Product Manual and Reference Guide

NeXGen™ RTU Series

Remote Terminal Unit
Model 8844

Version 1.0 Revision E

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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** 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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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	-	11-05-07	CM	Original Release
	A	1-20-09	CM	Technical Specifications Update
	B	2-24-11	CM	DNP Device Profile Update
	C	6-20-11	DC	Communications Specifications Update
	D	2-6-12	CM	MODBUS Register Map Update
	E	8-11-15	CM	DNP Point Map Update

1. About This Product Manual

Purpose

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

Additional Reference Documentation

Telescada NeXGen™RTU 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*

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 a condition which may result in instrument damage

Highlights special or important information

4. Product Overview

The Telescada NeXGen™ RTU Remote Terminal Unit is a powerful, flexible and economical solution for distribution substation, feeder and recloser automation, monitoring, alarming and control. Built upon a modular and expandable framework, the NeXGen™ RTU meets the needs of distribution engineers for the monitoring and control of new distribution facilities or the upgrade of existing ones.

The NeXGen™ RTU's flexible design provides users with an I/O core of 8 configurable analogs, 8 digital status points and 4 Control Outputs. The NeXGen™ RTU can be expanded to add additional I/O though the networking of additional NeXGen™ modules. The NeXGen™ is an addressable distributed RTU that can be quickly expanded to meet the specific requirements of the user.

In additional to configurable I/O the NeXGen™ RTU 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 and an Ethernet port 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™ RTU using the NeXGen™ *NGC* Maintenance Utility Software. DNP3.0 and Modbus standard communications protocol allows the NeXGen™ RTU to communicate with any modern SCADA system.

The NeXGen™ RTU core's small footprint allows for quick installation on distribution panels, or mounting within a wall mount or pole top enclosure. The NeXGen™ RTU supports 12VDC nominal input current for operation, and complete NeXGen™ RTU, power and communications packages are available from Telescada

5. Feature Set

5.1. Features Overview

- 8 (Eight) Configurable Analog Inputs
  - 0-5VDC
  - 4-20 mA Configurable
  - 0- 1 mA Configurable
  - Data Recording on Each Channel
  - Event Reporting on Each Channel
- 8 (Eight) Configurable Digital Status Inputs
  - Data Recording on Each Channel
  - Event Reporting on Each Channel
  - Can be configured as KYZ inputs
- 4 (Four) Control Relay Outputs
- 2 (two) RS-232/RS-485 2-wire or 4-wire Software Configurable IED Serial Communication Ports
- 1 (one) Ethernet Port
- 1 (one) RS-232 Local Maintenance Port
- DNP3.0 or Modbus Protocol – Software Configurable

5.2. Features Detail

- The low cost of the NeXGen™ RTU 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 and Modbus standard.

- Ethernet Communication port allows direct and network communications via TCP/IP.

- Remote Communication serial ports are RS-232 or RS-485 type and configurable for any manner of RF, cellular or dial-up modem.

- Local interrogation and programming of the NeXGen™ RTU via dropdown lists in the Windows® Based NeXGen™ *NGC* Utility software requires no programming knowledge.

6. Technical Specifications

6.1. Analog Inputs

- 8 (eight) analog inputs
    - 0 to 5 VDC inputs
    - Optional Termination board for 4-20 and 0-1 mA
    - Data recording on each channel
    - Event reporting on each channel
- Accuracy: 0.1% of full scale
    - Analog connector has +5 VDC and Vbatt+ (13.8V) for sensor power
    - Vbatt+ powers 4-20 mA loop
    - 20 K ohm input impedance – ESD protected

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 (5 VDC - 100K ohms) - Appropriate for dry relay contacts
- LED status indication for each digital input
- Each channel configurable for single or 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 5VDC
- Digital inputs are ESD protected

6.3. Control Outputs

- 4 Control Outputs
- 2 (two) Built-In Opto-MOS Relays, Support for momentary, pulse train, trip/close and latching operations – Optically isolated – DC bias required
- LED status indication for each control output
- 2 Mechanical 1 form C SPDT relays
- Contact Rating 1 Form C (SPDT), 20 Amps at 240VAC/28VDC
    - **Operational Characteristics:**
- Operate Time: 15mS
- Release Time: 20mS
- Dielectric Strength (Initial)
- Contact to Contact: 1500VAC/1 minute
- Coil To Contact: 1500VAC/1 minute
- Environmental Characteristics
- Operating: −55□C to +85□C
- Storage: −55□C to +125□C
    - **Life:**
- Electrical: 100,000 operations min.
- Mechanical: 10,000,000 operations min.

