button is not an end user control, but no harm can be done by clicking it. It is typically used in development.)

ATTENTION Use of the Reset Pushbutton will not result in defaulting the settings of the instrument. All programmed configurations, including programmed address are retained upon processor reset.

8.2. External Transceiver (Modem) Latching

Power to the external modem or radio transceiver can be switched by a latching circuit in the NeXGen™ GCU. A hardware reset causes the Modem Power transistor to restore power to the modem power port. By wiring an external communication transceiver through the NeXGen™ GCU, power control can be modulated by the NeXGen™ GCU.

ATTENTION Configure the proper external modem or radio transceiver power settings using Telescada NeXGen™ NGC or NeXGen™ GCU-Link software.

8.2..1. Poll Synchronized Power Cycling (PSPC)

The Power and Energy Issue
Considerable energy can be saved by "duty cycling" the communications device. For example, if the power is on for 15 minutes out of each active hour and there are 6 active hours in a day, energy use will be reduces by a factor of 16.

Poll Synchronized Power Cycling (PSPC)
The NeXGen™ GCU gives the user the ability to reduce the systems energy consumption. Our users would like the instrument to be a continuously available SCADA point, i.e. 24/7/365. This means long dead times caused by sleep modes would not be acceptable. They would like to frequently poll the NeXGen™ GCU and read the analogs. "Frequently" has not been defined as of yet. But, if the polling period were 5 minutes, and the NeXGen™ GCU's internal RTC (Real Time Clock) was synched to the SCADA clock, it is possible that the NeXGen™ GCU could cycle power to the modem and be "ON" when the SCADA came calling. This strategy should cut the power used by at least a factor of 2.

As a second strategy it is possible we could make the NeXGen™ GCU available as much as possible as determined by the state of the battery. If the battery were fully charged, we could turn on the instrument most of the time. If the battery were less than fully charged, we could cut back the "ON" time. One utility using a duty cycle strategy polls their RTUs periodically and gets a response only when the modem is powered up. The NeXGen™ GCU can be programmed to turn on and off the modem to save power.

Solar power is somewhat inconsistent. During the winter there can be there are long stretches of cloudy days. The power produced by solar panels is quite low unless the panel is exposed to direct sunlight. Energy conservation is extremely important. The gas utilities care about measuring pressure primarily during the heating season. Telescada would like NeXGen™ GCU users to consider any power saving strategies that extend battery life. A low battery should cause an error condition at SCADA.

The NeXGen™ GCU when operated at 12 volts uses about 10 milli-Amps after the 10 minute sensor power has timed out. A modem or radio will typically use about 10 times as much power.

8.3. QuickView™ LED Indicators

In the absence of a local display, Telescada has incorporated QuickView™ LED Indicators to the Analog LEDs to permit quick and easy visual indication of the HIGH, LOW and NORMAL operating range of the Analogs. When correctly programmed for the User's specified range with the Telescada NeXGen™ NGC or NeXGen™ Link Configuration Software, the active Analog channel LED will blink according to the following formula.

LED Indicator State	Operating Range Detected
SOLID GREEN	RANGE NORMAL
FLASHING GREEN – SLOW FLASH RATE	RANGE LOW
FLASHING GREEN – FAST FLASH RATE	RANGE HIGH

ATTENTION To activate the LED indicator lights once they have expired after the 10 minute time-out, press the TEST PB once briefly and release. Holding the TEST PB for more than 10 seconds will default all parameters.

ATTENTION To activate the LED indicator lights they must be programmed into the NeXGen™ GCU database using Telescada NeXGen™ NGC or NeXGen™ Link Configuration Software. The QuickView™ LED Indicators will not operate if their values are not programmed into the NeXGen™ GCU database.

8.4. General LED Indicators

The NeXGen™ GCU has a number of LED indicators to quickly visually confirm instrument systems operations and health status.

LED	Location	Color	Description
Heartbeat	Panel Front - HB/RX	RED	Indicates normal operation when blinking at 1" (one second) intervals.
Heartbeat	Panel Front - HB/RX	RED	Provides 3 short blinks (in one second) at startup
Heartbeat	Panel Front - HB/RX	RED	Provides 2" (two seconds) of solid LED ON at soft restart of firmware
Heartbeat	Panel Front - HB/RX	RED	Provides 3 short blinks (in one second) during CFD scan for data recording
Test Push Button	Panel Front - TPB/TX	RED	Indicates the pressing of the Test Pushbutton, and sending a COMM message.
COMM Tx/Rx	Panel Front - LOCAL	RED	Indicates tranmission and receipt of communications through Local Port
COMM Tx/Rx	Panel Front - IED 1	RED	Indicates tranmission and receipt of communications through IED Port 1
COMM Tx/Rx	Panel Front - IED 2	RED	Indicates tranmission and receipt of communications through IED Port 2
Sensor Power	Panel Front - Sensor Power	GREEN	Indicates normal power to analog sensors - LED Solid for the initial 5' after power up, then blinks once at each analog sampling period.
Analog 0	Panel Front - AN0	GREEN	Indicates HI / NORMAL / LOW Analog State when programmed into GCU. Blinks every 2" when LOW. Blinks every 1" when HI. Solid LED when NORMAL
Analog 1	Panel Front - AN1	GREEN	Indicates HI / NORMAL / LOW Analog State when programmed into GCU. Blinks every 2" when LOW. Blinks every 1" when HI. Solid LED when NORMAL
Analog 2	Panel Front - AN2	GREEN	Indicates HI / NORMAL / LOW Analog State when programmed into GCU. Blinks every 2" when LOW. Blinks every 1" when HI. Solid LED when NORMAL
Analog 3	Panel Front - AN3	GREEN	Indicates HI / NORMAL / LOW Analog State when programmed into GCU. Blinks every 2" when LOW. Blinks every 1" when HI. Solid LED when NORMAL

