

SCADAPack E Operational Reference Manual



Documentation

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Documentation

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed. Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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2 Safety Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

CAUTION

CAUTION used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damage..

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and the installation, and has received safety training to recognize and avoid the hazards involved.

BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

CAUTION

EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

Failure to follow these instructions can result in injury or equipment

damage.

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

Software testing must be done in both simulated and real environments.

Verify that the completed system is free from all short circuits and grounds, except those grounds installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove ground from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

3 Preface & Introduction

Scope

This document covers the operational aspects of the SCADAPack E RTU.

Target Audience

- Systems Engineers
-

- Commissioning Engineers
- Maintenance Technicians

References

- SCADAPack E Configuration Reference manual
- SCADAPack E hardware manuals

Introduction

This manual describes details of various SCADAPack E RTU operational facilities. It describes the operation of the SCADAPack E RTU LEDs, switch settings, RTU start-up and shutdown, time conversion, I/O operation, communication port assignments and command line diagnostics.

4 General

- [*RTU LED Description & Operation for TCP/IP*](#)^[16]
 - [*RTU LEDs*](#)^[11]
 - [*RTU Start-Up*](#)^[17]
 - [*RTU Shutdown*](#)^[22]
 - [*RTU Parameter Changes & Engineering Mode*](#)^[23]
 - [*Time Conversion*](#)^[24]
 - [*RTU Configuration Revisions*](#)^[28]
 - [*Saving RTU Configurations*](#)^[29]
-

4.1 RTU LEDs

RTU LED Description

The following sections list the LEDs indications for RTU processors (not including I/O indicators) and describes their behaviour for SCADAPack E RTUs.

For information on I/O indicators see the relevant device hardware manual.

The following table describes the behavior of the SCADAPack E RTU RUN indication LED.

RUN LED

Table 4.1: RTU RUN LED Behavior

LED Name	Behavior	Description
RUN	10 rapid blinks	RTU Operating system firmware start-up
RUN	1.5 sec blink rate	RTU Operating system running
RUN	4 sec no-blink	RTU Operating system shutting-down

Also see the following sections.

- [SCADAPack 300E RTU LEDs^{\[11\]}](#)
- [SCADAPack ES RTU LEDs^{\[13\]}](#)
- [SCADAPack ER RTU LEDs^{\[15\]}](#)
- [RTU LED Operation for TCP/IP^{\[16\]}](#)

4.1.1 SCADAPack 300E RTU LEDs

The SCADAPack 300E RTU indication LEDs (including description) are detailed in the following table.

Table 4.5: SCADAPack 300E Indication LEDs

LED Name	Behaviour	Description
Power Mode	OFF OFF (and LEDs are disabled) ON (and LEDs are enabled)	RTU powered off RTU operating but LEDs disabled RTU powered on and operating (see RUN LED 1.5 sec blink) (Sleep Mode not yet supported in SCADAPack E)
Power Mode ON, and RUN LED	ON OFF	Boot Monitor running - upgrading firmware or starting the RTU

LED Name	Behaviour	Description
RUN	BLINK 10 rapid blinks	RTU Operating system firmware start-up
RUN	BLINK 1.5 sec rate	RTU Operating system running
RUN	OFF for 4 secs with no blink	RTU Operating system shutting-down
STAT	BLINK	an error has occurred - see SCADAPack E Configurator General Controller Status page for Error Code and Description
FORCE	ON	An ISaGRAF application on the RTU has some Variables LOCKED
USB STAT	ON	User software controlled
LINK	ON	LAN port has established a link
ACT.	BLINK	signal activity on the LAN port
RX	BLINK	receiving data on the corresponding serial port
TX	BLINK	transmitting data on the corresponding serial port
CTS	ON	CTS input is asserted on the corresponding serial port
DCD	ON	DCD input is asserted on the corresponding serial port

4.1.2 SCADAPack ES RTU LEDs

The following table describes the behavior of the SCADAPack ES RTU indication LEDs.

Table 4.3: SCADAPack ES RTU LED Behavior

LED Name	Colour	Behaviour	Description
RUN	Red	BLINK 0.5 sec rate	Boot Monitor running
RUN	Red	BLINK 1.5 sec rate	RTU Operating system running
RUN & RX	Red & Red	Alternate flashing	Boot Monitor "F9" re-program mode
TX	Yellow	Network data transmit	DNP driver transmitting DNP3 frames
RX	Red	Network data receive	DNP driver receiving DNP3 frames
LAN/IP (LED1)	Green	Ethernet receiving data TCP/IP data activity	Remote I/O comms activity on Ethernet interface – LED active for ES Remote I/O units, active for Main unit only when TCP/IP disabled. See Section RTU LED Operation for TCP/IP^[16] and the <i>SCADAPack ES Remote I/O Technical Reference</i>. TCP/IP frames being transmitted or received on Ethernet or PPP interfaces See Section RTU LED Operation for TCP/IP^[16] and the <i>SCADAPack E TCP/IP Technical Reference</i> for more information
COMM (LED2)	Green	PLC Device comms	Transmit or receive comms activity from ISaGRAF I/O board to PLC or peripheral device See the <i>SCADAPack E PLC Interface</i> manuals.
UTIL	Green	Utility Port Operation	Blinks when Utility Port (Compact FLASH) operation is complete
E1 Link **	Green	UTP connection active for Ethernet Interface 1	UTP Ethernet interface synchronized.
E1 Activity **	Green	Ethernet activity detected on interface 1	Flashes on activity for Ethernet Interface 1
E2 Link **	Green	UTP connection active for Ethernet Interface 2	UTP Ethernet interface synchronized.
E2 Activity **	Green	Ethernet activity detected on interface 2	Flashes on activity for Ethernet Interface 2

** These indicated LEDs are positioned on the side of the SCADAPack ES RTU, adjacent to the appropriate Ethernet RJ-45 connector.

4.1.3 SCADAPack ER RTU LEDs

The SCADAPack ER RTU indication LEDs (including description) are detailed in the following table.

For LEDs common with the SCADAPack ES, see section [RTU LEDs](#)^[11] and subsequent sections for more information.

Table 4.4: SCADAPack ER Indication LEDs (Processor Module)

LED Name	Colour	Description
RUN	Red	0.5 Sec Blink Rate - Boot Monitor running
RUN	Red	1.5 Sec Blink Rate - RTU Operating system running
Port Tx *	Red	Transmitting data on a communication port (serial or Ethernet)
Port Rx *	Green	Receiving data on a communication port (serial or Ethernet)
Ethernet 1 - LNK	Green	UTP Ethernet 1 Link Up
Ethernet 2 - LNK	Green	UTP Ethernet 2 Link Up
LAN/IP (LNK 1)	Green	Ethernet OR TCP/IP activity. Refer to Section RTU LED Operation for TCP/IP ^[16] for specific details
COMM (LNK 2)	Green	PLC Device communications. Refer to Section RTU LED Operation for TCP/IP ^[16] for specific detail
UTIL	Green	Blinks when Utility Port (Compact FLASH) operation is complete
PORT 0 – RTS	Red	Ready To Send
PORT 0 – CTS	Green	Clear To Send
PORT 0 – DTR	Red	Data Terminal Ready
PORT 0 – DSR	Green	Data Set Ready
PORT 0 – CD	Green	Carrier Detect
PORT 0 – RI	Green	Ring Indication
IRIG	Green	Receiving IRIG-B time source signal (SCADAPack ER - P620 only)

* each communication interface on the SCADAPack ER has its own TX and RX LEDs, i.e. serial ports and Ethernet interfaces.

4.1.4 RTU LED Operation for TCP/IP

RTU LED Operation for TCP/IP (SCADAPack ES and SCADAPack ER only)

When TCP/IP communication is enabled on an SCADAPack ES or SCADAPack ER RTU, the operation of **LED 1** reflects TCP/IP activity.

This section is not applicable to SCADAPack 300E RTUs as each port has their own LEDs.

LAN/IP (LED 1) is used for TCP/IP communications activity when:

- an RTU Ethernet Interface has a valid TCP/IP configuration, OR
- an RTU serial interface has a valid PPP configuration.

LAN/IP (LED 1) blinks upon *transmit* and *receive* IP activity on any of the active TCP/IP interfaces on the SCADAPack E RTU. It can be used to trouble-shoot LAN or WAN communication activity received by the RTU. It is possible that the SCADAPack E may not blink this activity LED, if the received LAN/WAN data is rejected as not being addressed to this RTU. In this case the LED is still useful in trouble-shooting. Despite the fact that there may be network activity, no LED blinking indicates that no valid data is being received for this RTU.

Where DNP3 data is being delivered via TCP/IP to an RTU, **LAN/IP (LED 1)** may first blink indicating reception of valid TCP/IP traffic. This is followed by the blinking of the **RX** and then **TX** LEDs to indicate the reception of DNP3 request and transmission of DNP3 response. Finally **LAN/IP (LED 1)** would blink indicating transmission of the corresponding TCP/IP message.

4.2 RTU Start-Up

Indication of the commencement of the SCADAPack E RTU operating system start-up sequence is provided via 10 rapid successive blinks of the **RUN** LED.

Operation of the RTU prior to the operating system start is described in the SCADAPack E *Firmware Update Technical Reference* manual.

The RTU start-up diagnostics for the SCADAPack E RTU are detailed in Section [Start-Up Diagnostics](#) [159].

Database Validation

Upon start-up of the RTU, the Point Database is scanned to delete configurations for user and system database records previously marked for delete. As physical point records are present in the point database, deleted physical point record attributes are initialized to default values.

Where point database re-configuration affects configurations for Profiler and Trend Sampler operation, the Profiler and Trend sub-systems within the RTU are notified to restart using the new configured values.

Configuration Corrupt Indicator

Configuration integrity checks are performed at RTU start-up (and upon Restart Config). At RTU start-up, NV-RAM point database integrity is checked.

If any NV-RAM database inconsistencies are detected, the DNP3 **Config Corrupt IIN** flag is set in the next DNP3 response to the SCADA Master. A Configuration Corrupt system binary point is also set.

The Config Corrupt IIN flag is set under the following conditions:

- NV-RAM database integrity test found inconsistencies
- RTU has not been configured with a valid configuration file after being set to factory default.
- Valid NV-RAM database references a non-existent Profile ID.

The DNP3 Config Corrupt IIN flag is cleared upon receipt of a valid re-configuration (i.e. after a future Restart Config successfully reconfigures the RTU).

Upon detection of a Config Corrupt IIN flag in an RTU response, a DNP3 SCADA Master station may re-initialize the RTU. Automatic re-initialization may include the following:

- Transfer profile files to RTU.
- Transfer complete point attribute database configuration to RTU.
- (profiles should have already been loaded at this stage).
- Issue a Restart Config.
- Transfer ISaGRAF applications.
- (RTU user points should have already been created at this stage).
- Issue a Restart ISaGRAF.

Configuration Error Code

A configuration error code will be updated in the RTU Error System Point if the configuration file contents are not valid. Configuration errors will be ignored, and the remainder of the configuration will be loaded. This condition will not set the "Config Corrupt" IIN bit. The configuration file is not deleted by the RTU, in order to assist diagnosing the error.

The following sections detail RTU sub-system operation upon RTU initialization.

4.2.1 File System, Trend Sampler & TCP/IP Start-Up

File System Start-Up

The SCADAPack E main file system resides in FLASH memory. At start-up, a validation of the file system structure is carried out and the file allocation table (FAT) is validated.

If the main file system is found to be in a non-recoverable invalid state, the controller will automatically initiate a file system format. This may take several minutes and delay the startup of the controller. The controller will appear inactive during the file system format. Do not power off the controller during this process.

A more rigorous validation of the file system can be initiated by the user at the command line (see the [CHKDSK](#)^[75] command).

The file system may also be formatted by the user to initialize it or deal with fragmentation. See SCADAPack 300E [Factory Boot Mode](#)^[37] and SCADAPack ES / SCADAPack ER **Format Boot Mode**.

Trend Sampler Start-Up

At start-up, the trend sampler system performs an integrity check of trend files held in the RTU file system. Trend sample files under construction (i.e. not closed at the time of a non-controlled RTU shutdown) are finalized. New trend sample files are opened as configured in the RTU database trend record configurations. For more information see the *SCADAPack E Trend Sampler Technical Reference* manual.

TCP/IP Start-Up

The SCADAPack E RTU starts TCP/IP services when a TCP/IP interface is configured on the SCADAPack E RTU. Further details are provided in the *SCADAPack E TCP/IP Technical Reference* manual.

4.2.2 Profiler Start-Up & Serial Port Hardware Handshaking

Profiler Start-Up

At start-up, the profiler system performs an integrity check on the RTU point database and profile configurations held in the RTU file system.

Profile configuration files found in the RTU file system are deleted if they are not configured in at least one RTU point's **Profile ID** attribute in the point database. Profile ID's found in the database without a corresponding profile file cause a "Config Corrupt IIN" flag to be set.

For more information see the *SCADAPack E Profiler Technical Reference* manual.

Serial Port Hardware Handshaking

Serial ports on the SCADAPack E RTUs have a outgoing hardware handshaking line(s).

The handshake lines vary from port to port and controller to controller. For information on specific hardware lines see the relevant device hardware manual.

Generally the handshake lines are RTS and/or DTR lines, but these may be used in various ways by different communication drivers. By default, the RTS and DTR lines, when present, are asserted on a serial port when the DNP driver starts and establishes a connection a serial port.

In addition, the SCADAPack E RTU asserts the RTS and DTR lines on a serial port configured for PPP operation when the PPP driver starts.

Serial ports also have in-coming hardware handshaking line(s). These are variously CTS, DCD and DSR depending on the port and controller. Some lines are not available on every port.

These lines are used in various ways by different communication drivers. For more information see the *SCADAPack E RTU Communication Interfaces Technical Reference* manual.

In standard RS232 modes, the in coming lines are generally ignored by the RTU. However, incoming control lines on PPP and Modem serial ports need to be asserted for correct operation. For more information on PPP ports see the *SCADAPack E TCP/IP Technical Reference* manual.

4.2.3 ISaGRAF Target Kernel

ISaGRAF Target Kernel Start-Up

At start-up, the ISaGRAF user applications are loaded from the SCADAPack E file system FLASH memory into the Target Kernel(s). The kernel(s) are initialized, but user's ISaGRAF application(s) are not executed until the following RTU system initializations are complete:

- I/O sub-system initialized
- Remote I/O initialized
- Profiler initialized

Remote I/O may take several seconds to initialize, delaying execution of user ISaGRAF application(s). The duration of the delay depends upon the number of Remote I/O units and whether communication is successfully established with each Remote I/O unit. For more information on Remote I/O start-up, see the *SCADAPack E Remote I/O Technical Reference* manual.

4.2.4 Data Processor Start-Up

Data Processor Start-Up

At start-up, the RTU's Data processor checks for the uniqueness of RTU point configurations including the use of binary points for point property status.

Binary Points used for Attribute Indication

Where a point property binary point is already used in the database, an RTU error code is produced. The first point configuration found in the database that is using the binary point is allowed to continue to use it. Subsequent point configurations found using the same point will not be allowed to use the binary point. In this case the point property binary point number will be set to zero in the database. For more information see the *SCADAPack E Data Processing Technical Reference* manual.

4.3 RTU Shutdown

Each RTU sub-system and operating system task performs an orderly shutdown after receiving a DNP3 “Cold Restart” function code, or an ISaGRAF RTUPARAM Cold Restart command.

A **Restart Controller** command from SCADAPack E Configurator is equivalent to a DNP3 Cold Restart command. This is different from a COLD BOOT which initialises the RTU's configuration.

Orderly shutdown includes closing any open RTU file system files, releasing operating system resources, and terminating ISaGRAF application logic.

The following characters are displayed on the ASCII Diagnostic Session during orderly RTU shutdown:

- \$ Indicates shutdown sequence is commencing
- ^ Indicates operating system tasks are shutting down
- # Indicates shutdown sequence is complete,
SCADAPack E RTU will then restart

The RTU also provides visual indication to the user during orderly shutdown. The RTU stops flashing the **RUN** LED for about 4 seconds during the shutdown process. The RTU automatically performs a hardware restart following orderly shutdown completion. As the SCADAPack E RTU Boot Monitor does not start the operating system for around 2 seconds, the user has an opportunity to power off the RTU off during Boot Monitor start-up.

It is preferable that once the RTU operating system is running, that it be shutdown in an orderly fashion using a **Restart Controller** command prior to powering off.

The following sections detail specific RTU sub-system operation upon orderly shutdown.

Trend Sampler Shutdown

Upon orderly shutdown, the trend sampler system finalizes any open sample files by writing summary information about the sample file progress to the sample file. Files are closed in a manner consistent with the normal sample file completion.

Serial Port Hardware Shutdown

Serial ports having their output controls line asserted by a driver task, have them de-activated during RTU shutdown.