6.4. Communications

6.4.1. Remote Communications

- 1 (one) Ethernet port
    - Connectors for Ethernet communications are standard RJ-45 type
    - LED indicators for Ethernet link and Activity
    - DNP3.0 TCP/IP, Modbus TCP Protocol Configurable
- 2 (two) optically-isolated serial communication ports configurable for RS-232 or RS-485 (2-wire/4-wire software configurable)
    - Configurable baud rates up to 38.4kbps
    - 1500VAC isolation (from processor core)
    - Connectors for serial communications ports are RJ-12 type
    - DNP3.0, Modbus RTU / ASCII Protocol Configurable

6.4.2. Local Communications

- RS-232 serial maintenance port for “LOCAL” interrogation, programming and data transfer.
- Configurable baud rates up to 38.4kbps

- 1500VAC isolation (from processor core)
- 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

6.4.3. Distributed Communications

- 2 (two) RS-485 ports for networking multiple NeXGen™ modules
- 1500VAC isolation from processor core
- Individually Addressable by parameters

6.5. Power Supply

- The NeXGen RTU Core Module is powered by an internal DC/DC converter
- Input power – 6-18 VDC (12VDC Nominal)
- 1500 VAC isolation between input and outputs
- Always on when powered
- Power indication LED
- Short circuit protection
- Reverse polarity protection
- Resettable fused power input
- 7 W maximum input supply draw

6.6. Processor and Memory

- The NeXGen instrument series operates from a transportable core module. The Core module processor is the R3000 operating at 22.1 MHz.
- Memory:
    - FLASH: 512k
    - SRAM: 512k
    - Serial Flash Memory: 1MB
    - Battery Backed RTC (Real Time Clock)
    - Watchdog timer

6.7. Physical & Environmental

6.7.1. Physical Specifications

- The NeXGen RTU is housed in a protective thermoformed high impact ABS plastic enclosure 8.375" x 7.375” x 1.500”
- Panel Mountable Design
- LED status indications for
    - Main Power, Logic Power and CPU status
    - Communication port line status (RX/TX)
    - IED port line status (RX/TX)
    - Status points
    - Control Outputs On/OFF
    - Control Relay (2 each) (RED/GREEN)
- 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.
- All connections are made without removing the protective cover
- All field termination locations are clearly labeled on the PCB and enclosure cover

6.7.2. Module Outside Dimensions and Baseplate Mounting Detail

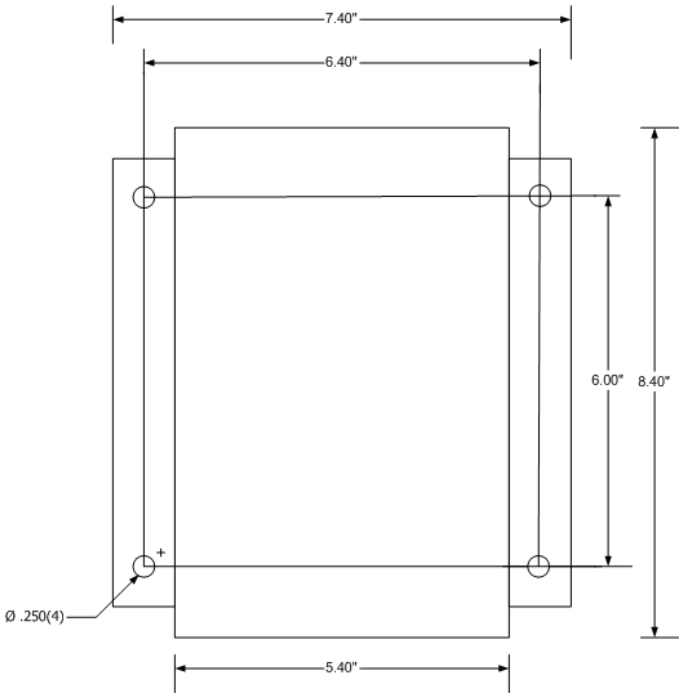

FIG. 1 NeXGen RTU Baseplate Mounting Detail

6.7.3. Environmental Operating Conditions

- Operating Temperature range: -40° to +70°C
- Storage Temperature: -40° to +90°C
- Humidity: 5% to 95% Non-condensing

6.8. Expansion Capability

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

7. Installation and Power-Up

ATTENTION For accurate and reliable operation of your NeXGen™ RTU 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™ RTU if it has been dropped, damaged or the packaging indicates it may have been dropped or damaged.