9. DNP Device Profile

9.1. Device Profile

DNP V3.0 DEVICE PROFILE DOCUMENT	
Vendor Name:	Telescada
Device Name:	NeXGen™ 3700 Instrument Platform
Device Function:	Slave
Maximum Data Link Frame Size (octets):	Transmitted: 292 Received 292
Maximum Data Link Re-Tries:	Configurable, range 0 to 5, via NGC
Maximum Application Layer Fragment Size (octets):	Transmitted: 2048 Received: 2048
Maximum Application Layer Re-Tries:	Configurable, range 0 to 5, via NGC
Requires Data Link Confirmation:	Configurable, via NGC
Requires Application Layer Confirmation:	Configurable, via NGC
Timeouts While Waiting For:	Data Link Confirm: Configurable via NGC Complete Appl. Fragment: Configurable via NGC Application Confirm: Configurable via NGC Complete Appl. Response: Configurable via NGC
Executes Control Operations:	WRITE Binary Outputs: Never SELECT/OPERATE: Always DIRECT OPERATE: Always DIRECT OPERATE - NO ACK: Configurable via NGC Count > 1: Never Pulse On: Always Pulse Off: Always Latch On: Always Latch Off: Always Queue: Never Clear Queue: Never
Reports Binary Input Change Events When No Specific Variation Requested:	Configurable via NGC, Never or Time-tagged

Reports Time-tagged Binary Input Change Events When No Specific Variation Requested: Configurable via NGC, Never or Change With Time
Sends Unsolicited Responses: Configurable via NGC, See Explanation Below
Sends Static Data in Unsolicited Responses: Never

9.2. Unsolicited Responses

The unit sends unsolicited responses only when configured to do so, using NGC. Only events (no static data) are reported in this manner.

Event generation can be enabled or disabled.

Event reporting can be enabled or disabled. Events can be retrieved via active polling by the master, or in unsolicited fashion. In the latter case the unit can be configured to let the master know events are available (after which the master must poll for events), or it can be configured to send all available event data.

In case of analog inputs, for an event to be generated, analog input value must cross configurable high or low threshold. Configurable chatter filter and event class are available.

In case of counters, for an event to be generated, counter value change since last report must cross configurable threshold. Configurable chatter filter and event class are available.

In case of status (binary) inputs, for an event to be generated, binary input value must change. Configurable chatter filter and event class are available.

In case of control (binary) outputs, for an event to be generated, binary output value must be changed by someone other than the slave. Configurable chatter filter and event class are available.

9.3. Implementation Table

Request columns identify all requests parsed by the device. Response columns identify all responses sent by the device.

Obj	Var	Description * = Default Responses ** = Event Unsolicited Responses	Req. Func. Codes	Req. Qual. Codes (hex)	Resp. Func. Codes	Resp. Qual. Codes (hex)
01	01	SINGLE-BIT BINARY INPUT	1	All	129	27
01	02	BINARY INPUT WITH STATUS*	1	All	129	27
02	01	BINARY INPUT CHANGE WITHOUT TIME	1	All	129	27
02	02	BINARY INPUT CHANGE WITH TIME* **	1	All	129, 130	27
10	01	BINARY OUTPUT	3,4,5, 6	All	129	27
10	02	BINARY OUTPUT STATUS**	1	All	129, 130	27
12	01	CONTROL RELAY OUTPUT BLOCK	2	All	129	27
20	01	32-BIT BINARY COUNTER*	1	All	129	27
20	02	16-BIT BINARY COUNTER	1	All	129	27
21	05	32-BIT FROZEN COUNTER WITH TIME OF FREEZE**	1	All	129, 130	27
30	01	32-BIT ANALOG INPUT*	1	All	129	27
30	02	16-BIT ANALOG INPUT	1	All	129	27
30	03	32-BIT ANALOG INPUT WITHOUT FLAG	1	All	129	27
30	04	16-BIT ANALOG INPUT WITHOUT FLAG	1	All	129	27
31	03	32-BIT FROZEN ANALOG INPUT WITH TIME OF FREEZE**	1	All	129, 130	27
50	01	TIME AND DATE	2	All	129	
50	02	TIME DELAY FINE	17	All	129	
60	01	CLASS 0 DATA	1	All		27
60	02	CLASS 1 DATA	1	All		27
60	03	CLASS 2 DATA	1	All		27
60	04	CLASS 3 DATA	1	All		27
80	01	INTERNAL INDICATIONS	1, 2	All	129	
83	01	PRIVATE REGISTRATION OBJECT – See Below.	1, 2	All	129	27

9.4. Private Registration Object

Private registration object is used to implement device specific functionality. In all cases:

- The four ‘Vendor’ bytes are (hex) 42 54 45 00.
- The six byte (48 bit) time is in standard DNP time format.

The table below shows this object Private Registration Numbers (PRN), and associated functionality.