TCP/IP Shutdown

A TCP ABORT is sent to active TCP socket connections during RTU shutdown, clearing connections to attached applications.

4.4 RTU Parameter Changes & Engineering Mode

RTU Parameter Changes

For many RTU parameter changes an SCADAPack E RTU restart is not required.

RTU point database attribute changes, DNP Network Routing table changes, BOOTP changes, etc. take effect immediately.

DNP3 communications parameter changes generally require a Reinitialize DNP3 command or DNP3 Warm Restart message in order to take effect but not an RTU restart.

Parameter changes relating to hardware configuration or RTU tasks require controller restart (this can be achieved through a configurator *Restart Controller* command, RTU power on, DNP3 Cold Restart, hardware reset, change of switch settings, etc).

Engineering Mode

Whenever a privileged SCADAPack E Configurator user sends a control or configuration information to an SCADAPack E RTU, the RTU's ENGINEERING TIMER is started which activates the RTU's ENGINEERING MODE system binary point:

ENGINEERING TIMER:	System Analog Point	50014
ENGINEERING MODE:	System Binary Point	50204

Each control and configuration request sent by the SCADAPack E Configurator Tool to the RTU sets the SCADAPack E RTU Engineering Timer and activates the Engineering Mode system binary point. The SCADAPack E Configurator restarts the Engineering Timer value at 60 secs for each configuration or control sent to the RTU. The RTU counts down the Engineering Mode Timer after an SCADAPack E Configurator control or configuration request.

Upon expiry of the RTU Engineering Timer (i.e. The timer expires the preset time period after the user has ceased sending controls to the RTU from the SCADAPack E Configurator), the RTU deactivates the Engineering Mode system binary point.

As the Engineering Mode system binary point is a configurable RTU system point, the RTU configuration may contain a point database configuration for the Engineering Mode system point. This could, for example, raise a SCADA Master alarm to indicate that a privileged user was sending controls or configuration changes to the RTU.

Other mechanisms wishing to provide the RTU with Engineering Mode indication may use the same "Engineering Timer" mechanism described above. (E.g. when a SCADA Master Station is selected in Engineering Mode and begins sending configuration or control information to the RTU, it may send a control to the Engineering Timer system analog point). The value of the point Engineering Timer point is in SECONDS, and the RTU will activate the Engineering Mode binary system point for the duration of the time set.

4.5 Time Conversion

UTC and Standard Time

The SCADAPack E RTU can operate using UTC or Standard Time in the RTU Real Time Clock.

When UTC Time is set in the SCADAPack E RTU real time clock, the **Time Offset from UTC** system point (float system point 63201) should be set appropriately.

Where Standard Time is set in the RTU real time clock, the Time Offset from UTC should be set to zero.

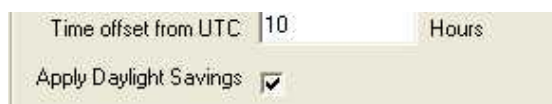
NTP time synchronization facilities provided by the SCADAPack E devices require UTC time operation. For more information on deciding whether to use UTC or Standard time, see the *SCADAPack E Technical Overview* manual and the *SCADAPack E TCP/IP Technical Reference* manual.

Summer Time

If Summer time activities are required, it is not necessary to adjust the RTU Real Time Clock. Rather, the **Time Zone Modifier** system point (binary system point 50302) can be activated. This system point is also known as **Apply Daylight Savings** point. Setting this point is normally the responsibility of the Master Station or a combination of information from the master station and a user logic program.

The Time Zone Modifier selects summer time on the RTU when the binary system point is active. The SCADA Master is responsible for setting this system point. The RTU immediately adjusts for summer time upon receiving a control from the SCADA Master to set the point.

When Summer Time is selected, certain RTU facilities receive local from the RTU based on Standard Time + 1.0 Hours. When summer time is not selected, these facilities receive standard time.



Time Presentation

Except where noted below, RTU facilities use UTC or Standard time (e.g. RTU Real Time Clock, Trends, and DNP3 Time-stamps).

Summer Time (Daylight Savings) corrected time only affects RTU sub-systems that use Local Time. The following table indicates which SCADAPack E RTU facilities use Local times (UTC offset and Daylight Savings / Summer time adjusted) or UTC / Standard (Summer time independent) times.

RTU FACILITIES USING UTC or STANDARD TIME (Independent of Summer Time)		RTU FACILITIES USING LOCAL TIME (Adjusted for UTC offset and Summer Time)
RTU Real Time Clock		Profiler Task
Trend sample time-stamps		ISaGRAF TIMEDATE Function Block
DNP3, IEC60870-5 protocol event		ISaGRAF LOC_TIME Function Block

time-stamps		
ISaGRAF OS_TIME Function		ISaGRAF DAY_TIME Function
Times shown in RTU diagnostics		

ISaGRAF function block **OS_TIME** receives time from the RTU's real time clock. This may be in UTC or Standard Time format depending on how the RTU's real time clock has been set. It is not affected by Summer Time (Daylight Savings time).

An ISaGRAF User Application receives Local RTU time via C Function Block calls: **LOC_TIME**, **TIMEDATE** and via ISaGRAF Function call: **DAY_TIME**. The SCADAPack E RTU offsets local time from UTC or Standard Time including summer time adjustment when presenting an ISaGRAF user application with time from one of these facilities.

A change in the state of the RTU Time Zone Modifier (Summer Time / Daylight Savings) system point does not affect any other ISaGRAF application timing, including internal **TIMER** variables and ISaGRAF timer function blocks.

The RTU Profiler applies UTC and Summer Time corrected time to its profile scheduling. For more information see the *SCADAPack E Profiler Technical Reference* manual.

The following examples illustrate the effect on the time returned by various RTU facilities for several combinations of the 'Time Offset to UTC' and 'Apply Daylight Savings' fields.

Example 1 – SCADAPack E RTU clock set to UTC time, Daylight Savings not applied

UTC Time = 11:15:10.5

Time Offset to UTC = 10.0 hours

Apply Daylight Savings = NO

- Trend samples, DNP3 events, RTU diagnostics indicate 11:15:10.5
- ISaGRAF **OS_TIME** returns seconds since Jan 1, 1970 UTC
- Profiler control time = 21:15:10.5
- ISaGRAF **LOC_TIME** & **TIMEDATE** function block indicates 21:15:10
- ISaGRAF **DAY_TIME** function indicates 21:15:10

Example 2 – SCADAPack E RTU clock set to UTC time, Daylight Savings applied

UTC Time = 11:15:10.5

Time Offset to UTC = 10.0 hours

Apply Daylight Savings = YES

- Trend samples, DNP3 events, RTU diagnostics indicate 11:15:10.5
- ISaGRAF **OS_TIME** function returns seconds since Jan 1, 1970 UTC
- Profiler control time = 22:15:10.5
- ISaGRAF **LOC_TIME** & **TIMEDATE** function block indicates 22:15:10
- ISaGRAF **DAY_TIME** function indicates 22:15:10

Example 3 – SCADAPack E RTU clock set to Standard time, Daylight Savings not applied

RTU Time = 11:15:10.5

Time Offset to UTC = 0.0 hours

Apply Daylight Savings = NO

- Trend samples, DNP3 events, RTU diagnostics indicate 11:15:10.5
- ISaGRAF OS_TIME returns seconds to 11:15:10 since Jan 1, 1970 standard time
- Profiler control time = 11:15:10.5
- ISaGRAF LOC_TIME & TIMEDATE function block indicates 11:15:10
- ISaGRAF DAY_TIME function indicates 11:15:10

Example 4 – SCADAPack E RTU clock set to Standard time, Daylight Savings applied

RTU Time = 11:15:10.5

Time Offset to UTC = 0.0 hours

Apply Daylight Savings = YES

- Trend samples, DNP3 events, RTU diagnostics indicate 11:15:10.5
- ISaGRAF OS_TIME returns seconds to 11:15:10 since Jan 1, 1970 standard time
- Profiler control time = 12:15:10.5
- ISaGRAF LOC_TIME & TIMEDATE function block indicates 12:15:10
- ISaGRAF DAY_TIME function indicates 12:15:10

4.6 RTU Configuration Revisions

The SCADAPack E RTU provides a revision number tracking facility for RTU configurations. The following rules are applied when configurations are changed. The RTU maintains the configuration revision numbers in non-volatile RTU memory.

For further information see the *SCADAPack E RTU Configuration Technical Reference Manual*.

CONFIGURATION MAJOR REVISION NO.: System Analog Point **50050**

CONFIGURATION MINOR REVISION NO.: System Analog Point **50051**

The CONFIGURATION MAJOR REVISION NUMBER is updated under the following conditions:

- When the SCADAPack E RTU configuration is built, or re-built with a complete configuration (.RTU file), the Major Revision Number is incremented by 1
- If the Major Revision Number is written via System Analog Point 50050

The CONFIGURATION MINOR REVISION NUMBER is updated under the following conditions:

- When the SCADAPack E RTU configuration is built, or re-built with a complete configuration (.RTU file), the Minor Revision Number is reset to 0
- When the RTU configuration is updated with an incremental configuration (.INC file), the Minor Revision Number is incremented by 1
- When a Record Exchange modification is made to the RTU database for Point record attributes *, or Trend records
- If the Minor Revision Number is written via System Analog Point 50051

Record exchange configurations individually made to the following point attribute fields result in the Minor Revision Number not incrementing.

- Point Alarm Inhibit attribute
- Point Trend Inhibit attribute
- Point is Bad attribute

The SCADAPack E Configurator does not individually change attributes, so the Minor Revision Number is updated, regardless of which attributes are modified.

For more information on Record Exchange see the *SCADAPack E RTU Configuration Technical Reference manual*.

4.7 Saving RTU Configurations

The configuration for an RTU comprises of several components. Saving the components allows the configuration of the RTU to be restored at a later time. The Master Station may maintain outstation RTU configurations, or they may be manually maintained via the SCADAPack E Configurator. Many of the configuration components are optional and need only be saved if the particular service is configured for use.

The following summarises the separate configuration components for a SCADAPack E RTU:

- RTU Point Database & communications Configuration file
- ISaGRAF application file(s)
- Profile file(s)
- NTP configuration file

See individual technical and reference manuals and the *SCADAPack E Configurator User Manual* for more information.

5 Operating Modes

The following sections describe the RTU operating modes. One of the operating modes is selected when the RTU starts up.

- [SCADAPack 300E RTU Startup Modes](#)³¹
 - [SCADAPack ES/SCADAPack ER Startup Modes](#)³⁹
-

5.1 SCADAPack 300E Startup Modes

The user can change the startup mode of SCADAPack E RTUs for maintenance purposes.



WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment monitored and controlled by the SCADAPack E RTU prior to initializing the SCADAPack E RTU.

Failure to follow these instructions can result in death, serious injury or equipment damage.

SCADAPack 300E Startup Modes

A SCADAPack 300E may start up in RUN, SERVICE, COLD BOOT or FACTORY BOOT modes.

- Start up in the RUN mode automatically loads the RTU database, executes ISaGRAF programs in the controller memory, and communicates on its interfaces, as per its configuration.
- Start up in the SERVICE mode stops the ISaGRAF user applications and overrides RTU ports with DNP3 communications at node address "0" to allow controller reprogramming and initialization.
- Start up in the COLD BOOT mode initializes the controller and erases user application programs.
- Start up in FACTORY BOOT reformats the Flash file system, initializes the controller and erases user application programs.

Each boot mode is determined by the amount of time that the LED power switch is depressed when power is applied or a board reset occurs.

The boot mode is not performed until the LED power switch is released. As such power can be removed prior to releasing the LED power switch without performing the selected boot mode.

The following sections describe in detail the selection of each operating mode.

- [Run Mode](#)^[32]
- [Service Mode](#)^[33]
- [Cold Boot Mode](#)^[35]
- [Factory Boot Mode](#)^[37]
- [Boot Mode Effects](#)^[38]

5.1.1 Run Mode

The RUN mode is the normal operating mode of the controller. No action is required to select RUN mode.

When the controller starts:

- The RTU loads the defined serial and Ethernet communication parameters, for COM ports
 - RTU database configuration and point attributes are loaded
 - ISaGRAF application programs are loaded and executed
 - If there is no ISaGRAF application program in RAM and there is an application program in flash ROM then the flash ROM program will be loaded in RAM and executed.
-

5.1.2 Service Mode

SERVICE mode is used for configuration, programming and maintenance work, usually when the communication settings are unknown.

When a SCADAPack 300E controller starts in SERVICE mode:

- DNP3 node address zero (0) is set, enabling communication via SCADAPack E Configurator at a known DNP address. Connect SCADAPack E Configurator to USB, or serial PORT 2 or PORT 3.
- The ISaGRAF user applications are stopped.
- Programs and configurations are retained in non-volatile memory.
- Serial port configurations are restored to default (see tables below)

SERVICE mode is selected by performing a SERVICE BOOT using the following procedure:

1. Remove power from the controller.
2. Hold down the LED POWER button.
3. Apply power to the controller.
4. Continue holding the LED POWER button until the **STAT LED** turns on.
5. Release the LED POWER button.

If the LED POWER button is released before the STAT LED turns on, the SCADAPack controller will start in RUN mode.

Default Port Settings for SCADAPack 300E

Default Serial Port Settings for: SCADAPack 314E

	USB	COM1	COM2
Serial interface type	USB Peripheral	RS485*	RS232*
Port speed	Auto	9600 bps	9600 bps
Duplex	-	Half	Full
Parity	-	None	None
Data bits	-	8-bits	8-bits
Stop bits	-	1-bit	1-bit
Protocol	SCADAPack E Configurator DNP3	None (disabled)	DNP3

* Default software configuration setting shown. Check that hardware jumpers match this setting.

Default Serial Port Settings for: SCADAPack 330E / SCADAPack 334E / SCADAPack 350E /

SCADAPack 357E

	USB	COM1	COM2	COM3
Serial interface type	USB Peripheral	RS485*	RS232*	RS232
Port speed	Auto	9600 bps	9600 bps	9600 bps
Duplex	-	Half	Full	Full
Parity	-	None	None	None
Data bits	-	8-bits	8-bits	8-bits
Stop bits	-	1-bit	1-bit	1-bit
Protocol	SCADAPack E Configurator DNP3	None (disabled)	DNP3	ISaGRAF

* Default software configuration setting shown. Check that hardware jumpers match this setting.

5.1.3 Cold Boot Mode

COLD BOOT mode is used when it is required to clear a configuration from the RTU. It is optional after installing new SCADAPack Econtroller firmware.

Cold Boot mode does not format the Flash file system (see [Factory Boot Mode](#)³⁷ for doing this)

When a SCADAPack 300E controller starts in COLD BOOT mode:

- The ISaGRAF user applications are erased.
- The RTU point database is cleared
- RTU configurations are returned to default
- DNP3 Device Address is set to 0
- Ethernet configurations are restored to default (Ethernet communications disabled)
- Serial port configurations are restored to default (see tables below)

COLD BOOT mode is selected by performing a COLD BOOT using the following procedure:

1. Remove power from the SCADAPack controller.
2. Hold down the LED POWER button.
3. Apply power to the SCADAPack controller.
4. Continue holding the LED POWER button for 20 seconds until the **STAT LED** begins to flash on and off repeatedly.
5. Release the LED POWER button.

If the LED POWER button is released before the STAT LED begins to flash, the SCADAPack controller will start in SERVICE mode.

Default Port Settings for SCADAPack 300E

Default Serial Port Settings for: SCADAPack 314E

	USB	COM1	COM2
Serial interface type	USB Peripheral	RS485*	RS232*
Port speed	Auto	9600 bps	9600 bps
Duplex	-	Half	Full
Parity	-	None	None
Data bits	-	8-bits	8-bits
Stop bits	-	1-bit	1-bit

Protocol	SCADAPack E Configurator DNP3	None (disabled)	DNP3
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* Default software configuration setting shown. Check that hardware jumpers match this setting.

Default Serial Port Settings for: SCADAPack 330E / SCADAPack 334E / SCADAPack 350E / SCADAPack 357E

	USB	COM1	COM2	COM3
Serial interface type	USB Peripheral	RS485*	RS232*	RS232
Port speed	Auto	9600 bps	9600 bps	9600 bps
Duplex	-	Half	Full	Full
Parity	-	None	None	None
Data bits	-	8-bits	8-bits	8-bits
Stop bits	-	1-bit	1-bit	1-bit
Protocol	SCADAPack E Configurator DNP3	None (disabled)	DNP3	ISaGRAF

* Default software configuration setting shown. Check that hardware jumpers match this setting.

5.1.4 Factory Boot Mode

FACTORY BOOT mode is used to reformat the Flash File system and initialize the SCADAPack 300E controller to factory default settings.