7.1. Instrument Connection Overview

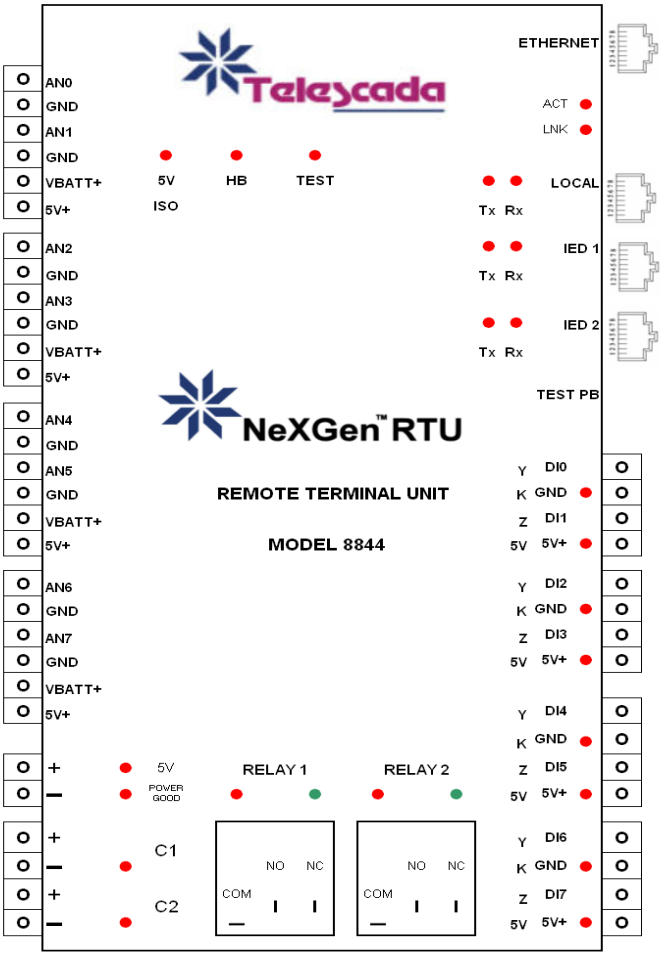

FIG. 2 NeXGen™ RTU Circuit Board Interconnect Overview

7.2. Installation Environment

The NeXGen™ RTU is an instrument powered by hazardous voltage. Installation must be acceptable to the regulatory authority having legal jurisdiction over the installation. The NeXGen™ RTU ABS enclosure IS NOT intended for outdoor use. The NeXGen™ RTU 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™ RTU 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.

7.3. Input Power Supply

7.3.1. Input Power Configuration

The NeXGen™ RTU is powered by 2 internal DC/DC converters. One of the converters isolates the processor from the I/O and communications circuits. Input voltage for the RTU is 9 – 18 VDC (13.8 VDC nominal). The NeXGen™ RTU 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

7.3.2. Input Power Fusing

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

DANGER 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.

7.3.3. Grounding

To ensure safe operations, you must connect the NeXGen™ RTU 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™ RTU has 3 serial interfaces for local and remote communications. Serial interfaces are 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™ RTU 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.

ATTENTION When using Ethernet communications, the Ethernet port can be configured as Interface Slave-1, and the Local Port can be configured as Interface Slave-2 allowing the RTU to be interrogated or programmed in situ, while maintaining the Ethernet connection to the Master Controller.

8.1.1. Local/Programming/Serial Port

The NeXGen™ RTU 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™ RTU Local/Programming Port is located at LOCAL label on the Enclosure Front Cover.