PRN	F	DATA
0	2	Set data recording period, in ms (4 bytes)
1	1	Download analog point data 'since' time (6 bytes), point index (4 bytes), max readings (4 bytes)
2	1	Download pulse counter data 'since' time (6 bytes), point index (4 bytes), max readings (4 bytes)
3	1	Download status point data 'since' time (6 bytes), point index (4 bytes), max readings (4 bytes)
4	1	Reserved.
5	2	Analog point data recording Enable == 1, Disable == 0 (1 byte), point index (4 bytes)
6	2	Pulse counter data recording Enable == 1, Disable == 0 (1 byte), point index (4 bytes)
7	2	Status point data recording Enable == 1, Disable == 0 (1 byte), point index (4 bytes)
8	2	Reserved.
9	2	Reserved.
10	1,2	Reserved

In above Table:

- Column Header ‘F’ is Application Layer function: 1 = Read, 2 = Write.
- Response to data downloads consists of standard DNP time stamped objects.

DNP 3.0 Slave (**DNPS**)

DNP slaves communicate with assigned external master stations. Two independent, asynchronous slaves are available, one on each port. When both slaves are mapped to the same communications port, secondary slave is disabled. Each slave

- Responds to polls for data from the master station,
- Reports data events and software error events to the master station (unsolicited reports)
- Executes commands issued by the master station, including
  - Clock synchronization with the master station
  - Operation of relays on attached I/O board
  - Database updates (RTU configuration editing)
  - Data recording management and data downloads
- Stores and forwards messages to the local DNP master running concurrently with the slave (in support of message routing).

The following DNP objects are supported:

Group	Variation	Format
01	1	SINGLE-BIT BINARY INPUT
01	2	BINARY INPUT WITH STATUS
02	1	BINARY INPUT CHANGE WITHOUT TIME
02	2	BINARY INPUT CHANGE WITH TIME
10	1	BINARY OUTPUT
10	2	BINARY OUTPUT STATUS
12	1	CONTROL RELAY OUTPUT BLOCK
20	1	32-BIT BINARY COUNTER
20	2	16-BIT BINARY COUNTER
21	5	32-BIT FROZEN COUNTER WITH TIME OF FREEZE
30	1	32-BIT ANALOG INPUT
30	2	16-BIT ANALOG INPUT
30	3	32-BIT ANALOG INPUT WITHOUT FLAG
30	4	16-BIT ANALOG INPUT WITHOUT FLAG
31	3	32-BIT FROZEN ANALOG INPUT WITH TIME
50	1	TIME AND DATE
52	2	TIME DELAY FINE
60	1	CLASS 0 DATA
60	2	CLASS 1 DATA
60	3	CLASS 2 DATA
60	4	CLASS 3 DATA
80	1	INTERNAL INDICATIONS
83	1	PRIVATE REGISTRATION OBJECT

Data Recording Control

Data recording can be controlled via DNP object G83V01 write operations. The following table lists supported PRN values and their corresponding functionality.

PRN	DATA
0	Set data recording period, in milliseconds (4 bytes), 0 == Off
5	Analog point data recording Enable == 1, Disable == 0 (1 byte), point index (4 bytes)
6	Counter data recording Enable == 1, Disable == 0 (1 byte), point index (4 bytes)
7	Status point data recording Enable == 1, Disable == 0 (1 byte), point index (4 bytes)

DNP 3.0 Master (DNPM)

DNP master communicates with external DNP slave stations. The master

- Forwards messages received from the local, concurrently running DNP slave to remote slave stations (store and forward routing)
- Stores replies from external slaves, and forwards them to the local, concurrently running DNP slave (store and forward routing)
- Stores unsolicited reports from external slaves, and forwards them to the local, concurrently running DNP slave (store and forward routing)

Master functions are not available when two slaves are being used. For supported DNP objects please see the table in the *DNP 3.0 Slave (DNPS)* section.

DNP Error Events

CCDC reports errors via DNP event mechanism when CCDC_ERROR_EVENT_PRINTOUTS is not defined. When an error occurs, a pair of 32 bit unsigned integer values is generated. Both values are reported as DNP class 1 events associated with a pair of analog points with respective addresses 0xFFE (4094) and 0xFFF (4095). The first value register (reported as analog value at address 0xFFE) is partitioned as follows:

- Event Identifier (bits – 0 – 7, bit 0 = lsb)
- Source file id (bits 8 – 15)
- Source file line number (bits 16 – 29)
- Event log entry value type (bits 30 – 31)

The second value register (reported as analog value at address 0xFFF) is filled with entry value, if any. The tables below list the various identifiers in the first register.

Error Event Identifiers – System Resources

0	System restart
1	Memory allocation failure
2	Serial port open failure
3	Failed to send data via RS232 port
4	Failed to initialize serial flash disk
5	Serial flash disk page read failed
6	Serial flash disk RAM read failed
7	Serial flash disk RAM write failed
8	Serial flash disk page write failed
9	System restart requested

Error Event Identifiers – System Miscellaneous

50	Copy from root to xtended memory (root2xmem) failure
51	Copy from xtended memory to root(xmem2root) failure
52	Destination buffer too short
53	General assertion failure
54	Index out of bounds condition has occurred
55	Sorting of an array failed
56	This station database version mismatch
57	Serial Flash Disk page too short
58	This station database CRC mismatch
59	Failed to set this station time
60	Failed to sample data
61	Data recording record larger than SFD page
62	Data recorder failed to locate oldest record on SFD
63	Failed to record data
64	Failed to generate a data event
65	Master station does not generate events
66	Data manager received request for unrecognized I/O point type
67	Data recording ON/OFF operation failed
68	Data manager failed to record data recording period
69	Timer reporting PT to AT conversion failed
70	Timer reporting AT to PT conversion failed
71	Timer reporting PT of last Top Of Hour failed
72	Timer reporting failed time computation
73	Data manager was asked to set recording period too high - max limit enforced
74	Data manager was asked to set recording period too low - min limit enforced
75	Data manager failed to schedule the next data recording cycle