When the controller starts in FACTORY BOOT mode:

- The ISaGRAF user applications are erased.
- The RTU point database is cleared
- RTU configurations are returned to default
- Flash File system is reformatted
- Ethernet configurations are restored to default (Ethernet communications disabled)
- Serial port configurations are restored to default (see tables in [Cold Boot Mode](#)³⁵⁾)

FACTORY BOOT mode is selected by performing the following procedure:

1. Remove power from the SCADAPack controller.
2. Hold down the LED POWER button.
3. Apply power to the SCADAPack controller.
4. Continue holding the LED POWER button for longer than 30 seconds until the **STAT LED** turns solid.
5. Release the LED POWER button.

The FACTORY boot will take approximately 60 seconds to complete. During this time the controller may appear unresponsive while the file system is being formatted to fix any corruption. The STAT LED will remain on until the FACTORY boot has completed and the controller restarts.

5.1.5 Boot Mode Effects

The table below summarizes the effects of the various boot modes.

Table 15.1: Effects of Various Boot Modes

Run Mode	Service Mode	Cold Boot	Factory Boot	Action
	X	X	X	DNP node address set to zero (0)
	X			Serial ports protocol set to DNP3
		X	X	Serial port settings restored to defaults
		X	X	LED power mode set to default (On)
		X	X	Configuration Database initialized
		X	X	ISaGRAF applications erased in RAM and Flash
		X	X	Protocols are set to defaults
			X	Files are erased
			X	Flash File System reformatted
X				ISaGRAF applications started
X	X			Settings retained in non-volatile memory

5.2 SCADAPack ES/SCADAPack ER Startup Modes

The user can change the startup mode of SCADAPack E RTUs for maintenance purposes.



WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment monitored and controlled by the SCADAPack E RTU prior to initializing the SCADAPack E RTU.

Failure to follow these instructions can result in death, serious injury or equipment damage.

SCADAPack ES / SCADAPack ER Startup Modes

SCADAPack ES and SCADAPack ER RTUs use HEX Switches for setting the startup mode.

See the *SCADAPack ES Hardware Manual* and *SCADAPack ER Hardware Manual* for locating the HEX Switches.

00 on the HEX Switches is the normal RTU startup mode.

- See [SCADAPack ES/SCADAPack ER Run Mode](#)^[40].

F0 on the HEX Switches is Service mode.

- See [SCADAPack ES/SCADAPack ER Service Mode](#)^[41].

FB on the HEX Switches is Format Boot mode used for formatting file systems.

- See **SCADAPack ES/SCADAPack ER Format Boot Mode**.

FC on the HEX Switches is Cold Boot mode.

- See [SCADAPack ES/SCADAPack ER Cold Boot Mode](#)^[43].

01-EF settings are used for SCADAPack ES Remote I/O addresses.

- See [SCADAPack ES Remote I/O Switch Settings](#)^[47].

Other HEX Switch settings are used for selecting special startup modes.

- See [Other SCADAPack ES/SCADAPack ER Startup Modes](#)^[45].

5.2.1 SCADAPack ES/SCADAPack ER Run Mode

The RUN mode is the normal operating mode of the SCADAPack ES and SCADAPack ER controller.

The controller starts in RUN mode when the HEX Switches are set to **00**.

When the controller starts:

- The RTU loads the defined serial and Ethernet communication parameters, for COM ports
 - RTU database configuration and point attributes are loaded
 - ISaGRAF application programs are loaded and executed
 - If there is no ISaGRAF application program in RAM and there is an application program in flash ROM then the flash ROM program will be loaded in RAM and executed.
-

5.2.2 SCADAPack ES/SCADAPack ER Service Mode

SERVICE mode is used for configuration, programming and maintenance work, usually when the communication settings are unknown.

When the HEX Switches are set to **F0**, the SCADAPack ES or SCADAPack ER controller restarts in SERVICE mode.

When the controller starts up:

- Temporarily sets the DNP3 node address to zero (0), enabling communication via SCADAPack E Configurator at a known DNP address. Connect SCADAPack E Configurator to PORT 0, PORT 1 or PORT 2.
- The ISaGRAF user applications are stopped.
- Programs and configurations are retained in non-volatile memory.
- PORT 4 is set as CMDLINE mode at 9600bps (No Parity, 8-bits, 1 stop-bit).
- Normal RTU functions are operational, other than port communication settings.
- Serial port configurations are restored to default (see tables below)

SCADAPack ES and SCADAPack ER Default Port Settings

Default Serial Port Settings for: SCADAPack ES & SCADAPack ER

	PORT 0	PORT 1	PORT 2	PORT 3	PORT 4
Serial interface type	RS232	RS232	RS232	RS232	RS232
Port speed	9600 bps	9600 bps	9600bps	9600bps	9600bps
Duplex	Full	Full	Full	Full	Full
Parity	None	None	None	None	None
Data bits	8-bits	8-bits	8-bits	8-bits	8-bits
Stop bits	1-bit	1-bit	1-bit	1-bit	1-bit
Protocol	ISaGRAF	DNP3	DNP3	DNP3	Cmd Line

Default Serial Port Settings for: SCADAPack ER - P620

	PORT 5	PORT 6	PORT 7	PORT 8
Serial interface type	RS232	RS232	RS232	RS232
Port speed	9600 bps	9600 bps	9600 bps	9600 bps
Duplex	Full	Full	Full	Full
Parity	None	None	None	None
Data bits	8-bits	8-bits	8-bits	8-bits

Stop bits	1-bit	1-bit	1-bit	1-bit
Protocol	DNP3	DNP3	DNP3	DNP3

5.2.3 SCADAPack ES/SCADAPack ER Cold Boot Mode

The **FC** startup mode HEX Switch setting is used for COLD BOOT Mode for SCADAPack ES and SCADAPack ER RTUs only.

To Cold Boot a SCADAPack ES or SCADAPack ER controller:

- Set the HEX Switches to **FC** mode
- Power the controller OFF and then ON

When a SCADAPack ES or SCADAPack ER controller starts in COLD BOOT mode:

- The ISaGRAF user applications are erased.
- The RTU point database is cleared
- RTU configurations are returned to default
- DNP3 Device Address is set to 0
- Ethernet configurations are restored to default (Ethernet communications disabled)
- Serial port configurations are restored to default (see [tables](#) ⁴³ below)

Cold Boot mode does not format the controller's main Flash file system. For information on how to format file systems see **SCADAPack ES/SCADAPack ER Format Boot Mode**.

SCADAPack ES and SCADAPack ER Default Port Settings

Default Serial Port Settings for: SCADAPack ES & SCADAPack ER

	PORT 0	PORT 1	PORT 2	PORT 3	PORT 4
Serial interface type	RS232	RS232	RS232	RS232	RS232
Port speed	9600 bps	9600 bps	9600bps	9600bps	9600bps
Duplex	Full	Full	Full	Full	Full
Parity	None	None	None	None	None
Data bits	8-bits	8-bits	8-bits	8-bits	8-bits
Stop bits	1-bit	1-bit	1-bit	1-bit	1-bit
Protocol	ISaGRAF	DNP3	DNP3	DNP3	Cmd Line

Default Serial Port Settings for: SCADAPack ER - P620

	PORT 5	PORT 6	PORT 7	PORT 8
Serial interface type	RS232	RS232	RS232	RS232

Port speed	9600 bps	9600 bps	9600 bps	9600 bps
Duplex	Full	Full	Full	Full
Parity	None	None	None	None
Data bits	8-bits	8-bits	8-bits	8-bits
Stop bits	1-bit	1-bit	1-bit	1-bit
Protocol	DNP3	DNP3	DNP3	DNP3

5.2.4 Other SCADAPack ES/SCADAPack ER Startup Modes

The complete list of HEX Switch settings applicable to SCADAPack ES and SCADAPack ER RTUs is shown below.

Switch settings **F0-FF** are used for RTU startup modes on SCADAPack ES and SCADAPack ER RTUs.

(the SCADAPack E device address for the various RTU protocols is set by software configuration and is not by the switch settings).

As there are startup modes that force the SCADAPack E DNP3 device address to 0, it is recommended that DNP3 device Address '0' not be configured for use in SCADAPack E RTU DNP3 systems. For more information see the *SCADAPack E DNP3 Technical Reference* manual.

Changing the HEX switch settings **to** a value in the range 00-F0 will cause an RTU system restart with entry into the appropriate start mode.

Switching the RTU **to** addresses F1 - FF will require the RTU to be separately reset (e.g. powered off & on) in order for the special operation to take affect.

Table 5.1: SCADAPack ES & SCADAPack ER Startup Mode HEX Switch Settings

RTU Switch Setting (Hex)	Description	Notes
00	RUN Mode	Normal RTU startup mode. See SCADAPack ES/SCADAPack ER Run Mode ^[40] .
01-EF	Remote I/O addresses	See SCADAPack ES Remote I/O Switch Settings ^[47] . RTU functions vary by Remote I/O settings.
F0	Service Mode	Overrides DNP3 device address and serial port settings so device can be accessed with known configurations. See SCADAPack ES/SCADAPack ER Service Mode ^[41] . Normal RTU functions are operational, other than port communication settings.
F1	Clear ISaGRAF applications	Clears ISaGRAF applications from RAM and FLASH memory. Command line interface is available on PORT 4. Connect a serial terminal program to PORT 4 at 9600bps. Normal RTU functions are NOT operational.
F8	System memory test	Runs a test on the RAM of the SCADAPack E RTU. Normal RTU functions are NOT operational. Connect a

RTU Switch Setting (Hex)	Description	Notes
		serial terminal program to PORT 4 at 9600bps.
F9	Boot Monitor Re-programming mode	Allows Boot Monitor Flash to be re-programmed. Connect SCADAPack E Configurator to PORT 4 on SCADAPack ES or SCADAPack ER. Normal RTU functions are NOT operational.
FB	Format Boot Mode	This mode forces the Command line interface on PORT 4 so that file system format commands can be entered. Connect a serial terminal program to PORT4 at 9600 bps. Normal RTU functions are NOT operational. See SCADAPack ES/SCADAPack ER Format Boot Mode
FC	Cold Boot Mode	See SCADAPack ES & SCADAPack ER Cold Boot Mode ⁴³ . Normal RTU functions are NOT operational.
FE	Calibrate Hardware	Calibration interface is provided on PORT 4. Connect an ANSI (VT) terminal program to PORT 4 at 9600bps. Normal RTU functions are NOT operational.
FF	Flash Firmware transfer	Allows RTU Operating System Firmware in Flash memory to be re-programmed. Connect SCADAPack E Configurator to PORT 4 on SCADAPack ES or SCADAPack ER. Normal RTU functions are NOT operational.

5.2.5 SCADAPack ES Remote I/O Switch Settings

The SCADAPack ES and SCADAPack ER RTUs use hardware HEX switches to set MAIN and Remote I/O **Group** and **Unit** addresses for SCADAPack ES Remote I/O.

Both SCADAPack ES and SCADAPack ER RTU supports operation as a MAIN RTU for communication with SCADAPack ES Remote I/O units via serial and Ethernet links.

Remote I/O operation uses HEX switch settings in the range 00- EF. The first switch setting (first hex digit) indicates the Remote I/O Group number. Up to 15 different Remote I/O groups are supported on the same physical link(s), being selected by switch settings 0 – 9, A – E. Each Remote I/O Group needs to have 1 Main unit and may have multiple Remote I/O units.

In many systems there is only one remote I/O group. Typically the group number is set to 0.

The second switch setting (second hex digit) indicates the Remote I/O Unit number. One MAIN unit is permitted per Remote I/O group (unit address 0), and up to 15 Remote I/O units may be connected to the same Main unit, being selected by switch settings 1 – 9, A – F.

Each Main and Remote I/O unit on the same physical network needs to have a unique HEX address switch setting.

For normal RTU operation as a Single RTU, it is recommended that the SCADAPack ES or SCADAPack ER RTU HEX Switches be set to "00".

For more information see the *SCADAPack E Remote I/O Technical Reference* manual.

6 ASCII Terminal Connections (Cmd Line and ISaGRAF ports)

Command Line on a *Cmd Line* Port

If an SCADAPack E RTU has a configured **Cmd Line** port, then an ASCII terminal can be connected to the port for command line operations & diagnostic display session.

At RTU start-up, configuration information and diagnostics are displayed on the ASCII terminal, after which the RTU defaults to command line mode. Entering **DIAG** at the command prompt starts the **Diagnostic Display** mode.

To enter the **Command** mode, from the **Diagnostic Display** session, press the Escape key **<esc>**.

In SYSDIAG **OVERRIDE** mode, the RTU remains in Diagnostic Display mode after start-up rather than entering Command mode. To enter Command mode press **<esc>**. See [System Diagnostic Command](#) [103].

Command Line on an *ISaGRAF* Port

Command line operations and diagnostic display session are supported on the **ISaGRAF** workbench port when IEC 61131-3 Target 3 is enabled. Command line shell is not available with Target 5. The RTU need not be configured with a **Cmd Line** port in this case. An ASCII terminal can be connected to the ISaGRAF workbench port, and after inputting **<enter><enter><enter>**, the port enters Command mode.

To return to ISaGRAF Workbench debugging mode, enter the command **BYE**.

ISaGRAF Workbench communications on the ISaGRAF port will be inoperable if the port enters shell command mode. The BYE command should be issued prior to disconnecting the ASCII terminal for correct operation.

Command Line Summary

The command line prompt for SCADAPack E is the current working directory, typically C:\ as shown as follows:

C:\>

Specific command help is available by typing *command /?* For example typing **DNPDIAG /?** Will display the help information for the DNPDIAG command.

The command summary is obtained by entering the **HELP** command: Commands can be entered in UPPER or lower case.

AGA12diag	Filter AGA12 diagnostics
ATTRIB	Display file attributes
APPEND	Append file to end of another
BOOTP	Manipulates BOOTP configuration table
BYE	Disconnect command session (ISaGRAF / Telnet)
CD	Change working directory
CHKDSK	Check a specified drive for errors
CLEAR	Clear specified RTU information
CONdiag	Filter CONITEL protocol diagnostics
COPY	Duplicate a file
DATE	Display RTU clock Date
DEL	Delete a file
DELTREE	Delete files and directories
DEVINFO	Lists drive information
DIAG	Connect to diagnostic display
DIR	Lists existing files
DSKSEL	Select current drive
DNPdiag	Filter DNP3 diagnostics
DUMP	Dump the contents of a file as HEX

EDIT	Create ASCII file from console input
FILEDIAG	Writes diagnostics to log file (rtudiag.log)
FILLFILE	Fill a file with a supplied string
FORMAT	Format the selected drive (FB HEX mode only)
GETconfig	Get active RTU configuration into a file
HELP	Display this information
IFCONFIG	Set interface IP address and subnet
M103diag	Filter 60870-5-103 Driver diagnostics
MD	Make a new directory
NTPdiag	Filter NTP diagnostics
PING	Send IP network test messages
PLCdiag	Filter PLC protocols diagnostics
PPPecho	Send PPP test message
RENAME	Rename a file
RESTART	Restart specified RTU facilities
ROUTE	Manipulates IP network routing table
RMDIR	Remove a directory
S101diag	Filter IEC60870-5-101/-104 Slave diagnostics
STATUS	Display RTU operational status
SYSdiag	Filter RTU system diagnostics
TASKS	Display RTU task information
TCPdiag	Filter TCP/IP diagnostics
TIME	Display RTU clock Time
TYPE	Dump the contents of a file as ASCII
VER	Display RTU firmware versions
WhoAmI	Display RTU identity
command /?	Displays command specific help

7 RTU I/O Operation

The following sections describe the operation of I/O on SCADAPack E RTU's:

- [Inputs](#)⁵¹
 - [Output Controls](#)⁵²
 - [Local I/O Status](#)⁵³
 - [Remote I/O Status](#)⁵⁶
-

7.1 Inputs

The SCADAPack E RTU physical input channels are managed by the SCADAPack E RTU I/O interface. Changes in local physical input data are time-stamped by the I/O interface, and sent through to the I/O Processor for data manipulation. For further information on SCADAPack E data manipulation see the *SCADAPack E Data Processing Technical Reference* manual.

The I/O Processor updates the processed input data into the RTU Point Database, and forwards time-stamped events for DNP3 event handling, if required. Other RTU sub-systems utilize the updated data in the Point Database (for example ISaGRAF, Trend Sampler, etc).

Changes in physical input data on Remote I/O units are time-stamped by the I/O interface on the remote units. These are forwarded via serial or Ethernet link to the main RTU unit, where they are manipulated in the same way as local inputs. For further information on SCADAPack E telemetry handling of remote I/O see the *SCADAPack ES Remote I/O Technical Reference* manual.

SCADAPack E RTU input data imported into an ISaGRAF application via ISaGRAF Input Boards remain consistent for the cycle of a whole ISaGRAF application program scan. Inputs that are updated from local I/O changes or remote I/O changes during the ISaGRAF scan will not affect ISaGRAF input variable values until updating at the end of the ISaGRAF scan.