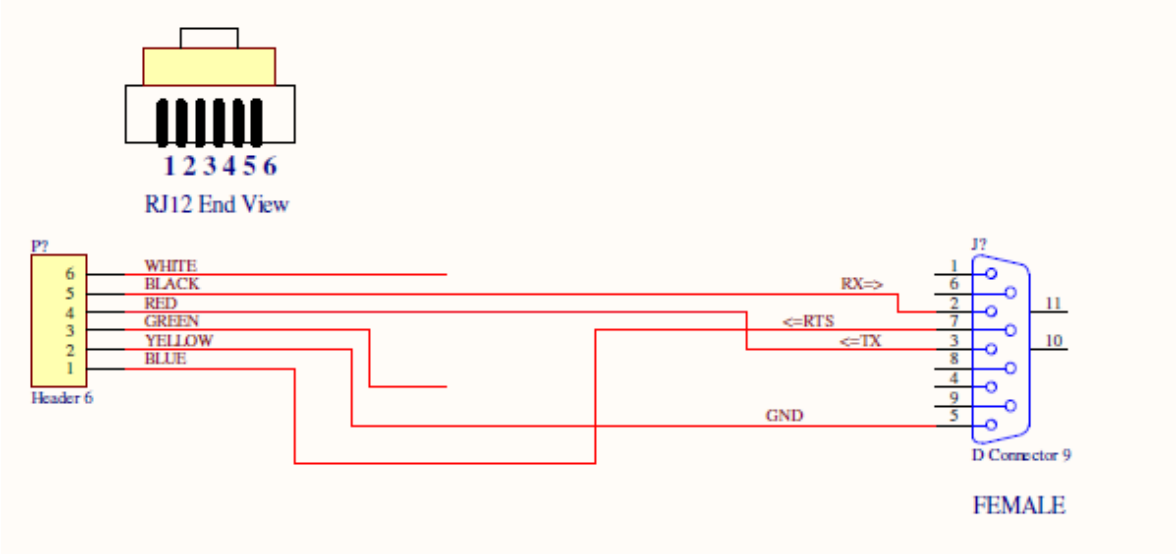

FIG. 4 NeXGen™ TAC-01 Series Local Cable

8.1.2. IED Communications

8.1.2.1. RS-232 Type

The NeXGen™ RTU IED communications ports are configured using the Telescada NeXGen™ NGC Configuration Software.

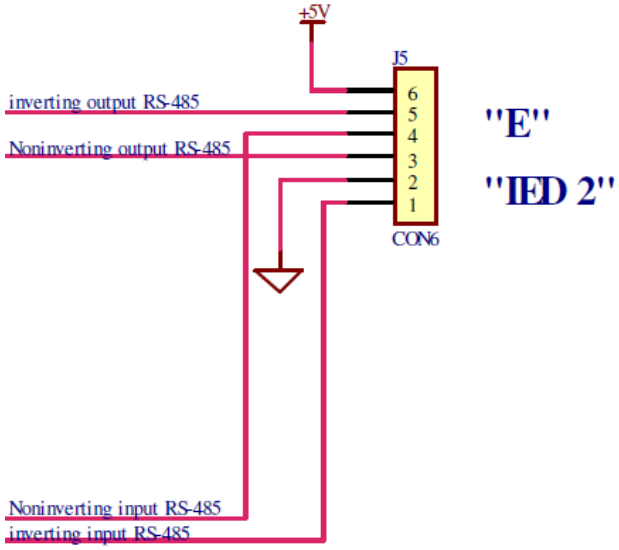

FIG. 3 NeXGen™ RTU Remote Port Pin Configuration – Use pins 5 for TX (output) and 4 as RX (input)

8.1.2.2. Programming RS-485 ports

The NeXGen™ RTU IED communications ports can be programmed to operate as an RS-232 port without hardware handshaking, or RS-485 2-wire or an RS-485 4-wire (aka RS422) are configured using the Telescada NeXGen™ NGC Configuration Software.