76	Invalid (null) buffer address
77	Analog input out of specified range (overflow)

Error Event Identifiers – DNP Data Link

100	Incoming message too long
101	Incoming message too short
102	DNP data link frame de-serialization failed
103	DNP data link frame contains incorrect number of blocks
104	DNP data link frame integrity bad
105	DNP data link frame header block has incorrect length
106	DNP data link frame header block first byte bad
107	DNP data link frame header block second byte bad
108	DNP data link frame block CRC bad
109	DNP data link frame block length bad
110	DNP data link source and destination addresses equal
111	DNP data link frame had insufficient data
112	DNP data link frame serialization failed
113	DNP data link response function (ACK, NACK, LINK_STATUS) received illegal function argument
114	DNP data link ACK not sent
115	DNP data link NACK not sent
116	DNP data link LINK_STATUS not sent
117	DNP data link RESET LINK STATE not sent
118	DNP data link RESET USER PROCESS not sent
119	DNP data link USER DATA not sent
120	DNP data link TEST REMOTE LINK not sent
121	DNP data link USER DATA WITH COMFIRM not sent
122	DNP data link function received unsupported function code request
123	DNP data link function received user data which is too long
124	DNP data link failed to receive response from a station
125	DNP data link reporting route table full

Error Event Identifiers – DNP Transport Layer

150	DNP transport layer missing a specific segment, message incomplete
151	DNP transport layer missing segment(s), message incomplete
152	DNP transport layer failed to send message to specified station address

Error Event Identifiers – DNP Application Layer

200	DNP application layer fragment too short
201	DNP application layer received bad range specifier code
202	DNP application layer received a non-first fragment while no message was accumulating, fragment discarded
203	DNP application layer missing a specific fragment, message incomplete
204	DNP application layer missing fragment(s), message incomplete
205	DNP application layer failed to send message to outstation

206	DNP application layer received bad range (start & stop) values
207	DNP application layer fragment contains insufficient data to deserialize an object
208	DNP application layer failed to deserialize object group
209	DNP application layer received bad offset value
210	DNP application layer received bad index size value
211	DNP application layer received bad object type value
212	DNP application layer received bad function code value
213	DNP application layer failed to save object group data to this station
214	DNP application layer received message from station reporting restart
215	DNP application layer failed to arm (select) control point(s)
216	DNP application layer failed to operate control point(s)
217	DNP application layer source object size undefined
218	DNP application layer private registration object contains unknown vendor id
219	DNP application layer received bad private object registration number
220	DNP application layer object contains insufficient data
221	DNP application layer failed to execute routing management command

Source File Identifiers

0	IOBoard.lib
1	BigDig.lib
2	Timer.lib
3	Buffer.lib
4	SerialFlqashDisk.lib
5	Array.lib
6	SerialPort.lib
7	Ethernet.lib
8	CommChannel.lib
9	IOPoint.lib
10	ControlPoint.lib
11	StatusPoint.lib
12	CounterPoint.lib
13	AnalogPoint.lib
14	Config.lib
15	DataManager.lib
16	OutMsgQueItem.lib
17	OutMsgQue.lib
18	DnpCfg.lib
19	DnpStation.lib
20	DnpFrame.lib
21	DnpDataLink.lib
22	DnpSegment.lib

23	DnpTspLayer.lib
24	DnpObject.lib
25	DnpObjectGroup.lib
26	DnpFragment.lib
27	DnpAppLayer.lib
28	DnpClient.lib
29	DnpServer.lib
30	DnpI.lib
31	ThisStation.lib
32	ModbusI
33	ModbusCfg

Event Log Entry Value Types

0	None (No entry)
1	Signed 16 bit integer
2	Unsigned 16 bit integer
3	Unsigned 32 bit integer

Message Routing (Store and Forward)

Routes must be used when the master station cannot directly communicate with one or more units in the field. This can be because those units are too far, or they may be obstructed so direct line of communication is not possible, etc.

Routing is implemented in the Data Link layer over standard DNP in such a way as to remain fully compatible with DNP. DNP messages contain routing information in the N most significant bits of their destination address as part of standard DNP addressing, where N is a number between 0 (no routing) and 8. In addition, route users (see definition below) need not be units running CCDC, i.e. they can communicate with the master station via above described network using standard DNP. In other words, route users can be built by any vendor, running standard DNP, as long as they are addressed between 1 and 2**(16-N) - 1.

When so configured, DNP slave can store and forward messages to the local DNP master, and vice versa. This capability makes NeXGen units running CCDC capable of storing and forwarding messages to neighboring units, thus forming a DNP network. This network has the following properties:

- It contains one, centrally located master station (star topology)
- Each unit can be configured as store and forward message repeater (router)
- There can be up to (2**N)-1 routes in the network, i.e. each unit can be a member of up to (2**N) -1 routes.
- Routes can cross, i.e. they can share arbitrary number of units.

- Units doing the routing (repeaters) need to have equal DNP master and slave addresses.