The SCADAPack E RTU allows two ISaGRAF target kernel tasks to execute different user applications simultaneously. ISaGRAF Input boards in the two user applications may share the same RTU points, including physical input channels. For more information see the *SCADAPack E ISaGRAF Technical Reference* manual.

At times it may be desirable to enforce an "Allowed" ISaGRAF application scan rate to set the user's application scan rate for timing dependent ISaGRAF applications. This does not affect the operation of other RTU facilities such as obtaining input data from I/O interfaces or remote I/O. For more information on allowed scan rates, see the ***ISaGRAF Workbench Manual***.

7.2 Output Controls

The SCADAPack E RTU physical output channels are updated in one of several ways:

- Local RTU physical outputs controlled by an ISaGRAF application are updated in synchronization with the end of the ISaGRAF application scan
- Outputs controlled externally via DNP3 controls or via the SCADAPack E Profiler are sent to the I/O interface asynchronously to other RTU operational facilities. i.e. controls may occur at any time with respect to scanning of the ISaGRAF user application(s).
- Requests to control Remote I/O, whether from ISaGRAF, DNP3, Profiler, etc. are forwarded to the appropriate remote I/O unit via serial link or Ethernet link. Controls are sent to remote I/O asynchronously to other RTU operational facilities.

The SCADAPack E RTU allows two ISaGRAF target kernel tasks to execute different user applications simultaneously. ISaGRAF output boards in the two user applications may NOT use the same RTU output points, including physical output channels and derived data points. Physical outputs defined on ISaGRAF Output boards (including channels not connected to ISaGRAF variables) can be used in only one of the ISaGRAF user applications. For more information see the *SCADAPack E ISaGRAF Technical Reference* manual.

7.3 Local I/O Status

The following RTU system points are provided to indicate the operational status of local RTU I/O. Where indicated as **Config**, points may be added to RTU point database with complete point configuration attributes available.

Table 6.1: Local I/O Status System Points

Point Type	Point Number	Description	Access
System Binary Points	50205	Local I/O Module Failure (SCADAPack ES only)	Rd Only / Config
	50206 *	Local Input Power Supply Low	Rd Only / Config
	50207	Local On-Board Battery Low	Rd Only / Config
	50208 **	Local Calibration Parameters Invalid	Rd Only / Config
System Analog Point	50060 *	Local Input Supply Voltage	Rd Only / Config

* supported for SCADAPack 300E and SCADAPack ES RTUs, Not available on SCADAPack ER

** Not available on SCADAPack ER (individual I/O Card Status available, see [SCADAPack ER I/O Card Status Points](#)⁵⁴⁾)

7.3.1 SCADAPack ER I/O Card Status Points

The SCADAPack ER includes a range of system points that indicate the current status of each I/O Card (on a per slot basis). The table below details these system points.

Table 6.2: SCADAPack ER I/O Card Status System Points

Slot Number	16-bit Analog system point number
1	56600 (read only / configurable)
2	56601 (read only / configurable)
3	56602 (read only / configurable)
4	56603 (read only / configurable)
5	56604 (read only / configurable)
6	56605 (read only / configurable)
7	56606 (read only / configurable)
8	56607 (read only / configurable)
9	56608 (read only / configurable)
10	56609 (read only / configurable)
11	56610 (read only / configurable)
12	56611 (read only / configurable)
13	56412 (read only / configurable)

These points are used to present the status of the I/O Card configurations on a per-slot basis. The possible status values that these points may report are listed as follows:

- 0 = STATUS OK – No Card Configured and None Detected
- 1 = STATUS OK – Configured Card and Detected correctly
- 2 = STATUS NOT OK – Configured Card NOT Detected
- 3 = STATUS NOT OK – Card Detected Though None Configured
- 4 = STATUS NOT OK – Incorrect Card Type Detected
- 5 = STATUS OK – Card Configuration Change Detected (COLD RESET required)
- 6 = STATUS NOT OK – Card Configuration Detected.
- 7 = STATUS NOT OK – Card Uncalibrated.

These values listed above are typical for normal operating conditions. The additional status codes listed in the following paragraphs are exceptions. Contact Schneider Electric for further information.

Status values greater than 255 decimal (0x00FF) include card status that have been reported directly from the I/O Interface processor for a given card. In this case, the lower byte (least significant byte) of the 16-bit status information will be one of the values listed above, whereas the high byte (most significant byte) of the status information represents the card status reported by the SCADAPack ER I/O Interface processor.

The following bit fields therefore correspond to the high byte.

- Bit 0 – 3V Power Lost – 3 Volt supply on I/O card is not present.
- Bit 1 – 5V Low – 5 Volt backplane supply is getting low.
- Bit 2 – Time Sync Lost
- Bit 3 – Event FIFO Over-run – The event FIFO on the I/O Card is full and events have been lost.

For example, consider the following I/O Card status value,

System Analog 56602 = 1025 decimal (0x0401)

This would indicate that the I/O Card located in Slot 3, has been correctly configured and detected (indicated by lower byte value of 0x01), and that the I/O Interface processor has detected a **Time Sync Loss** with this particular I/O card (indicated by the high byte value of 0x04).

7.4 SCADAPack ES Remote I/O Status

The following SCADAPack E RTU system points provide, on the main RTU, the operational status of remote I/O on the expansion units. For more information see the *SCADAPack ES Remote I/O Technical Reference* manual.

Where indicated “Configurable” in the table below, database points that monitor the status of the remote I/O units may be added to RTU point database at these addresses, with full point configuration attributes available.

Table 6.3: SCADAPack ES Remote I/O Status System Points

Point Type	Point Number	Description	Access
	50209	Remote '1' I/O Module Failure	Read Only / Configurable
	50210	Remote '1' Input Power Supply Low	Read Only / Configurable
	50211	Remote '1' On-Board Battery Low	Read Only / Configurable
	50212	Remote '1' Calibration Parameters Invalid	Read Only / Configurable
	50213	Remote '2' I/O Module Failure	Read Only / Configurable
System	50214	Remote '2' Input Power Supply Low	Read Only / Configurable
Binary	50215	Remote '2' On-Board Battery Low	Read Only / Configurable
Points	50216	Remote '2' Calibration Parameters Invalid	Read Only / Configurable
		...	
	50265	Remote 'F' I/O Module Failure	Read Only / Configurable
	50266	Remote 'F' Input Power Supply Low	Read Only / Configurable
	50267	Remote 'F' On-Board Battery Low	Read Only / Configurable
	50268	Remote 'F' Calibration Parameters Invalid	Read Only / Configurable
	50500	Remote I/O Clear Outputs	Read / Write

8 Port Assignments

Serial Ports

Each SCADAPack E RTU serial port can be configured for a variety of communications protocols, functions, speeds and data formats.

Port functions available depend on the physical port and the controller type.

SCADAPack E configurable serial port functions are:

- **DNP3** (multiple ports supported)
- **ISaGRAF** (workbench debug software) / Command Shell when IEC 61131-3 Target 3 is enabled. Command line shell is not available with Target 5.
- **ISaGRAF 2** (for a second workbench serial debug link)
- **Modbus Slave** (multiple ports supported)
- **Cmd Line** - Command Line & Diagnostics (one port only)
- **ISaGRAF User** - ASCII communications from a user application (multiple ports supported)
- **PLC Device** via ISaGRAF PLC Device I/O boards (multiple ports supported) - e.g. Modbus RTU Master protocol
- **ES Remote I/O** - SCADAPack ES and SCADAPack ER only (multiple ports supported)
- **PPP – TCP/IP** (multiple ports supported)
- **TCP Service Port** (multiple ports supported)
- **DNP VT Service** - DNP3 Virtual Terminal Service Port (multiple ports supported)
- **IEC--103 Master** - IEC 60870-5-103 Master (multiple ports supported)
- **IEC--101 Slave** - IEC 60870-5-101 Slave (two ports supported)
- **NTP GPS Rcvr** - NMEA-0183 compatible GPS Receiver (for time synchronisation)
- **Conitel Slave** – SCADAPack ER-P620 Processor only (multiple ports supported)
- **NONE** (port disabled)

Ethernet Ports

The following function settings are provided for the **Ethernet Port**. See the SCADAPack E Configurator **TCP/IP** configuration page.

Ethernet Function

Enabled TCP/IP Services

For more information see the *SCADAPack E TCP/IP Technical Reference*.

8.1 Default Port Settings

The default port settings for the SCADAPack E RTUs are listed in the tables below.

Default Port Settings for SCADAPack 300E RTUs

Table 7.1: Communication Port Defaults Settings for SCADAPack 350E and SCADAPack 357E

PORT 0	PORT 1	PORT 2	PORT 3	Ethernet 1
DNP3	NONE	DNP3	ISaGRAF	TCP/IP Enabled
USB	RS485 2-wire	RS232 (RTS On)	RS232 (RTS On)	
	9600 bps	9600 bps	9600 bps	

The default port format for each serial port is:

Port Format: 8-bit, No-parity, 1-stop-bit

Serial communication ports support data rates from 300 to 115200bps. RS232 interfaces are supported on serial ports 2 and 3. RS485 2-wire interfaces are only supported on serial Ports 1 and 2.

Default Port Settings for SCADAPack ES and SCADAPack ER RTUs (Ports 0 - 4)

Table 7.2: Communication Port Defaults Settings for SCADAPack ES and SCADAPack ER (Ports 0 – 4)

PORT 0	PORT 1	PORT 2	PORT 3	PORT 4	Ethernet 1	Ethernet 2
ISaGRAF	DNP3	DNP3	DNP3	Cmd Line	TCP/IP + ES Remote I/O	TCP/IP + ES Remote I/O
RS232 (RTS On)	RS232 (RTS On)	RS232 (RTS On)	RS232 (RTS On)	RS232 (RTS On)		
9600 bps	9600 bps	9600 bps	9600 bps	9600 bps		

The default port format for each serial port is:

Port Format: 8-bit, No-parity, 1-stop-bit

Serial communication ports support data rates from 300 to 115200bps. RS232 interfaces are supported on serial ports. RS422/RS485 interfaces are only supported on serial Ports 2 and 3.

Default Port Settings for Port 5 - 8 on SCADAPack ER - P620

Table 7.3: Communication Port Default Settings for SCADAPack ER - P620 (Ports 5 – 8)

PORT 5	PORT 6	PORT 7	PORT 8
RS232 (RTS On)	RS232 (RTS On)	RS232 (RTS On)	RS232 (RTS On)
9600 bps	9600 bps	9600 bps	9600 bps

The default Port Format for each serial port is:

Port Format: 8-bit, No-parity, 1-stop-bit

Serial communication ports support data rates from 300 to 115200bps. RS232/RS422/RS485 interfaces are supported on ports 2,3,5,6,7,8.

8.2 DNP Protocol & DNP3 Virtual Terminal Ports

DNP Protocol Port

Multiple ports on the SCADAPack E RTU can be configured as **DNP3** protocol ports.

Multiple DNP3 ports are supported simultaneously, allowing multiple devices to simultaneously access the SCADAPack E RTU. Messages may be routed between any of the DNP3 ports.

Each port may use the same, or different physical communication media, depending on the physical channels that are connected to the RTU.

Connection types available are RS232, RS422, RS485 (2-wire and/or 4-wire), USB, Keyed RS232 with collision avoidance, Hayes Modem. See the *SCADAPack E Communication Interfaces Technical Reference*.

DNP3 Virtual Terminal Port

Any SCADAPack E RS232 serial port may be configured as a **DNP VT Service** port. Multiple DNP VT Service ports may be used simultaneously on the same RTU. Devices connected to this port may communicate with other similar devices across a DNP3 network using DNP3 Virtual Terminal objects.

In general, the DNP3 Virtual Terminal protocol allows passing of unstructured data between Master and Slave sides of a DNP3 communication link, allowing local terminal interfaces on specific RTU ports to be accessed remotely using the DNP3 Virtual Terminal objects.

Refer to the *SCADAPack E DNP3 Technical Reference* for more information regarding DNP3 Virtual Terminal support.

8.3 ISaGRAF 3 Workbench & User Ports

ISaGRAF Workbench Port

Up to two **ISaGRAF** ports may be assigned to any one SCADAPack E RTU port (one port configured as **ISaGRAF** and one port configured as **ISaGRAF 2**). These ports provide a means for directly connecting ISaGRAF Monitoring/Diagnostic or ISaGRAF Workbench tools for loading, monitoring, controlling or debugging an ISaGRAF application. Access to both of the ISaGRAF kernel Targets is available through either ISaGRAF (or ISaGRAF 2) port.

An ISaGRAF application previously loaded on a SCADAPack E RTU will execute whether, or not, an ISaGRAF port is assigned to the RTU.

The ISaGRAF Workbench debug set-up options select which of the two SCADAPack E RTU ISaGRAF Targets to communicate with.

The ISaGRAF Workbench Target Slave Number needs to match the SCADAPack E RTU Target Slave Number for the appropriate target. The two ISaGRAF targets within the RTU have fixed ISaGRAF Target Slave Numbers (addresses) of 1 and 2 respectively. The ISaGRAF port (not ISaGRAF 2) also supports Command-line Shell operations including RTU diagnostic display session when IEC 61131-3 Target 3 is enabled. Command line shell is not available with Target 5. For more information see the *ISaGRAF Technical Reference* manual.

When starting a Command-line Shell session on the "ISaGRAF" port, ISaGRAF workbench functions on that port (including Modbus) will be disabled until a command-line BYE command is issued.

ISaGRAF User Port

ISaGRAF-User ports may be configured on a SCADAPack E RTU to allow for an ISaGRAF user application to communicate with ASCII peripheral devices. SCADAPack E ISaGRAF functions **ComOpen**, **ComRx**, **ComTx**, **ComRxClr** and **ComClose** are provided for the user application to interface with the ISaGRAF-User ports. Multiple ISaGRAF-User ports may be configured if required by an ISaGRAF application and accessed by ISaGRAF functions.

- Use **ComRx** and **ComTx** to receive and transmit ISaGRAF ASCII message strings.
- Use **ComRxB** and **ComTxB** to receive and transmit ISaGRAF Binary message strings.

For more information see the *SCADAPack E ISaGRAF Function Blocks Reference* manual.

8.4 SCADAPack Workbench & User Ports

SCADAPack Workbench Port

Up to two ports may be assigned to any one SCADAPack E RTU port (one port configured as **ISaGRAF** and one port configured as **ISaGRAF 2**). These ports provide a means for directly connecting SCADAPack Workbench for loading, monitoring, controlling or debugging an IEC 61131-3 project. Access to both Resources is available through either ISaGRAF or ISaGRAF 2 port.

An IEC 61131-3 project previously loaded on a SCADAPack E Smart RTU will execute whether, or not, an ISaGRAF port is assigned to the RTU.

The ISaGRAF port (not ISaGRAF 2) also supports Command-line Shell operations including RTU diagnostic display session when IEC 61131-3 Target 3 is enabled. Command line shell is not available with Target 5. For more information see the *ISaGRAF Technical Reference* manual. When starting a Command-line Shell session on the "ISaGRAF" port, ISaGRAF workbench functions on that port (including Modbus) will be disabled until a command-line BYE command is issued.

ISaGRAF User Port

ISaGRAF-User ports may be configured on a SCADAPack E Smart RTU to allow an IEC 61131-3 Resource to communicate with ASCII peripheral devices. Functions **ComOpen**, **ComRx**, **ComTx**, **ComRxClr** and **ComClose** are provided to interface with the ISaGRAF-User ports. Multiple ISaGRAF-User ports may be configured if required.

- Use **ComRx** and **ComTx** to receive and transmit ISaGRAF ASCII message strings.
- Use **ComRxB** and **ComTxB** to receive and transmit ISaGRAF Binary message strings.

For more information see the *SCADAPack E Target 5 Function Block Reference* manual.

8.5 MODBUS Slave, Command Line, & PPP-TCP/IP Ports

MODBUS Slave Port

Modbus Slave functionality may be assigned to any SCADAPack E RS232 or RS485 RTU port. When configured, these ports provide access to the native Modbus Slave functionality of the RTU. This Modbus Slave implementation does NOT require ISaGRAF and is the preferred way of accessing RTU data via Modbus.

Configuring an SCADAPack E port to **Modbus Slave** starts a Modbus Slave task to service Modbus requests received on that port. Where the communication protocol and media from the serial port allows, multiple devices can be connected to the same Modbus Slave port (e.g. via RS485 or RS232 with external multi-drop hardware). The single configurable Modbus Slave "**Slave Address**" for the SCADAPack E RTU is applied to each Modbus Slave port.

For more information consult the *SCADAPack E Modbus Communication Interfaces* manual.

Command Line Port

An SCADAPack E port configured as a **Cmd Line** port will be permanently available for command line functions and RTU diagnostic output.