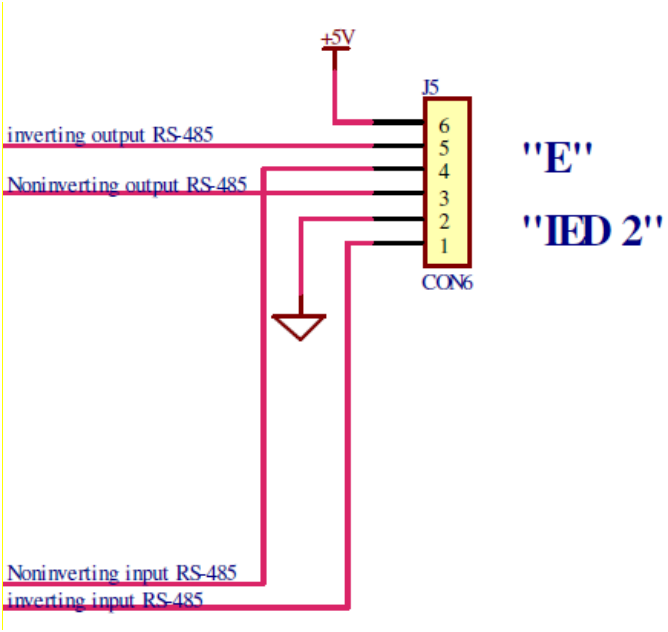

FIG. 4 NeXGen™ RTU Remote Port Pin Configuration
Use pins 3 and 5 for 2-wire RS-485 and RS-232 Comm

8.1.3. Test and Reset Push Buttons

The NeXGen™ RTU Test pushbutton is used for remote field diagnostics and instrument configuration. The NeXGen™ RTU Test Pushbutton is located at “TEST PB” label on the right side of the RTU Enclosure.

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

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

8.1.3.1. Test Pushbutton Functionality

The NeXGen™ RTU Test Pushbutton is the small white button located at TEST PB on the right side of the NeXGen™ RTU. 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 RTU address.

When the Test Pushbutton is pressed momentarily, the Test LED labeled “TEST” 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™ RTU 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 3 (three) 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.

Note: RTUs with firmware created after 2011 require the test pushbutton to be held for 10 seconds in order to reset the RTU.

8.1.3.2. Reset Pushbutton Functionality

The NeXGen™ RTU Processor Reset Pushbutton is the small white button located at S2 on the RTU PCB. 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. LED Indications

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

LED	Location	Color	Description
Heartbeat	Panel Front - HB	RED	Indicates normal operation when blinking at 1" (one second) intervals.
Heartbeat	Panel Front - HB	RED	Provides 3 short blinks (in one second) at startup
Heartbeat	Panel Front - HB	RED	Provides 2" (two seconds) of solid LED ON at soft restart of firmware
Heartbeat	Panel Front - HB	RED	Provides 3 short blinks (in one second) during CFD scan for data recording
Test Push Button	Panel Front - TEST	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
Control Relay 1	Panel Front - RELAY 1	RED/GREEN	Indicates actuation and position of Control Relay 1
Control Relay 2	Panel Front - RELAY 2	RED/GREEN	Indicates actuation and position of Control Relay 2
Control Output 1	Panel Front - C1	RED	Indicates actuation and of Control Output 1
Control Output 2	Panel Front - C2	RED	Indicates actuation and of Control Output 2
Status Input 0	Panel Front - D0	RED	Indicates change of Status Input in Status 0
Status Input 1	Panel Front - D1	RED	Indicates change of Status Input in Status 1
Status Input 2	Panel Front - D2	RED	Indicates change of Status Input in Status 2
Status Input 3	Panel Front - D3	RED	Indicates change of Status Input in Status 3
Status Input 4	Panel Front - D4	RED	Indicates change of Status Input in Status 4
Status Input 5	Panel Front - D5	RED	Indicates change of Status Input in Status 5
Status Input 6	Panel Front - D6	RED	Indicates change of Status Input in Status 6
Status Input 7	Panel Front - D7	RED	Indicates change of Status Input in Status 7
Logic Supply	Panel Front - 5V ISO	RED	Indicates status of Isolated 5VDC Logic Supply
Input Supply	Panel Front - POWER GOOD	RED	Indicates status of 6 - 18VDC Input Power Supply
5V Input Supply	Panel Front - 5V	RED	Indicates status of 5VDC Input Power Bus

9. DNP Device Profile

9.1. Device Profile

DNP V3.0 DEVICE PROFILE DOCUMENT	
Vendor Name:	Advanced Control Systems / Telescada
Device Name:	NeXGen RTU 8844
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

Default Counter Object / Variation: Static Data: Default Object 20, Variation 01 Events Default Object 21, Variation 05
Counters Roll Over At: 32 Bits
Sends Multi-Fragmented Responses: No

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

IMPLEMENTATION TABLE

Request columns identify all requests parsed by the device. Response columns identify all responses sent by the device. Response qualifier codes are defaults, changeable via NGC.

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.