A distinction needs to be made between *route members* (store and forward repeaters), and *route users* (units communicating with the master station via above described network, but not themselves forwarding DNP messages). As far as firmware is concerned, there can be

1. Up to (2**N) -1 routes in a network,
2. Up to 2**(16-N) - 1route members per route
3. Up to 2**(16-N) - 1route users.

Practical limitations, such as timing, reduce these numbers to lower values.

Power-Poll

As part of configuration, each pulse counter can be associated with a fictitious analog point. CCDC samples each pulse counter, and records the rate of change in a respective analog point. The so generated analog points are treated like all other analog points – their values are returned in polls, they can be assigned class, they can generate events, etc.

Since polling for data can thus return not only pulse counter values, but also their rate of change, all in the same message, these kind of polls are called ‘Power-Polls’. They are useful when trying to determine not only energy consumption up to the time of the poll (meter reads), but also which customers are active (power consumption) at the time of the poll.

Addressing is arranged as follows: if there are M regular analog points (addresses 0 to M -1), and if there are N pulse counters (addresses 0 to N-1), then CCDC creates above mentioned additional N analog points addressed from M to M+N-1.

For example, suppose there are eight analog points (M = 8), and two counters (N = 2). This means regular analog point addresses are 0 – 7, pulse counter addresses are 0 – 1, and fictitious analog point (used for power poll data) addresses are 8 – 9. Specifically, in this example,

- Pulse counter address 0 rate of change is stored in analog point address 8,
- Pulse counter address 1 rate of change is stored in analog point address 9.

For power-poll functionality to function conditions need to be satisfied:

1. There must exist at least one pulse counter (N > 0 above),
2. That pulse counter(s) must be enabled,
3. The corresponding fictitious analog point(s) must be enabled,

4. Power-poll sampling period must be greater than zero.

Power-poll sampling period, expressed in seconds, determines how often pulse counter values are sampled internally, and rates of change computed and stored in above mentioned fictitious analog points. To disable power-poll feature one must set power-poll sampling period to zero.

10. Modbus Slave Profile

Modbus slaves communicate with assigned external master stations. Two independent, asynchronous slaves are available, one on each port. When both slaves are mapped to the same communications port, secondary slave is disabled.

10.1 Base Register Map

Complexity of NeXGen platform prohibits existence of one simple register map. The map changes as programming of the instrument changes. For this reason a 'base' register map exists, in a sense a map of maps (metadata), which publishes numeric values for all other register maps for a given instrument configuration that is in effect at the time when the base register map is downloaded.

Register Number	Symbol	Description
0	AN	Base register # for analog points (including PowerPoll).
1	NAN	Number of analog point registers (including PowerPoll), including point addresses
2	A0	Base register # for analog points Min. values
3	NA0	Number of analog point Min. value registers, including point addresses
4	A1	Base register # for analog points Max. values
5	NA1	Number of analog point Max. value registers, including point addresses
6	A2	Base register # for analog points Ave. values
7	NA2	Number of analog point Ave. value registers, including point addresses
8	CN	Base register # for counters
9	NCN	Number of counter registers, including point addresses
10	ST	Base register # for status points
11	NST	Number of status point registers, including point addresses
12	CT	Base register # for control points
13	NCT	Number of control point registers, including point addresses
14	DC	Base register # for data recording control

15	NDC	Number of registers for data recording control
16	DL	Base register # for data recording downloads
17	NDL	Number of registers for data recording downloads
18	NPT	Base register number for programming of the unit - unit time
19	NNPT	Number of registers used for transferring time from master to unit
20	P0	Base register number for programming of the unit - unit configuration
21	NP0	Number of registers used for transferring unit configuration
22	P1	Base register number for programming of the unit - I/O point attributes
23	NP1	Number of registers used for transferring unit configuration - I/O point attributes
24	P2	Base register number for programming of the unit - DNP configuration
25	NP2	Number of registers used for transferring unit configuration - DNP configuration
26	P3	Base register number for programming of the unit - Modbus configuration
27	NP3	Number of registers used for transferring unit configuration - Modbus configuration

10.2 Current Data Register Map

To poll for current data, a master uses values obtained from the base table. Let ‘R’ represent a general register symbol (AN, AP, CN, etc.), and let ‘NR’ represent the number of those registers obtained from the same table. Standard Modbus (16 bit registers) Latest Data map looks like this:

Byte No.	Reg. No.	Item
0	R	Point Index – MSB
1	R	Point Index
2	R + 1	Point Index
3	R + 1	Point Index – LSB
4	R + 2	Point Value – MSB
5	R + 2	Point Value
6	R + 3	Point Value
7	R + 3	Point Value – LSB
8	R + 4	Point Index – MSB
Etc.		

Enron Modbus (32 bit registers) Latest Data map looks like this:

Byte No.	Reg. No.	Item
0	R	Point Index – MSB
1	R	Point Index
2	R	Point Index
3	R	Point Index – LSB
4	R + 1	Point Value – MSB
5	R + 1	Point Value
6	R + 1	Point Value
7	R + 1	Point Value – LSB
8	R + 2	Point Index – MSB
Etc.		