For occasional command line use it is suggested that the ISaGRAF port may be used with the command line Shell facility instead of dedicating an RTU port to permanent command line operation. Command line shell is available when IEC 61131-3 Target 3 is enabled. Command line shell is not available with Target 5. For more information see Section [Command Line & Diagnostics](#)^[65].

Alternatively, the SCADAPack E may use Telnet for command line and diagnostic display session. For

more information see the *SCADAPack E TCP/IP Technical Reference*.

SYSDIAG **OVERRIDE** mode on an SCADAPack E RTU overrides the RTU port configured as Cmd Line such that the RTU by default enters the diagnostic display session, rather than entering the command line interpreter. It is handy to use this override mode when it is required to view RTU start-up diagnostics, or if it is required that an RTU remain in diagnostic output mode after start-up rather than exiting diagnostic output mode and entering command line mode. For more information see Section [System Diagnostic Command](#)^[103].

PPP-TCP/IP Ports

Any SCADAPack E port may be configured as a **PPP – TCP/IP** port. Multiple PPP ports may be used simultaneously on the same SCADAPack E RTU. For more information about configuring PPP ports, see the *SCADAPack E TCP/IP Technical Reference* manual.

8.6 IEC 60870-5-103 Master & 101 Slave Ports

IEC 60870-5-103 Master Port

Multiple SCADAPack E ports may be configured as **IEC--103 Master** port. When configured, these ports provide connection to IEC 60870-5-103 slave devices whereby the SCADAPack E RTU behaves as an IEC 60870-5-103 Master. Where the communication protocol and media from the serial port allows, multiple slave devices can be connected to the same **IEC--103 Master** port.

The Data Concentrator interface is used to identify the IEC 60870-5-103 slave devices, using the physical port number, Data Link (and Common) address, and the General Interrogation polling interval for example. The Data Concentrator interface is also used to identify the mapping of object information identifiers in the slave device to configuration points in the data concentrator.

IEC 60870-5-103 Master protocol support requires licensing.

For more information consult the *SCADAPack E Data Concentrator Technical Reference* manual and the *SCADAPack E IEC 60870-5-103 Master Interoperability* document.

IEC 60870-5-101 Slave Port

IEC--101 Slave ports may be assigned to up to two RTU ports. When configured, these ports provide connection to IEC 60870-5-101 Master devices whereby the SCADAPack E RTU behaves as an IEC 60870-5-101 Slave.

IEC 60870-5-101/104 Slave protocol support requires licensing.

For more information consult the *SCADAPack E IEC 60870-5-101 Slave Technical Reference Manual* and the *SCADAPack E IEC 60870-5-101 Slave Interoperability* document.

8.7 PLC Device, SCADAPack ES Remote I/O

PLC Device Port

Multiple SCADAPack E serial ports can be configured as a **PLC Device**. When configured, these ports provide connection to PLC devices, through ISaGRAF PLC Device I/O Boards.

Configuring an SCADAPack E serial port function as *PLC Device* starts a PLC Cache Task to provide PLC communication functions on that port and present data to ISaGRAF. Where the communication protocol and media from the serial port allows, multiple devices can be connected to the same PLC Device port (e.g. RS485 or RS232 with external multidrop hardware).

The ISaGRAF PLC Device I/O board sets the type of PLC protocol used, the port number and PLC device address. For more information see the *SCADAPack E ISaGRAF Technical Reference* manual and the *SCADAPack E PLC Interface* manual.

ES Remote I/O Port

ES Remote I/O is not supported on SCADAPack 300E RTUs.

Any SCADAPack ES serial or Ethernet port can be configured as an **ES Remote I/O** port.

SCADAPack ER Port 0, Port 1, Port 2, Port 3, Port 4, Ethernet 1 and 2 (excluding Ports 5 - 8 on the SCADAPack ER-P620) can be configured as an **ES Remote I/O** port for communication with SCADAPack ES devices.

These ports provide serial or Ethernet connection to SCADAPack ES Remote I/O RTU devices, for the purposes of expanding the I/O capacity of the main RTU. Using this RTU facility, the multiple RTU units are arranged such that one unit is the **Main** RTU unit (a SCADAPack ES or SCADAPack ER) and the remaining units are SCADAPack ES Remote I/O units.

When using remote I/O units, the Main unit appears as a large logical RTU made up of its own local I/O, and I/O from Remote I/O units. The Main unit maintains RTU functionality. From the user's perspective, the Remote I/O unit is a simple I/O device, only. Main and Remote I/O units are determined from the Hex Switch settings. For more information see Section [Remote I/O Switch Settings](#)⁴⁷ and the *SCADAPack ES Remote I/O Technical Reference* manual.

Remote I/O serial ports on the Main and Remote RTU units operate with the following fixed configuration. These settings cannot be altered.

57600 bps, 8-bit, No-parity, 1-Stop bit

Where multiple ES Remote I/O ports are configured on the same Main RTU, Remote I/O devices can be connected to any serial port configured as Remote I/O, or RTU Ethernet port(s). Chaining of Remote I/O units via serial links is also possible, providing the ability to connect multiple Remote I/O units via the same serial connection on a single main RTU.

9 Command Line & Diagnostics

The SCADAPack E RTU provides a command line interface that can be used in two discrete modes. These are:

- command line mode
- diagnostic display mode.

Command Line Mode

The **command line mode** presents a standard prompt to the user (indicating the current file path - e.g. C:\>)

From the command line mode, a range of commands can be used to monitor and influence the current operating status of the RTU. The complete range of available commands are detailed in this section.

Typing **help <enter>** at the command line prompt will also display a list of available commands.

The command line interface can be accessed using one of the following methods

- **Cmd Line** serial port (via ASCII terminal)
- ISaGRAF serial port shell access (via ASCII terminal - press <enter> <enter> <enter>) when IEC 61131-3 Target 3 is enabled. Command line shell is not available with Target 5.
- TELNET session
- Remote Command Line (Virtual Terminal over DNP3 from SCADAPack E Configurator)

Diagnostic Display Mode

The **diagnostic display mode** allows for display of run-time diagnostics.

The specific diagnostic information displayed is dependent on the enabled diagnostic filters. These diagnostic filters commands are:

- SYSDIAG (see Section [System Diagnostic Command](#)^[103])
- PLCDIAG (see Section [PLC Protocol Diagnostic Command](#)^[101])
- DNPDIAG (see Section [DNP3 Diagnostic Command](#)^[76])
- TCPDIAG (see Section [TCPDIAG Command](#)^[108])
- NTPDIAG (see Section [NTPDIAG Command](#)^[119]).
- M103DIAG (see Section [IEC 60870-5-103 Diagnostic Command](#)^[127])
- S101DIAG (see Section [IEC 60870-5-101 Diagnostic Command](#)^[125])
- AGA12DIAG (see *SCADAPack E Security Technical Reference Manual*)

The diagnostic display mode is not available over the Remote Command Line due to high bandwidth impact.

The FILEDIAG command-line command can be used to remotely acquire diagnostic information if a direct serial connection or TELNET session is not available to the RTU. See Section [Diagnostic File](#)

[Logging \(FILEDIAG\)](#)^[122] for more information on the FILEDIAG command.

9.1 RTU File System

The SCADAPack E RTU has an on-board file system. The capacity and available functions of the file system depends on the target hardware type. The file system is typically used to store the following information

- configuration files (RTU configurations, NTP configuration, license file, etc)
- configuration logs
- ISaGRAF application files
- Profile files
- Trend Sample files
- output data from specific tasks

See:

- [File System Overview](#)⁶⁸
- [Filenames](#)⁶⁹
- [File Commands](#)⁷¹

9.1.1 File System Overview

The SCADAPack E RTU has an on-board file system is typically used to store or load the following information:

- configuration files (RTU configurations, NTP configurations, license files, security files, etc)
- configuration logs
- ISaGRAF application files
- Profile files
- Trend Sample files
- output data from specific tasks
- Logged diagnostics

The main file system (Drive C:) is stored in FLASH memory with directory support.

The file system supports a maximum filename length (including path) of 255 characters. Spaces in the filename (and or path) are not supported.

The file system on SCADAPack ES and SCADAPack ER RTUs also support a COMPACT FLASH drive.

The use of a COMPACT FLASH drive is application specific. ISaGRAF function blocks are provided for user access to the external drive.

The mounted drives and directories on the SCADAPack E RTU are as follows:

- C: drive. FLASH memory file system drive
- C:\Sampler\ directory. Used for Trend Sampler file storage
- D: drive (RAM disk). **Volatile drive**. Resides in RAM. Used for temporary files by the Trend Sampler and File Diagnostics for performance reasons
- E: drive. COMPACT FLASH Slot (SCADAPack ES and SCADAPack ER RTUs only)
- F: drive. FLASH memory file system drive (SCADAPack ES and SCADAPack ER RTUs only)
- G: drive. Internal COMPACT FLASH Slot (SCADAPack ES RTU only)

The SCADAPack E Flash file system root directory of C:\ and E:\ and F:\ is each limited to **150 files**. This limit does not exist for other directories that the user creates.

File system sizes are as follows:

Drive	Type	Size	Size	Size
		SCADAPack 300E	SCADAPack ES	SCADAPack ER

C:	Flash	7 MB	12 MB	12 MB
D:	RAM Drive	128 KB	2 MB	2 MB
E:	COMPACT FLASH	-	up to 2 GB	up to 2 GB
F:	Flash	-	16 MB	16 MB
G:	COMPACT FLASH (internal slot)	-	up to 2 GB	-

9.1.2 Filenames

Filenames

Filenames in the SCADAPack E file system have a maximum length of 255 characters, are case insensitive and can include a “.” for file extension support. This maximum length includes the complete path (drive and directory) and filename. Spaces are not supported in filenames or directory names.

Files commonly found in the SCADAPack E file system include:

Filename	Used for:
filename.rtu	A complete RTU configuration file (loaded externally, or generated locally, but not necessarily reflective of the latest RTU configuration held in memory)
filename.inc	An RTU incremental configuration file (loaded externally and representing configuration changes to the RTU database)
Config.log	RTU messages saved from the last configuration attempt
isa11	ISaGRAF target kernel 1 application
isa21	ISaGRAF target kernel 2 application
isa11_backup	system copy of ISaGRAF target kernel 1 application where backup copy cannot be saved elsewhere in RTU permanent memory (do not delete)
isa21_backup	system copy of ISaGRAF target kernel 1 application where backup copy cannot be saved elsewhere in RTU permanent memory (do not delete)
rtudiag.log	RTU diagnostic stream log file

Ntp.conf	NTP time server configuration file
eNet.lic	SCADAPack E RTU license file
7xxxxx.biz	Compressed RTU operating system Firmware file
7xxxxx.bip	RTU operating system Firmware Patch file
Mon_xxx.bin	Boot Monitor firmware file
M386v1xx.bin	SCADAPack ER I/O processor firmware file
profile_xxx.dat	Profile files for time-scheduled setting of point alarm limits and controls
Sampler	sub-directory for Trend Sampler files

9.1.3 File Commands

The following commands are commonly used for the file system resident on the SCADAPack E RTU's.

DIR DEL COPY RENAME APPEND TYPE CD DSKSEL

The following commands support the *wild-card* "*" command for multiple files:

DIR DEL APPEND

- [DIR, DEL, COPY, RENAME, APPEND, JOIN](#)^[71]
- [TYPE, CD, DEVINFO, DSKSEL, MD, RMDIR](#)^[73]
- [CHKDSK, DELTREE, DUMP, ATTRIB, EDIT](#)^[75]

9.1.3.1 DIR, DEL, COPY, RENAME, APPEND, JOIN

The **DIR** command provides a directory listing of the RTU file system. For each file the name, size and time/date of modification are listed. The DIR command can be used with no parameters, listing files in the file system, or with 1 parameter, being the file-name to list, or multiple files to list matching a wild-card file specification. The directory listing displayed for the RTU file system also details sub-directories and the 8.3 ~ *equivalent* for long filenames.

The **DEL** command takes a single file-name parameter or complete path and deletes a single file, or multiple files with a matching wild card file specification.

The **COPY** command takes two file-name parameters or complete paths, the first being the name of an existing source file to copy, the second being the name of a new destination file to create, and copies the contents of the source into the destination files. There is a third optional parameter that allows the destination file to be overwritten if it already exists in the file system. To overwrite the destination file, the third parameter should be **OVERWRITE**. This can be contracted to the single letter **o** or **O**.

For example:

```
COPY ISA11 ISA11_OLD
COPY APPLI.X8M ISA11 OVERWRITE
```

The **RENAME** command takes two parameters, the first being the name or complete path of an existing file, the second being the new name to which the existing file will be re-named.

The **APPEND** takes two or three parameters. The first parameter may specify a single source file, or multiple source files selected by a matching wild-card specification. Source files are appended in ascending alphanumeric file-name order. Once appended to the destination file, each source file is deleted. The second parameter specifies a destination file to which the source file (or files) indicated by the second parameter are appended (may include complete path). If the file in the second parameter does not exist, it is created. The third optional parameter specifies a maximum size for the destination file and is used to limit the destination file size when a large number of source files may be appended. If appending a further source file to the destination file would increase the destination file size beyond a specified maximum size, the source file is not appended and further appending to the destination file is halted. If the third optional parameter is not specified, source files will be unconditionally appended to the destination file,

For example:

```
APPEND SF* HISTORY 8000
```

adds files whose file names start with SF, to file HISTORY, in alphanumeric sequence.

If the destination file does not exist (HISTORY in this example) it will be created. The destination file size limit in this example is 8000 bytes; appending will cease if this limit is exceeded.

JOIN same as APPEND command

9.1.3.2 TYPE, CD, DEVINFO, DSKSEL, MD, RMDIR

The **TYPE** command takes a single file-name parameter or complete path and displays the content of a single file in ASCII. While a file is displaying, the <SPACE> key may be used to pause the display. The <ESC> key may be used to halt the TYPE command.

The **CD** command changes the working directory within a given drive. If the target directory is directly below the current working directory, only the directory name is required, otherwise the complete path is required. "**CD ..**" will change the working directory to one level above the current working directory. **CD** does not support changing to a working directory on another drive. The command DSKSEL allows switching between drives.

The **DEVINFO** command lists devices (drives) that exist in the SCADAPack E file system. A typical listing is displayed as follows

File System Device List

=====

```
Device name : StrataFlash 1 is mounted on C:
Device name : RAM DISK 1 is mounted on D:
Device name : Compact Flash slot 1 is mounted on E:
Device name : StrataFlash2 1 is mounted on F:
Device name : Compact Flash slot 2 is mounted on G:
```

In this example, the following drives are shown:

- StrataFlash is internal the SCADAPack E file system and is available as drive letter **C:**
- RAM DISK is used for temporary files and is available as drive letter **D:**
- Compact Flash slot 1 is the externally accessible slot on the SCADAPack ES & SCADAPack ER and is available as drive letter **E:**
- StrataFlash2 is an additional internal SCADAPack E file system and is available as drive letter **F:**
- Compact Flash slot 2 (internal to the SCADAPack ES) is available as drive letter **G:**

The **DSKSEL** command allows switching between drives. This command requires a single argument, i.e. the target drive. After executing this command, the current working on the target drive will be selected, e.g. if the current working directory is currently "C:\testdir", and the last specified working directory on the "D drive" was "D:\targetdir", the command "**DSKSEL D:**" would then select "D:\targetdir" as the current working directory. "**DSKSEL C:**" would then select "C:\testdir" as the current working directory.

The **MD** command allows directories to be created, and requires a single argument which specifies the directory name (or complete path) to be created. If the directory name alone is specified, the directory is created as a subdirectory of the current working directory. A complete path specification allows directories to be created wherever required. The MD command supports creation of directories on other drives, i.e. different to the current drive.

The **RMDIR** command allows directories to be removed, and requires a single argument which specifies

the directory name (or complete path) to be removed. If the directory name alone is specified, the directory needs to exist as a subdirectory of the current working directory. A full path specification allows directories to be removed wherever required. The directory is only removed if it is empty. The RMDIR command supports removal of directories on other drives, i.e. different to the current drive.

9.1.3.3 CHKDSK, DELTREE, DUMP, ATTRIB, EDIT

The **CHKDSK** command validates a given drive. The CHKDSK command requires two arguments. The first argument is the drive to be checked, e.g. **C:** , and the second argument (0 or 1) determines whether any lost chains are to be written to the file system, e.g.

Example:CHKDSK C: 1

Runs chkdsk on C: writes lost chains

Example:CHKDSK C: 0

Runs chkdsk on C: does not write lost chains

The **DELTREE** command removes the specified directory and all files in that directory. All subdirectories and files below the specified directory are also deleted. The DELTREE command requires a single argument which is the complete path specifying the specified directory (at the top of the tree).

The **DUMP** command takes a single file-name parameter or complete path and displays the content of a single file in HEX and ASCII. While a file is displaying <SPACE> may be used to pause the display, <ESC> may be used to halt the DUMP command.