9.5. NeXGen RTU-8844 DNP I/O Map

Analog Inputs

Index#	Analog Input #
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7

Status Inputs

Index#	Status Input #
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7

Pulse Counters

Index#	Counter #
0	0
1	1
2	2
3	3

Control Outputs

Index#	Ctl Output #
0	0
1	1
2	2
3	3

10. MODBUS Register Map

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 accociated point addresses
2	A0	Base register # for analog points Min. values
3	NA0	Number of analog point Min. values registers, including accociated point addresses
4	A1	Base register # for analog points Max. values
5	NA1	Number of analog point Max. values registers, including accociated point addresses
6	A2	Base register # for analog points Ave. values
7	NA2	Number of analog point Ave. values registers, including accociated point addresses
8	CN	Base register # for counters
9	NCN	Number of counter registers, including accociated point addresses
10	ST	Base register # for status points
11	NST	Number of status point registers, including accociated point addresses
12	CT	Base register # for control points
13	NCT	Number of control point registers, including accociated 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	PT	Base register # for programming of the unit - unit time
19	NPT	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
27	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 Time Synchronization

NeXGen units communicate time with the outside world by using the so called 48 bit Absolute Time (AT). Each (incoming or outgoing) time stamp is a 48 bit number expressing number of milliseconds since midnight, January 1, 1970.

To set NeXGen unit's time one must write current time to register #PT (#18 in Base Register Map), in the 6 byte AT format, MSB first. This takes three registers if one is using one for the standard (16 bit registers) Modbus flavors, or two registers if one is using an Enron flavor (32 bit registers). In the latter case, the most significant two bytes of the most significant register must be set to 0.

10.3 Current Data Register Map

To poll for current data, a master uses values obtained from the base table. Let 'R' represent one of the register AN, A0, A1, A2, CN, ST, or CT. Let 'NR' represent the number of those registers obtained from the same table (If R = AN, then NR = NAN, etc). The Latest Data Register Map looks like this:

Register Number	Item
R	Point address
R + 1	Point Value
R + 2	Point address

R + 3	Point Value
R + NR – 2	Point address
R + NR – 1	Point Value

Examples: Suppose an instrument has four counters with addresses 0, 1, 2, 3, and that all counters are enabled. Suppose one wants to poll for values of all counters (R = CN), and that polling base register map returns R = CN = 1000, and NR = NCN = 4. In this case, the counter portion of above table may look like this:

Register Number	Item
1000	0
1001	Point Value
1002	1
1003	Point Value
1004	2
1005	Point Value
1006	3
1007	Point Value

In above case, function 03 poll needs to request base register address 1000, and number of registers 8.

As another example, consider the same instrument with four counters, but counter address #2 is not available (it may have been disabled, and can not be used because it is faulty). In this case, polling base register map returns R = CN = 1000, NR = NCN = 3 and the register map may look like this:

Register Number	Item
1000	0
1001	Point Value
1002	1
1003	Point Value
1004	3
1005	Point Value

In above case, function 03 poll needs to request base register address 1000, and number of registers 6. Note that address 2 is missing.

In general, Modbus function 03 poll needs to request base register address R, and number of registers 2*NR. 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 = AP + 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 2*(NAN + NCN + NST + NCT + NA0 + NA1 + NA2) needs to be made.

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. The table below lists the 'worst case scenarios' (fully utilized capacities on selected NeXGen models, including Power Poll analog points):

	LMC - 411	RTU - 8844	GCU - 63833
NAN	4	24	22
NCN	4	8	12
NST	8	24	16
NCT	2	8	10
NA0	0	24	22
NA1	0	24	22
NA2	0	24	22
Total	18	136	126

This means that in some cases, when 'too many' features are enabled, current data must be downloaded using multiple requests.

10.4 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 (Private Registration Number - 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).

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 (Two registers for Enron format, three registers otherwise)
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

10.6 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

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.

APPENDIX A

Troubleshooting

Problem	Potential Cause	Suggestion	Caution Status
Heartbeat LED not active	NeXGen Core Module may not be loose in its board level connector.	Power down the instrument. Open Top Cover. Carefully press down the NeXGen Core Module into the board level connector. Power-up the instrument and observe heartbeat light	
Heartbeat LED not active	NeXGen Core Module connector may be misaligned	Power down the instrument. Open Top Cover. Carefully inplug the NeXGen Core Module. Align the module connector pins and re-plug the module. Power-up the instrument and observe heartbeat light	
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.	
5V and 5V ISO LEDs not active	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	
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	