Example: Suppose an instrument, running standard Modbus (registers are 16 bits wide), has four counters with addresses 0, 1, 2, 3, but only three of them are enabled – 0, 1, and 3 (pulse counter #2 is disabled). Suppose one wants to poll for values of the three enabled counters (R = CN), and suppose that polling base register map returns R = CN = 1000, and NR = NCN = 12. In this case, the counter portion of Latest Data table looks like this:

Byte No.	Reg. No.	Item
0	1000	0
1	1000	0
2	1001	0
3	1001	0
4	1002	Point Value – MSB
5	1002	Point Value
6	1003	Point Value
7	1003	Point Value – LSB
8	1004	0
9	1004	0
10	1005	0
11	1005	1
12	1006	Point Value – MSB
13	1006	Point Value
14	1007	Point Value
15	1007	Point Value – LSB
16	1008	0
17	1008	0
18	1009	0
19	1009	3
20	1010	Point Value – MSB

21	1010	Point Value
22	1011	Point Value
23	1011	Point Value – LSB

In above case, function 03 poll needs to request 12 registers, starting with register address 1000.

In general, Modbus function 03 poll needs to request base register address R, and number of registers 4*NR (2*NR for Enron Modbus). If more registers are requested, only number of registers available is returned. If fewer registers are requested, only requested number of registers is returned.

In order to be able to retrieve all current data with a single poll, the following equations can always be assumed to be true:

A0 = AN + NAN
A1 = A0 + NA0
A2 = A1 + NA1
CN = A2 + NA2
ST = CN + NCN
CT = ST + NST

This means that data mapping listed in base register map registers 0 – 13 is made contiguous. So to poll for all current data, Modbus 03 function call with base register number AN, and number of registers 4*(NAN + NCN + NST + NCT + NA0 + NA1 + NA2) needs to be made (once again, above multiplier is 2 instead of 4 in case of Enron Modbus).

One should be aware of Modbus protocol limitations though. Response length limit is governed by the ‘Number of Bytes’ field which is 8 bits wide. Maximum number of data bytes in a response is, therefore, limited to 256. For standard Modbus flavors (16 bit registers) this means at most 128 registers can be returned at any one time, while Enron flavors of Modbus (32 bit registers) can only return 64 registers at a time.

10.3 Data Recording Control

Data recording can be controlled by writing to register DC, and adjacent registers. Number of registers is not to exceed NDC. The following tables show register values and interpretation:

Register#	Data
DC	PRN (See table below)
DC + 1	Data, as needed per PRN (above) and table (below)
DC + 2	Data, as needed per PRN (above) and table (below)

DC + 3	Data, as needed per PRN (above) and table (below)

PRN	DATA
0	Set data recording period, in milliseconds (4 bytes, one register for Enron format, two registers otherwise), 0 == Off
5	Analog point data recording Enable == 1, Disable == 0 (1 byte, one register), point index (4 bytes, one register for Enron format, two registers otherwise).
6	Counter data recording Enable == 1, Disable == 0 (1 byte, one register), point index (4 bytes, one register for Enron format, two registers otherwise).
7	Status point data recording Enable == 1, Disable == 0 (1 byte), point index (4 bytes, one register for Enron format, two registers otherwise).

Data Recording Control Example

Message To NeXGen - Turn on Data Recording, period = 1 minute
01 - NeXGen Address
10 - Function 16
05 - Start Address Hi
00 - Start Address Lo
00 - No. of Registers Hi
03 - No. of Registers Lo
06 - Byte Count
00 - PRN Hi
00 - PRN - Lo
00 - Data Recording Milliseconds
00 - Data Recording Milliseconds
EA - Data Recording Milliseconds
60 - Data Recording Milliseconds
B8 - CRC
04 - CRC

Response From NeXGen
01 - NeXGen Address
10 - Function 16
05 - Start Address Hi
00 - Start Address Lo
00 - No. of Registers Hi

03 - No. of Registers Lo
80 - CRC
C4 - CRC

Message To NeXGen - Start data recording on one analog point, point address = 1
01 - NeXGen Address
10 - Function 16
05 - Start Address Hi
00 - Start Address Lo
00 - No. of Registers Hi
04 - No. of Registers Lo
08 - Byte Count
00 - PRN Hi
05 - PRN - Lo
00 - Data Recording Enable / Disable Hi
01 - Data Recording Enable / Disable Lo
00 - Point Address
00 - Point Address
00 - Point Address
01 - Point Address
13 - CRC
7F - CRC

Response From NeXGen
01 - GCU Address
10 - Function 16
05 - Start Address Hi
00 - Start Address Lo
00 - No. of Registers Hi
04 - No. of Registers Lo
C1 - CRC
06 - CRC

10.5 Data Downloads

Data downloads are done by writing to register DL, and adjacent registers. Number of registers is not to exceed NDL. The following table shows register values and interpretation:

Each download of data recorded by the unit is done in two steps:

First, download request parameters are uploaded (written to unit registers) per tables below.

Register#	Data
DL	PRN, 1 = analog point data, 2 = counter data, 3 = status point data (4 bytes, one register for Enron format, two registers otherwise)
DL + …	Data, as needed per PRN (above) and table (below)

# of bytes	DATA
6	Oldest time stamp of data to download, 48 bit AT format.
4	I/O point index (address) (One register for Enron format, two registers otherwise)
4	Max. number of readings to download (One register for Enron format, two registers otherwise)

Second, data is downloaded per above request by requesting maximum number of readings, starting with register number DL. The unit returns maximum number of readings worth of data or less, depending on whether enough data is available. For regular Modbus flavors (16 bit registers), downloaded data is returned as shown below:

Register#	Data
DL	Bytes 5 and 4 of AT format time stamp.
DL + 1	Bytes 3 and 2 of AT format time stamp.
DL + 2	Bytes 1 and 0 of AT format time stamp.
DL + 3	Bytes 3 and 2 of I/O point value
DL + 4	Bytes 1 and 0 of I/O point value

For Enron Modbus flavors (32 bit registers), downloaded data is returned as shown below:

Register#	Data
DL	Bytes 5 and 4 of AT format time stamp.
DL + 1	Bytes 3, 2, 1, and 0 of AT format time stamp.
DL + 2	I/O point value

Data Downloads Example

Below is example of data download conversation with NeXGen, in Modbus. Please note, all internal NeXGen time stamps are UTC time, so time keeping within units is invariant with respect to time zones:

Message To NeXGen - Request Data Newer than 12/4/2010 11:10:00 Eastern Time, No More than 10 values Max.:

01 - NeXGen Address
10 - Function 16
06 - Start Address Hi
00 - Start Address Lo
00 - No. of Registers Hi
08 - No. of Registers Lo
10 - Byte Count
00 - PRN Hi
01 - PRN Lo
01 - AT Time - MSB
2C - AT Time
B2 - AT Time
DD - AT Time
A9 - AT Time
20 - AT Time - LSB
00 - Point Address
00 - Point Address
00 - Point Address
01 - Point Address
00 - Max Readings
00 - Max Readings
00 - Max Readings
0A - Max Readings
0A - CRC
FB - CRC

Response From NeXGen - Standard Modbus Function Confirmation 16 Response

01 - NeXGen Address
10 - Function 16
06 - Start Address Hi
00 - Start Address Lo
00 - No. of Registers Hi
08 - No. of Registers Lo
C1 - CRC
47 - CRC

Message To NeXGen - Download Data Specified in Above Request
01 - NeXGen Address
03 - Function 3
06 - Start Address Hi
00 - Start Address Lo
00 - No. of Registers Hi
80 - No. of Registers Lo

44 - CRC
E2 - CRC

Message From NeXGen - Requested Data

01 - NeXGen Address
03 - Function 3
6E - Byte Count
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
DE - AT Time Stamp
93 - AT Time Stamp
A8 - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
DF - AT Time Stamp
7E - AT Time Stamp
09 - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
E0 - AT Time Stamp
68 - AT Time Stamp
64 - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
E1 - AT Time Stamp
52 - AT Time Stamp
D6 - AT Time Stamp
00 - Point Value

00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
E2 - AT Time Stamp
3D - AT Time Stamp
30 - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
E3 - AT Time Stamp
27 - AT Time Stamp
82 - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
E4 - AT Time Stamp
11 - AT Time Stamp
E5 - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
E4 - AT Time Stamp
FC - AT Time Stamp
47 - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp

E5 - AT Time Stamp
E6 - AT Time Stamp
AA - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
E6 - AT Time Stamp
D1 - AT Time Stamp
0C - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
01 - AT Time Stamp
2C - AT Time Stamp
B2 - AT Time Stamp
E7 - AT Time Stamp
BB - AT Time Stamp
6F - AT Time Stamp
00 - Point Value
00 - Point Value
00 - Point Value
00 - Point Value
40 - CRC
47 - CRC

10.7 Control Point Operation

Control point operation via Modbus can be done in one of two ways:

1. Using a single function 16 message, as shown in the table below (example in Modbus RTU flavor):

Byte (hex value)	Interpretation
11	Unit address (in this example address = 17)
10	Modbus Function (16)
CT – Hi	Hi byte of value of CT (from base register map)
CT – Lo	Lo byte of value of CT (from base register map)
00	Hi byte for Number of registers
02	Lo byte for number of registers
04	Byte count (this value = 8 for Enron flavors of Modbus)
00	Hi byte of control point address (in this example address = 2)

02	Lo byte of control point address (in this example address = 2)
TT	Hi byte – point state parameters (see below)
OP	Lo byte – point state parameters (see below)
CRC – Hi	Hi byte – CRC
CRC – Lo	Lo byte – CRC

One can choose the following TT and OP values from the table below:

OP	Meaning	Supported TT Values
00	Latched Operation	TT > 0 for ON, TT = 0 for OFF
01	Timed Operation	TT > 0 (in minutes) for OFF, TT = 0 for ON
02	Timed Operation	TT > 0 (in minutes) for ON, TT = 0 for OFF
03	Momentary Op.	TT > 0 (in milliseconds) for ON, TT = 0 for OFF
04	Momentary Op.	TT > 0 (in milliseconds) for OFF, TT = 0 for ON

2. Using two messages. First, Modbus function 6 message writes time (pulse duration) to a register as shown below (example in Modbus RTU flavor):

Byte (hex value)	Interpretation
11	Unit address (in this example address = 17)
06	Modbus Function (6)
CT – Hi	Hi byte of value of CT (from base register map)
CT – Lo	Lo byte of value of CT (from base register map)
00	Hi byte of duration (in this example 15 milliseconds)
0F	Lo byte of duration (in this example 15 milliseconds)
CRC – Hi	Hi byte – CRC
CRC – Lo	Lo byte – CRC

Second, Modbus function 5 message sets a ‘coil’ to activate the command.

Byte (hex value)	Interpretation
11	Unit address (in this example address = 17)
05	Modbus Function (5)
00	Hi byte of control point address (in this example address = 2)
02	Lo byte of control point address (in this example address = 2)
OP	Hi byte – point state parameters (see below)
00	Lo byte – point state parameters (always 00)
CRC – Hi	Hi byte – CRC
CRC – Lo	Lo byte – CRC

Above, OP = FF for ON, 00 for OFF.