The **ATTRIB** command takes a single file-name parameter or complete path and lists file attributes on a single file, or files matching a wild-card file specification. The SCADAPack E file system currently provides no mechanism for setting file attributes and always returns the value 20 for file attributes.

EDIT can be used to enter ad-hoc ASCII data into a file (Cmd Line port only)

9.2 DNP3 Diagnostic Command

The **DNPDIAG** command is used to filter DNP3 diagnostics displays when in Diagnostic Session display mode (use DIAG to return to diagnostic mode). The format of the DNPDIAG command is:

DNPDIAG mode filter [filter][param]

Where: mode = ENABLE DISABLE

Where: filter = * 0 1 2 3 4 ETH REMIO_ETH LINK BYTES NET TRANS APPL USER SOE COV TIME
FILTER_ADDR

Enabling DNP diagnostics can have some impact on system performance. **It is suggested that DNP diagnostics be disabled when not in use.**

See the [Example DNP3 Diagnostic Session](#)^[79] topic for an example of the DNP3 Diagnostic command.

The following filters can be individually enabled or disabled. These, with the exception of REMIO_ETH and REMIO_ETH2, are retained in non-volatile memory and survive an RTU restart.

*	All typically used filters enabled/disabled (excludes enabling BYTES, DBASE, FILTER_ADDR, RAW_NET which can be enabled separately)
0-8	DNP3 Communication channels for RTU PORT 0-8
ETH	DNP3 Communication via Ethernet 1 TCP/IP (diagnostics indicate ch# = 10)
ETH_2	DNP3 Communication via Ethernet 2 TCP/IP (diagnostics indicate ch# = 11)
REMIO_ETH	Remote I/O Ethernet interface 1 comm channel (diagnostics indicate ch# = 12)
REMIO_ETH_2	Remote I/O Ethernet interface 2 comm channel (diagnostics indicate ch# = 13)
LINK	DNP3 Link Layer packet header information
BYTES	DNP3 Link Layer packet bytes (requires LINK filter to be enabled)
NET	RTU DNP3 Network functions information
TRANS	DNP3 Transport functions information
APPL	DNP3 Application Layer information
USER	RTU User application request & response information
SOE	RTU DNP3 Sequence of Events Binary Event information
COV	RTU DNP3 Change of Value Analog, Floating Point, and Counter Event info
TIME	Time of DNP3 message diagnostic (see Section TIME DIAGNOSTICS ^[78])
FILTER_ADDR	Display diagnostics for messages from a single DNP3 node address

The diagnostic display session indicates the following symbols preceding the filtered DNP3 diagnostic information:

<... ch# addr:dest	DNP3 link layer TX
...> ch# addr:src	DNP3 link layer RX

***> ch# from:src to:dest SCADAPack E network functions RX
(diagnostic detail includes: Frame Discarded, Frame Addressed)

to Me, Frame Routed to Port #)

<--- ch# addr:dest DNP3 transport functions TX
 ---> ch# addr:src DNP3 transport functions RX

<~~~ ch# addr:dest DNP3 application layer TX
 ~~~> ch# addr:src      DNP3 application layer RX

<=== addr:dest          SCADAPack E user TX  
 ===> addr:src          SCADAPack E user RX

Binary Event:            Sequence of Events Binary Event data  
 Analog Event:           Change of Value Analog Event data  
 Counter Event:          Change of Value Counter Event data  
 Float Event:            Change of Value Floating Point Analog Event data

In addition to filtering diagnostics on DNP3 protocol layers, the diagnostic display session can be filtered on a single DNP3 node address using `FILTER_ADDR`. When a DNP3 node address is specified for filtering, protocol layer filtering is applicable as normal, but is displayed only for the nominated DNP3 node. For example:

#### **DNPDIAG ENABLE APPL TRANS FILTER\_ADDR 125**

Enables application layer and transport layer diagnostics, displaying for DNP3 node address 125 only.

#### **DNPDIAG DISABLE FILTER\_ADDR**

Removes the DNP3 nodes address filtering restriction and displays enabled protocol layer diagnostics for every DNP3 node address.

### 9.2.1 Time display for other Diagnostic messages

The use of the TIME filter (i.e. when set using the DNPDIAG ENABLE TIME command) adds a time marker to SCADAPack E system diagnostics other than DNP protocol diagnostics.

When the TIME filter is enabled, the following system diagnostics also display message diagnostic time:

- DNP TCP/IP diagnostic messages
- Hayes Modem driver messages
- Multi-drop Port Driver messages
- TCP Service Port messages
- DNP VT Service Port messages
- GPRS diagnostic messages
- 1xRTT diagnostic messages

The time displayed in SCADAPack E RTU diagnostics is in UTC or Standard Time format depending upon how the RTU real time clock has been set.

---

### 9.2.2 Example DNP3 Diagnostic Session

This diagnostic session shows DNP3 Link Layer, Transport Layer, Application Layer and User (object) Layer diagnostics using the commands: DNPDIAG ENABLE ETH1 APPL DBASE LINK TIME TRANSP USER and TCPDIAG ENABLE DNP

The Link Layer "ASSOC" indicator shows this communication is managed a DNP3/IP Association. Diagnostic information on DNP3/IP Associations known by this RTU can be shown by using the following command at the SCADAPack E command line: STATUS ASSOC

The "[30001]" indicator shows these transactions are coming from and going to DNP device 30001 (a master station in this case)

There are matching sequence numbers "SEQ# 2" for this transaction at the Application Layer for the received Request, transmitted Response and received Confirm fragments.

The Response includes two binary output event objects with time. The Timestamps on the event objects are marked "(invalid)" indicating that the time is potentially unreliable. This may be the result of loss of an external time synchronization source on the RTU, for example.

Inbound Link Layer messages are indicated as --->

Outbound Link Layer messages are indicated as <---

Inbound Transport Layer information is indicated as ~~~>

Outbound Transport Layer information is indicated as <~~~

Inbound Application Layer information is indicated as ===>

Outbound Application Layer information is indicated as <===

Inbound User Layer information is indicated as +++>

Outbound User Layer information is indicated as <+++

#### Diagnostic Session

|                            |                                             |
|----------------------------|---------------------------------------------|
| 19:47:36.291: ---> ASSOC   | Primary Frame - Unconfirmed User Data       |
| 19:47:36.297:              | LEN(17) DIR(1) PRM(1) FCV(0) FCB(0) DEST(1) |
| SRC(30001)                 |                                             |
| 19:47:36.303: ~~~> [30001] | Transport Header                            |
| 19:47:36.307:              | FIR(1) FIN(1) SEQ# 23                       |
| 19:47:36.313: ===> [30001] | Application Header, Read Request            |
| 19:47:36.318:              | FIR(1) FIN(1) CON(0) UNS(0) SEQ# 2          |
| 19:47:36.358:              | Rx Object 60(Class Data), variation 2,      |
| qualifier 0x06(All Points) |                                             |
| 19:47:36.364: <+++ [30001] | Build DNP3 Message: Read Response           |
| 19:47:36.370:              | Rx Object 60(Class Data), variation 3,      |
| qualifier 0x06(All Points) |                                             |
| 19:47:36.377: <+++ [30001] | Build DNP3 Message: Read Response           |

```

19:47:36.383: Rx Object 60(Class Data), variation 4,
qualifier 0x06(All Points)

19:47:36.388: <+++ [30001] Build DNP3 Message: Read Response

19:47:36.424: Tx Object 11(Binary Output Event),
variation 2, qualifier 0x17(8 Bit Index)

19:47:36.430: 15Apr11 19:46:34.923 (invalid) Binary Output 000000 = 0x81
19:47:36.436: 15Apr11 19:47:36.129 (invalid) Binary Output 000001 = 0x81

19:47:36.446: <+++ [30001] Insert request in queue: Read Response

19:47:36.493: <=== [30001] Application Header, Response
19:47:36.498: FIR(1) FIN(1) CON(1) UNS(0) SEQ# 2 IIN
(0x0000)

19:47:36.504: <~~~ [30001] Transport Header
19:47:36.508: FIR(1) FIN(1) SEQ# 6

19:47:36.514: <--- ASSOC Primary Frame - Unconfirmed User Data
19:47:36.519: LEN(30) DIR(0) PRM(1) FCV(0) FCB(0) DEST
(30001) SRC(1)

19:47:36.557: IP>>TX Message for node 30001 to TCP
address: 172.16.28.11:T

19:47:36.560: IP>>Sending to TCP socket no. 138

19:47:36.630: I P>>RX DNP Message on interface 10 from
address: 172.16.28.11, on TCP socket 138

19:47:36.645: ---> ASSOC Primary Frame - Unconfirmed User Data
19:47:36.650: LEN(8) DIR(1) PRM(1) FCV(0) FCB(0) DEST(1)
SRC(30001)

19:47:36.656: ~~~> [30001] Transport Header
19:47:36.660: FIR(1) FIN(1) SEQ# 24

19:47:36.666: ==> [30001] Application Header, Application
Confirmation
19:47:36.671: FIR(1) FIN(1) CON(0) UNS(0) SEQ# 2

```

### 9.3 STATUS Commands

The **STATUS** command displays the following operational information.

```
C:\>status
```

```
RTU Uptime: 4 days, 01:17:11
```

```
ISaGRAF Target 1: samp_cv Version: 6
```

```
ISaGRAF Target 1: RUN. Allowed=0ms Current=0ms
Maximum=90ms Overflow=0
```

```
ISaGRAF Target 2:      eio_mbus  Version: 43
ISaGRAF Target 2:      RUN. Allowed=0ms Current=0ms
                        Maximum=90ms Overflow=0

Reset Counter:         0
Reset Reason mask:     0x0000
Task Watchdog mask:    0x0000
Sys Last Error:        1033
Sys Memory Free:       60940788 bytes
Sys Memory Size:       62082860 bytes
```

The “**Reset Counter**” statistic is the value of the Analog System point no. 50016, which stores the cumulative number of Hardware Restarts of the RTU. This count is reset by an Factory Default Initialization (Cold Boot) restart or a “restart mask” command, or by pressing the SCADAPack E Configurator Controller Status page **Clear Errors** button.

### Related Topics

[STATUS PPP IP\\_STATS](#)<sup>[82]</sup>

[STATUS EVENTS](#)<sup>[83]</sup>

[STATUS I/O](#)<sup>[84]</sup>

[DNP3 STATUS ASSOCIATION](#)<sup>[85]</sup>

[DNP3 ASSOCIATION STATES](#)<sup>[90]</sup>

**9.3.1 STATUS PPP IP\_STATS**

The **STATUS** command supports optional parameters for displaying PPP link status (**PPP**) and IP interface statistics (**IP\_STATS**)

```
C:\>status PPP IP_Stats
```

```
RTU Uptime:          4 days, 01:27:43
```

```
ISaGRAF Target 1:    samp_cv  Version: 6
```

```
ISaGRAF Target 1:    RUN. Allowed=0ms Current=0ms Maximum=90ms
                     Overflow=0
```

```
ISaGRAF Target 2:    eio_mbus  Version: 43
```

```
ISaGRAF Target 2:    RUN. Allowed=0ms Current=0ms Maximum=90ms
                     Overflow=0
```

```
Reset Counter:       0
```

```
Reset Reason mask:   0x0000
```

```
Task Watchdog mask:  0x0000
```

```
Sys Last Error:      1033
```

```
Sys Memory Free:     60955924 bytes
```

```
Sys Memory Size:     62082860 bytes
```

```
IP Interface Statistics:
```

|        | <b>pkts_in</b> | <b>pkts_out</b> | <b>bytes_in</b> | <b>bytes_out</b> | <b>err_in</b> | <b>err_out</b> | <b>pkts_lost</b> |
|--------|----------------|-----------------|-----------------|------------------|---------------|----------------|------------------|
| PORT3: | 0              | 7426            | 0               | 297040           | 0             | 0              | 0                |
| ETHER: | 449780         | 435844          | 42763909        | 49616365         | 471           | 19             | 768              |

---

To determine the Link UP / DOWN indication when the “PPP” option is used with the STATUS command, the SCADAPack E RTU sends an LCP ECHO command on each PPP interface. A link UP is indicated if the peer PPP node responds to the LCP ECHO. A link DOWN is indicated if the local PPP FSM is not in an open state, or if the peer PPP node does not respond to the LCP ECHO. For some older PPP devices not supporting LCP ECHO, the user needs to use the “STATUS PPP” command to force the LCP ECHO commands to be issued. Where multiple PPP interfaces are configured on the same RTU, the link status for each PPP interface is displayed.

PPP link status is also available to a user ISaGRAF application using the PPP\_ECHO function block. This function block also sends a LCP ECHO command on the given PPP interface, and providing that the attached PPP device can respond to this command, then the status of the PPP link-state can be known. For more information see the **SCADAPack E ISaGRAF Function Blocks Reference** manual.

IP statistics are displayed when IP\_STATS option is included with the STATUS command. Statistics are displayed for each defined IP interface.

### 9.3.2 STATUS EVENTS

The **STATUS** command also supports an optional parameter for displaying DNP Event Count statistics (**EVENTS**).

#### STATUS events

```
RTU Uptime:           4 days, 01:16:52
ISaGRAF Target 1:     samp_cv  Version: 6
ISaGRAF Target 1:     RUN. Allowed=0ms Current=0ms Maximum=90ms
                       Overflow=0
ISaGRAF Target 2:     eio_mbus Version: 43
ISaGRAF Target 2:     RUN. Allowed=0ms Current=0ms Maximum=90ms
                       Overflow=0

Reset Counter:         0
Reset Reason mask:     0x0000
Task Watchdog mask:    0x0000
Sys Last Error:        1033
Sys Memory Free:       60952924 bytes
Sys Memory Size:       62082860 bytes
```

#### DNP Events:

```
Master no. 1
  Binary Input Events: 0
  Counter Input Events: 0
  Analog Input Events: 0
  Float Input Events: 0
  Binary Output Events: 2
  Analog Output Events: 3
  Float Output Events: 1
  Binary Command Events: 0
  Analog Command Events: 0
```

Float Command Events: 0

Free Pool size: 4994 events

The DNP3 Event counts are also available as 16-bit Analog System Points. See the *SCADAPack E Configuration Reference* manual for details.

### 9.3.3 STATUS I/O

The **STATUS** command also supports additional optional parameters for SCADAPack ER I/O card status (SCADAPack ER hardware only).

#### STATUS I/O

The STATUS IO is only relevant to the SCADAPack ER hardware. The command will report the following for the local rack.

- configured card type for each slot
  - detected card type for each slot
  - I/O card status for each slot.
-

This information is presented in addition to the standard status information and an example is shown as follows:

| SCADAPack ER IO Configuration and Status for the LOCAL Rack |                      |                    |              |
|-------------------------------------------------------------|----------------------|--------------------|--------------|
| Slot #                                                      | Configured Card Type | Detected Card Type | Status (hex) |
| 1                                                           | SME-16AI-A           | No Card            | 2            |
| 2                                                           | SME-32DI-A           | SME-32DI-A         | 1            |
| 3                                                           | SME-16RO-A           | SME-16RO-A         | 1            |
| 4                                                           | No Card              | No Card            | 0            |
| 5                                                           | No Card              | No Card            | 0            |
| 6                                                           | No Card              | No Card            | 0            |
| 7                                                           | No Card              | No Card            | 0            |
| 8                                                           | No Card              | No Card            | 0            |
| 9                                                           | No Card              | No Card            | 0            |
| 10                                                          | No Card              | No Card            | 0            |
| 11                                                          | No Card              | No Card            | 0            |
| 12                                                          | No Card              | No Card            | 0            |
| 13                                                          | No Card              | No Card            | 0            |

The possible status range of status values is detailed in Section [SCADAPack ER I/O Card Status Points](#)<sup>[54]</sup>

#### 9.3.4 DNP3 STATUS ASSOCIATION

The **STATUS** command supports additional optional parameters for DNP3 IP associations tracking. (**ASSOCIATION**).

- Maximum number of associations. This will be normally be one hundred.

The following information is displayed for each association:

- Association type (local, paired routing or solitary routing)
- Local or Source DNP3 address (a valid DNP3 address. Local address will be the RTUs local DNP3 address)
- Remote or Destination DNP3 address (a valid DNP3 address)
- *Remote or Destination IP address (a valid IP address)*
- IP connection type (TCP or UDP)
- Socket or port number (The TCP socket number will vary depending on the current connection. UDP port number will typically be 20000)
- Time since last activity on the association (hours:minutes:seconds)
- The current state of the association (ACTIVE, PAIR PENDING, INACTIVE, NO SOCKET)

Further information about DNP3 IP Associations can be found in *Annex "C", IEEE Standard for Electric Power Systems Communications - Distributed Network Protocol (DNP3), IEEE STD 1815™- 2012*.

This information is presented in addition to the standard status information and an example is shown as follows. The local DNP3 address in the example is 20:

```
C:\>status association
RTU Uptime:          0 days, 00:53:04
```

```
ISaGRAF Target 1: Stopped
ISaGRAF Target 2: Stopped
```

```
Reset Counter:      2
Reset Reason mask:  0x000E
Task Watchdog mask: 0x0000
Sys Last Error:     0
Sys Memory Free:    127696196 bytes
Sys Memory Size:    129049772 bytes
```

```
DNP IP Associations:
Limit of 100 associations
```

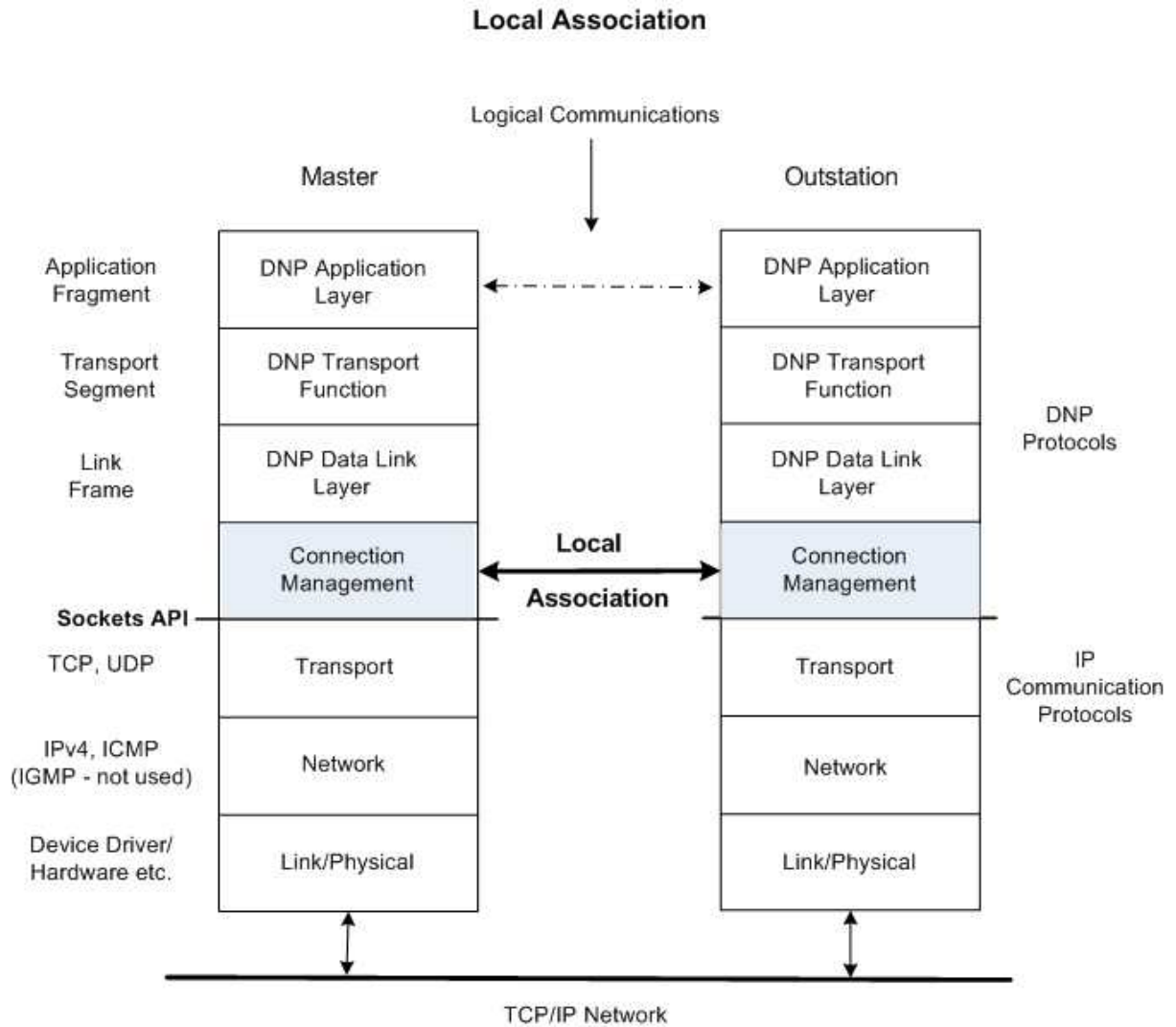
## ASSOCIATION TYPES

### Local Associations

Local Associations are associations between two nodes where one of the nodes is the local RTU. If the RTU has multi-master functionality enabled and configured, then the 'local' RTU is any of the configured DNP3 slaves.

The Protocol Stack communications and connection management configuration for Local Associations is shown in the figure, below:

---



The status information for Local Associations is presented below:

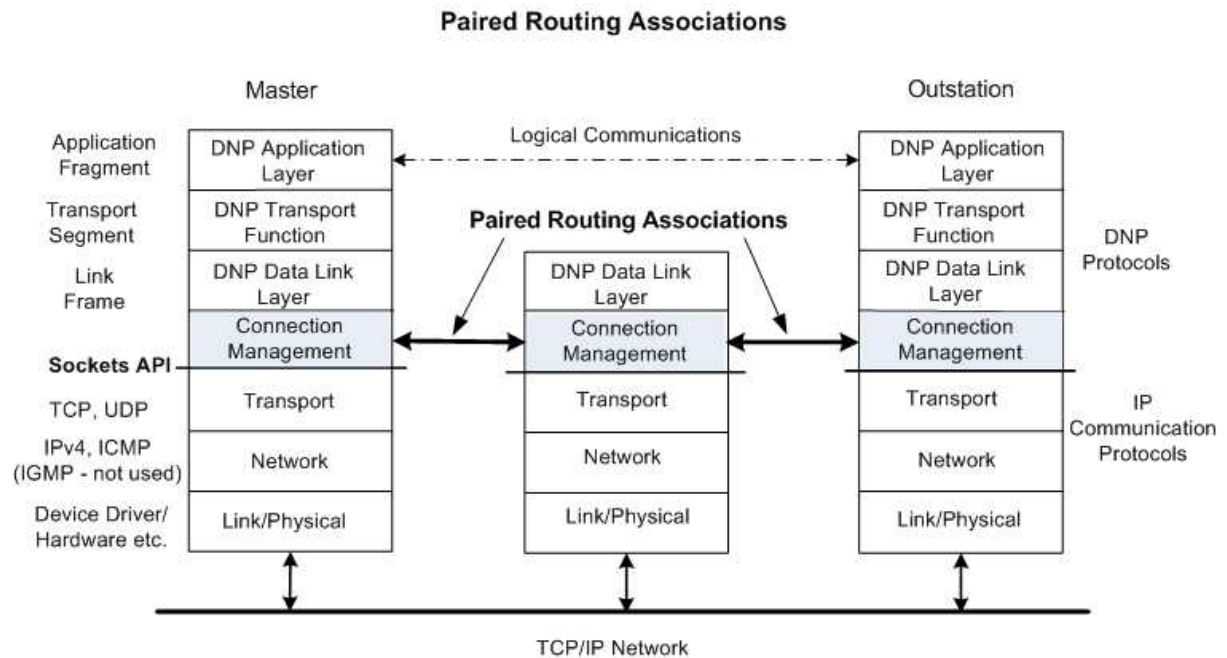
#### Local Associations

| Local DNP addr | Remote DNP addr | Remote IP address | TCP/UDP Type | Sock/Port Num | Time since last msg | State    |
|----------------|-----------------|-------------------|--------------|---------------|---------------------|----------|
| 20<->32111     | 172. 20. 1.165  | 172. 20. 1.165    | TCP          | -1            | 0:52:16             | INACTIVE |
| 20<->2000      | 172. 20. 1.165  | 172. 20. 1.165    | TCP          | 146           | 0:09:46             | ACTIVE   |

#### Paired Routing Associations

Paired Routing Associations are routing associations between two other nodes, neither of which are the local RTU. The local RTU performs DNP3 routing on behalf of the other RTUs. There are two associations; one for each transmission direction between the other two RTUs.

The Protocol Stack communications and connection management configuration for Paired Routing Associations is shown in the figure, below:



The status information for Paired Routing Associations is presented below:

#### Paired Routing Associations

| Source<br>DNP<br>addr | Dest<br>DNP<br>addr | Remote IP<br>address | TCP/<br>UDP<br>Type | Sock/<br>Port<br>Num | Time<br>since<br>last msg | State     |
|-----------------------|---------------------|----------------------|---------------------|----------------------|---------------------------|-----------|
| 100-->1300            |                     | 172. 16. 29. 75      | UDP                 | 20000                | 0:02:16                   | ACTIVE    |
| 1300-->100            |                     | 172. 20. 1.165       | TCP                 | -1                   | 0:02:16                   | INACTIVE  |
| 800-->1600            |                     | 172. 16. 29. 55      | TCP                 | 0                    | 0:01:41                   | NO SOCKET |
| 1600-->800            |                     | 172. 20. 1.165       | TCP                 | 142                  | 0:01:41                   | ACTIVE    |

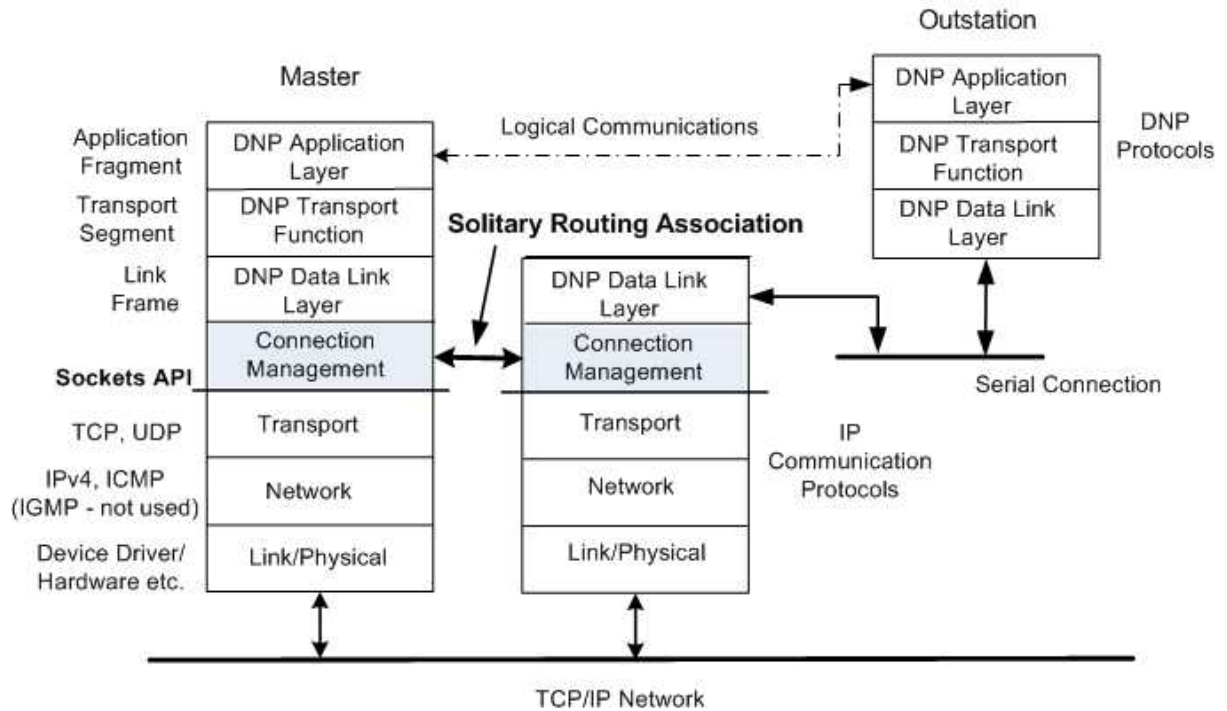
#### Solitary Routing Associations

##### Solitary Routing

Solitary Routing Associations are similar to Paired Routing Associations. Solitary Routing Associations apply to a single pair of nodes that are not the local RTU; one node in the pair is connected serially, and the other node is connected over IP. The Solitary Routing Association stores the information that is required to communicate with the RTU connected over IP. Association for the serially connected node is not necessary; the required information is currently stored in the DNP3 Route table.

The Protocol Stack communications and connection management configuration for Solitary Routing Associations is shown in the figure, below:

## Solitary Routing Association



The status information for Solitary Routing Associations is presented below:

### Solitary Routing Associations

| Source DNP addr | Dest DNP addr | Remote IP address | TCP/UDP Type | Sock/Port Num | Time since last msg | State  |
|-----------------|---------------|-------------------|--------------|---------------|---------------------|--------|
| 750-->1800      |               | 172. 16. 29. 55   | TCP          | 148           | 0:00:04             | ACTIVE |
| 375-->1252      |               | 172. 16. 29. 75   | UDP          | 20000         | 0:00:07             | ACTIVE |

### Security:

DNP3 Secure Authentication: Not configured

AGA12 Encryption for DNP3: Not configured

Master Key: Not set

C:\>

## Related Topics

[DNP3 ASSOCIATION STATES](#)

#### 9.3.4.1 DNP3 ASSOCIATION STATES

There are a number of Association States that apply to these Association Types:

- Local Associations
- Paired Routing Associations
- Solitary Routing Associations

### Association States

The Association States are listed below:

#### Active

The association is complete and fully operational.

#### Pair Pending

This state is valid for paired routing associations, only. The first association of a pair of routing associations is set to Pair Pending when the second association has not been set up correctly. After the second association has been set up correctly, the pair pending association changes to an "active" state.

#### Inactive

The association has become inactive; typically as a result of the socket being closed. New outgoing traffic requiring this association, can usually trigger the negotiation of a new socket. This action moves the association to the "no socket state". Incoming traffic must establish a new socket before being received and this moves the association to the "active" state.

#### No Socket

The association has been set up, but is waiting for the TCP/IP stack to successfully negotiate with the other device to establish a socket. After the socket has been established, the socket moves to the "active" state.

DNP3 associations are applicable to both Ethernet and PPP connections. During variable connection states, that is, when a connection is active/inactive over a keep-alive time interval, DNP3 TCP keep-alive messages are sent only when a TCP connection over IP or PPP is involved.

The DNP3 TCP keep-alive messages are issued on active DNP3 channels according to the configured keep-alive interval. Typically, there is a one-to-one correspondence between a DNP3 channel and a DNP3 association.

Under certain circumstances, in addition to these regular keep-alive messages, an association that is experiencing communication difficulties also triggers the transmission of a DNP3 keep-alive message. When a DNP3 keep-alive message fails, it triggers the closure of an RTU DNP3 channel and this in turn prompts the deactivation of any associations using that channel.

### Related Topics

[DNP3 STATUS ASSOCIATION](#)

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## 9.4 Miscellaneous Commands

- [VER, DIAG, & FILEDIAG](#)<sup>[92]</sup>
- [TIME & WHOAMI](#)<sup>[93]</sup>
- [DATE & Security and AGA12DIAG Commands](#)<sup>[94]</sup>
- [GETCONFIG & GETMAGCFG](#)<sup>[95]</sup>
- [TASKS](#)<sup>[96]</sup>
- [STATUS](#)<sup>[80]</sup>
- [BYE & CLEAR](#)<sup>[96]</sup>
- [RESTART Command](#)<sup>[98]</sup>

### 9.4.1 VER, DIAG, & FILEDIAG

#### VER

The **VER** command displays relevant SCADAPack E version information. The target hardware type is also indicated.

The following display is an example for the SCADAPack ES:

C:\>ver

Model (586) - DNP3 RTU

|               |                       |
|---------------|-----------------------|
| RTU           | Version 7.80 dd/mm/yy |
| DNP           | Version 1.20          |
| ISaGRAF       | Version 3.55          |
| RTOS          | Version G1.13         |
| TCP/IP        | Version 4.1           |
| BOOT MONITOR  | Version 2.13          |
| RTU PAL       | Version 1.2           |
| I/O INTERFACE | Version 2.04          |

The SCADAPack 350E and SCADAPack 357E RTUs display the hardware version of the RTU in addition to the information listed above.

#### DIAG

The **DIAG** command connects the command line to the SCADAPack E RTU Diagnostic Display session & exits the Command Line mode. Use <ESC>, <CTRL>K or <CTRL>\ to return to command line.

A diagnostic display session can also be disconnected from a remote service if required. If the diagnostic display is being currently directed to a command line or TELNET session, the RESTART DIAG command will disconnect the remote user. However if the diagnostic display is currently being directed to an SCADAPack E RTU file, the FILEDIAG 0 command will disable the diagnostic file logging.

#### FILEDIAG

The **FILEDIAG** directs the diagnostic display to a file (**rtudiag.log**). Use FILEDIAG to enable diagnostic file logging and FILEDIAG 0 to disable diagnostic file logging. If a direct serial port or a TELNET session already has an active diagnostic display, they be disconnected using RESTART DIAG.

The FILEDIAG command supports an optional parameter that is used to limit the maximum **size** of the diagnostic file, for example:

**FILEDIAG 10000 <enter>**

Whereby this command would invoke diagnostic file logging, whereby the maximum possible size of the rtudiag.log file is 10000 bytes (10 KB). Once the diagnostic log file exceeds the specified maximum size, the diagnostic file logging would be disabled by the operating system. See Section [Miscellaneous Commands](#) for more information of the use of the FILEDIAG command.

---

### 9.4.2 TIME & WHOAMI

#### Time

The **TIME** command displays RTU clock Time in 24-hour format. For example:  
The time will usually be in UTC time (Dependent on how the time is synchronized)

#### WHOAMI

The **WHOAMI** command displays the following RTU identification information.

C:\>whoami

Schneider Electric ES Model (586) - DNP3 RTU

Serial Number 2581

CPU ID Number xxxxxxxxxxxxxxxx

Ethernet MAC Addr 00-03-74-01-0A-15

Ethernet MAC Addr 2 00-03-74-02-0A-15

Ethernet IP Addr 172.16.15.200 Subnet-Mask 255.255.0.0

Ethernet IP Addr 2 0.0.0.0 Subnet-Mask 0.0.0.0

Enabled IP Services: ISaGRAF/TCP Modbus/IP(client) Modbus/TCP(server) Telnet FTP BOOTP NTP  
104

Licensed Services: AGA Gas Calculations, DNP3 Data Concentrator (unrestricted), Supports Multiple  
DNP3 Masters, Dual Ethernet, IEC60870-5-103 Data Concentrator, IEC60870-5-101/104 Slave, AGA12,  
Authentication SAV2, ISaGRAF, TCP/IP

Main RTU Unit - Group # 0

RTU DNP3 Address # 100 (0064 Hex)

DNP3 Master 1 Address # 30000, Local Address # 100

Mod/TCP Svr Unit ID # 1

RTU Switch Setting # 00 Hex (0 Dec)

Hardware Revision ID # FF Hex

PORT 0 ( 9600 bps): DNP3 - RS232

PORT 1 ( 9600 bps): DNP3 - RS232

PORT 2 ( 9600 bps): DNP3 - RS232

PORT 3 ( 9600 bps): DNP3 - RS232

PORT 4 ( 9600 bps): Command Line

### 9.4.3 DATE & Security and AGA12DIAG Commands

#### Date

The **DATE** command displays RTU clock Date in Day Date/Month/Year (DAY DD/MM/YYYY) format. E.g

Current Date is MON 31/ 5/ 2010

The date will usually be the UTC date (dependent on how the time is synchronized)

#### AGA12DIAG Commands

The **AGA12DIAG** command is used to filter AGA12 diagnostics displays when in Diagnostic Session display mode (use DIAG to access diagnostic mode).

The AGA12DIAG command is described in detail in the *SCADAPack E Security Technical Reference* manual.

---

#### 9.4.4 GETCONFIG & GETMAGCFG

##### GETCONFIG

The **GETCONFIG** command causes the RTU to generate the active RTU configuration into the nominated file in the RTU's file system. This file may be transferred for use with SCADAPack E Configurator, viewed using a text file editor, transferred to another RTU, etc.

An optional parameter specifies how system points are added to the configuration file.

|                      |                                                        |
|----------------------|--------------------------------------------------------|
| GETconfig filename*  | gets configured points & read/write system points      |
| GETconfig filename r | gets configured points & r/w + read only system points |
| GETconfig filename c | gets configured points only (no system points)         |
| GETconfig filename v | gets current values for user points                    |

For example:

**GETconfig MYCONFIG.RTU**

##### GETMAGCFG

The **GETMAGCFG** command is only available on the SCADAPack ER and is used to generate RTU configuration files based on detected I/O Cards. It used primarily as an initial configuration tool whereby the points associated with I/O card channels are auto-created with default attributes, other than the *SLOT / CHANNEL* attribute required to associate the DNP point with the physical channel. There are optional parameters that allow for variations in the point numbering scheme. The syntax of the GETMAGCFG command is as follows

**GETMAGCFG filename [option 1] [option 2]**

Where values for options 1 are:

- s = point mapping according to slot number \* 100 (default)
- e = point mapping according to (slot number - 1) \* 100
- c = contiguous point mapping according to point type
- n = no point mapping

and values for options 2 are:

- 1 = 1 based point mapping (default)
- 0 = 0 based point mapping

Refer to the *SCADAPack E RTU Configuration Technical Reference* manual for more information regarding SCADAPack ER I/O configurations.

### 9.4.5 TASKS

The **TASKS** command displays internal RTU task information including task states, time slice (ms), allocated stack size, priority and scheduled operation counter.

RTU operating system tasks are shown in separate rows.

Columns in the task information are as follows:

SCADAPack ES / SCADAPack ER Task Information:

| <b>TASK<br/>NAME</b> | <b>State</b> | <b>Slice</b> | <b>StkSize</b> | <b>Pri</b> | <b>Sched#</b> |
|----------------------|--------------|--------------|----------------|------------|---------------|
|----------------------|--------------|--------------|----------------|------------|---------------|

SCADAPack 300E Task Information:

| <b>TASK<br/>NAME</b> | <b>State</b> | <b>Slice</b> | <b>StkSize</b> | <b>Free</b> | <b>Pri</b> | <b>Sched#</b> |
|----------------------|--------------|--------------|----------------|-------------|------------|---------------|
|----------------------|--------------|--------------|----------------|-------------|------------|---------------|

**Task Name** shows the internal operating system name for each task

Common task **States** are:

- SLP = Sleeping
- RDY = Ready
- EVT = Event-suspended
- QUE = Queue-suspended
- MBX = Mailbox-suspended
- SEM = Semaphore-suspended
- PIP = Pipe-suspended