10.8 Data Sampling

CCDC scans all analog, counter, and status inputs, as well as control outputs on attached I/O board, and records the readings once every 100 milliseconds (default). This period is parameterized and can be changed. At the time of each scan, all computed values (Min., Max., and Ave.) are also updated.

10.9 Data Events

Sampled data is analyzed; events are generated if so configured. Globally, event generation must be enabled. On a point by point basis, an I/O point generates an event if the following conditions are satisfied:

- The point is enabled,
- The point's event generation is enabled,
- The point's chatter filter is not active (see below),
- The point class is 1, 2, or 3 (but not 0),
- The point event triggering condition has occurred.

Event triggering conditions vary by point type:

- Analog points must cross value region (high, OK, low) thresholds
- Counters must change by more than pre-configured amount
- Status points must change state
- Control points must change state

I/O point chatter filter is active when point inactivity period is defined, and previous event occurred less than that amount of time ago. Chatter filtering can be turned off on a point by point basis.

Events are reported quiescently (if so configured) or by polling. Unsolicited reports can be of two types, depending on configuration:

- Notification Only – report notifies the master that there is event data. It is up to the master to poll for event data when convenient.
- All Data – all event data is reported to the master station.

Default DNP objects used by CCDC to report event data quiescently are as follows:

- Analog Points – Group 31, Variation 03
- Counters – Group 21, Variation 05

- Status Points – Group 02, Variation 02
- Control Points – Group 10, Variation 02

Except for control points, above objects are used because they contain event date and time information.

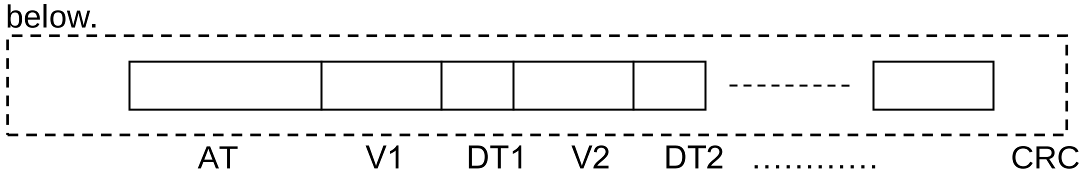
10.11 Data Recording

Data recording can be configured by the host SCADA, or NGC (RTU database upload). Every I/O point can be individually configured to record data. The following conditions need to be satisfied for I/O point data to be recorded:

- Data recording must be enabled globally
- Data recording interval must be defined (one interval for all I/O points)
- I/O point must be enabled
- Data recording must be enabled locally (I/O Point)

In addition,

- Data recording cannot be enabled until TSB is set to TRUE. This is to make sure that RTC has been set. – see time-keeping above.
- Data recording parameters (record schema, sampling frequency, etc) are defined in station configuration record.
- To minimize the number of writes onto serial flash disk, every sampling period all readings are stored as one record. Record structure is indicated below.



Above:

- AT = Absolute Time when measurement of all quantities in the record began.
- V1 = Value of the first measured item (number of bytes depends on item)
- DT1 = Number of milliseconds after AT when V1 was measured (1 byte)
- V2 = Value of the second measured item (number of bytes depends on item)
- DT2 = Number of milliseconds after AT when V2 was measured (1 byte)
- CRC = Checksum of the record

Each record lists values in the following order:

- Analog values (enabled I/O points only, if any) (4 bytes each)
- Counters (enabled I/O points only, if any) (4 bytes each),

- Status values (enabled I/O points only, if any) (1 byte each)
- Control point Boolean values (enabled I/O points only, if any) (TRUE / FALSE) (1 byte each).

10.12 Data Recording Startup Sequence

At startup, once data recording has been initialized and enabled, CCDC goes through the following steps to start data recording:

- Serialized record structure is constructed from data recording record schema in station's configuration database.
- The latest (newest) record in data recording database is tested for integrity and verified to be the latest record on file by using indexes stored in battery backed up RAM (BBRAM). If this fails (failure may occur after firmware update, battery replacement, etc), serial flash disk pages are scanned to find the last (newest) record in data recording database.
- Wait until after TSB is set to TRUE.
- Schedule the next data recording

APPENDIX A

Troubleshooting

Problem	Potential Cause	Suggestion	Caution Status
No LEDs active	GCU LEDs time-out after 5' (five minutes) for power saving	Press and release the TEST PB button to activate the LEDs for another 5' cycle	
No LEDs lighted after pushing the TEST PB	Resettable input power fuse may be tripped.	Power down the instrument. Inplug the main power from the input power connector. Allow the RTU to rest for approximately 20 minutes. Power-up the instrument and observe LEDs	
Heartbeat LED erratic	NeXGen Core Module may be programmed for a alternate NeXGen instrument with non-corresponding I/O.	Call the factory for specific advice.	
Tx/Rx LEDs not active during polling	Local cable, or remote tranceiver cable may be miswired	Check local and/or remote tranceiver cable for proper pin-out	
Rx LEDs not active during remote (Master) polling	Local cable, or remote tranceiver cable may be miswired	Press TEST PB button and observe TEST LED and indication of TX LED	
Analog LEDs not active	QuickView™ analog LEDs are active only when HI/NORMAL/LOW settings are programmed into the GCU	Using the NGC or NeXGen-Link configuration software program analog limits into the GCU	