**Slice** indicates the maximum task time slice (ms)

**StkSize** indicates the task's maximum stack size (bytes)

**Free** shows the amount of free stack space at the time when the stack was at its peak usage

**Pri** indicates the task's preemption priority (low number = high priority)

**Sched#** indicates the number of time the task has been scheduled to execute since the operating system started.

### 9.4.6 BYE & CLEAR

#### BYE

The **BYE** command disconnects a command line session (except for an RTU port configured for **Cmd Line**. Bye has no effect on a Cmd Line port).

For an ASCII terminal connected to an RTU port configured for ISaGRAF, it returns the port mode from ISaGRAF Shell to ISaGRAF Workbench debugger mode.

For a Telnet terminal connected to a command line session, it terminates the Telnet session.

#### CLEAR

---

The **CLEAR** command takes a service name parameter, and clears and initializes SCADAPack E RTU service data.

The CLEAR command is used as follows:

#### **CLEAR service**

### **⚠ WARNING**

Use this command with care as it can disrupt system operation!

- CLEAR CONFIG - sets the RTU's 'Configuration Corrupt' state to indicate the RTU needs a configuration download. This does not actually alter any configuration.
- CLEAR EVENTS - clears non-volatile DNP3 Slave event lists. Does not clear IEC60870-5 protocol events
- CLEAR ISAGRAF - clears ISA\* files from the file system and stops ISaGRAF user application(s).
- CLEAR FACTORY - initializes RTU configurations. Causes the equivalent of a [FACTORY BOOT](#)<sup>[37]</sup> on SCADAPack 300E controllers only. This command can only be issued locally from a serial port configured as CMDLINE.

For CLEAR ISAGRAF, an optional parameter indicates which ISaGRAF Target Kernel to clear.

Also see Section [Removing ISaGRAF Applications](#)<sup>[142]</sup> ([CLEAR ISAGRAF Initialization](#))<sup>[142]</sup>.

- CLEAR ISaGRAF - stops and clears both ISaGRAF Target applications
- CLEAR ISaGRAF 1 - stops and clears ISaGRAF Target 1 application
- CLEAR ISaGRAF 2 - stops and clears ISaGRAF Target 2 application

### 9.4.7 RESTART Command

The **RESTART** command restarts various SCADAPack E RTU services.

Restarting services will impact process control and RTU availability. Assess the impact prior to performing a restart operation.

#### WARNING

##### UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment monitored and controlled by the SCADAPack E RTU prior to restarting services.

**Failure to follow these instructions can result in death, serious injury or equipment damage.**

The RESTART command is used as follows:

**RESTART service [param]**

where [param] is an optional parameter that may be used with some services.

To avoid accidental RESTART operation, the **service** name needs to be entered in full.

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RESTART CONFIG  | rebuilds the RTU point database configuration on-line. The configuration file used to rebuild the point database is specified as a parameter. Files need to be of type <b>.RTU</b> for complete configuration files, or <b>.INC</b> for incremental update files.<br>For example: RESTART CONFIG NEWCONFIG.RTU<br><br>The result of the RTU re-configuration or update is available in file CONFIG.LOG in the RTU's file system. |
| RESTART DIAG    | resets a remote diagnostic display session and returns the remote session to Command-line mode (Telnet remote diagnostic display session & ISaGRAF Shell diagnostic display session).                                                                                                                                                                                                                                            |
| RESTART DNP     | re-initializes the DNP3 driver (equivalent to SCADAPack E Configurator <i>Reinitialize DNP3</i> and a DNP3 Warm Restart message)                                                                                                                                                                                                                                                                                                 |
| RESTART ISaGRAF | restarts nominated ISaGRAF target(s) sequencing & control task operations (equivalent to an ISaGRAF workbench application stop/start). An optional parameter indicates which ISaGRAF Target Kernel to restart.<br>RESTART ISaGRAF - restarts both ISaGRAF Targets<br>RESTART ISaGRAF 1 - restarts ISaGRAF Target 1<br>RESTART ISaGRAF 2 - restarts ISaGRAF Target 2                                                              |
| RESTART MASK    | clear reset reason, task watchdog mask and RTU System Error code points<br>(see <a href="#">STATUS</a> <sup>80</sup> command)                                                                                                                                                                                                                                                                                                    |
| RESTART PROFILE | re-initialise the time Profiler operations, re-reading profile files                                                                                                                                                                                                                                                                                                                                                             |
| RESTART RTU     | equivalent to SCADAPack E Configurator <i>Restart Controller</i> and DNP3 Cold Restart message (causes a hardware reset)                                                                                                                                                                                                                                                                                                         |

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RESTART SAMPLER     | restarts trend sampler task operations finalising current sample files                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| RESTART HISTORY     | restarts trend sampler task operations, finalising current sample files, and automatically appends trend sample files to a history file called HISTORY.<br>Eg. RESTART HISTORY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| RESTART PATCH       | <p>takes a file-name with ".BIZ" or ".BIP" extension as a parameter.<br/>Starts the RTU's Boot Monitor and applies the compressed RTU firmware binary image file (.BIZ extension) or firmware patch file (.BIP extensions) to the operating system Flash EEPROM. By default, the RTU will also further download and apply the patch file to each "on-line" SCADAPack ES Remote I/O units<br/>e.g. RESTART PATCH 751e586.biz</p> <p><b>This command results in a restart of the RTU.</b> The RTU will retain its point database configurations and ISaGRAF applications, but operation of the RTU is initialised. For more information see <i>SCADAPack E Firmware Update User Manual</i>.</p> |
| RESTART TCP_SERVICE | <p>restarts nominated TCP Service Port(s) (aborts TCP socket connection on RTU). An optional parameter indicates which port to restart.</p> <p>RESTART TCP_SERVICE                    - restarts TCP Service ports<br/>RESTART TCP_SERVICE 0                - restarts TCP Service on Port 0<br/>...<br/>RESTART TCP_SERVICE 4                - restarts TCP Service on Port 4</p> <p>For more information see <i>SCADAPack E TCP/IP Technical Reference</i>.</p>                                                                                                                                                                                                                             |
| RESTART LICENCE     | <p>Updates license features in the RTU as specified in the license file.<br/>Requires additional argument, which specifies the name of the license file, e.g.</p> <p>RESTART LICENCE 2581rtu.lic</p> <p>The RTU needs to be restarted after executing this command in order for the licensed features to be activated. The WHOAMI command can be used to determine the currently licensed features in the RTU.</p>                                                                                                                                                                                                                                                                            |
| RESTART IOFIRM      | <p>takes a file-name with <b>.BIN</b> extension as a parameter.<br/>Programs the SCADAPack ER RTU I/O Processor FLASH ROM with a new I/O Processor binary image file (.BIN extension).<br/>For example:    RESTART IOFIRM m386v101.bin</p> <p>For more information see the <i>SCADAPack E Firmware Update User Manual</i>.</p>                                                                                                                                                                                                                                                                                                                                                                |

- RESTART S101 re-initializes the IEC60870-5-101 and -104 Slave driver. This forces the driver to load new configuration parameters.  
For more information see *SCADAPack E Telemetry IEC 60870-5-101 Slave and IEC 60870-5-104 Slave Technical Reference* manual.
- RESTART BOOTMON takes a file-name with ".BIN" extension as a parameter.  
Programs the SCADAPack E RTU Boot Monitor FLASH ROM with a new Boot Monitor binary image file (.BIN extension). By default, the RTU will download and apply the Boot Monitor binary file to each "on-line" SCADAPack ES Remote I/O units
- For example: RESTART BOOTMON mon\_206.bin
- This command results in a restart of the SCADAPack E RTU.** The RTU will retain its point database configurations and ISaGRAF applications, but operation of the RTU is initialised. For more information see *SCADAPack E Firmware Update User Manual*.
-

## 9.5 PLC Protocol Diagnostic Command

The **PLCDIAG** command is used by the SCADAPack E to enable RTU system displays when communicating with PLC or peripheral devices. Typically, these devices communicate with the RTU via serial ports configured for PLC Device mode, or via the optional SCADAPack E RTU Ethernet link. It also permits display of RTU communications when using ISaGRAF or Modbus communications.

PLC protocol diagnostics are displayed in SCADAPack E RTU Diagnostic Display Session mode (use the **DIAG** command from the SCADAPack E RTU command line to return to the diagnostic display session). Hexadecimal format is used to display protocol data bytes.

The format of PLCDIAG command is:

**PLCDIAG mode filter [filter ....]**

Where: mode = ENABLE DISABLE

Where: filter = \* RX TX COMM\_ERR PLC\_ERR ISaGRAF MODBUS(ISaGRAF) MODTCP-SRV

Using RTU diagnostics can have an impact on system performance. It is suggested that diagnostics be disabled when not in use. The following system diagnostic filters can be individually enabled or disabled, and are retained in non-volatile memory.

|                 |                                                                                                                                                                                                                                                                     |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *               | Filters enabled / disabled.                                                                                                                                                                                                                                         |
| RX              | Protocol data displayed as received by the RTU from a PLC via "PLC Device" port or Ethernet link.                                                                                                                                                                   |
| TX              | Protocol data displayed as transmitted by the RTU to a PLC via "PLC Device" port or Ethernet link.                                                                                                                                                                  |
| COMM_ERR        | Warnings displayed on communication errors between RTU and PLC<br>(E.g. no response, timeout, connection success / failure)                                                                                                                                         |
| PLC_ERR         | Warnings displayed on errors returned by PLC.                                                                                                                                                                                                                       |
| ISaGRAF         | Receive and transmit data displayed by the RTU from a communication device on the RTU's "ISaGRAF" port. This mode is useful when diagnosing ISaGRAF communications. For more information see the <i>SCADAPack E ISaGRAF Technical Reference</i> manual.             |
| MODBUS(ISaGRAF) | Receive and transmit data displayed by the RTU from a communication device on the RTU's "ISaGRAF 2" port. This mode is useful when diagnosing ISaGRAF workbench communications. For more information see the <i>SCADAPack E ISaGRAF Technical Reference</i> manual. |
| MODTCP-SVR      | Receive and transmit data displayed by the RTU for Open Modbus/TCP protocol from a communications device connecting to the RTU's Modbus/TCP server. For more information see the <i>SCADAPack E ISaGRAF Technical Reference</i> manual.                             |
| MOD_SLAVE       | Receive and transmit data displayed by the RTU from a communication device on the RTU <b>Modbus Slave</b> port. This mode is useful when diagnosing Modbus communications where the RTU is connected to a Modbus master.                                            |

### 9.5.1 Example PLC Protocol Diagnostics

Outbound PLC messages are indicated as <--

Inbound link messages are indicated as -->

PLC protocol diagnostics display varies according to the protocol driver, but is displayed in a format similar to the following example:

```
<--Modbus Master- 02 01 00 00 00 10 3D F5
-Modbus Master--> 02 01 02 00 00 FD FC
<--Modbus Master- 03 01 00 12 00 10 9D C3
MODBUS>>No response from PLC #3
```

In this example,

```
<--Modbus Master- indicates TX data to a PLC,
-Modbus Master--> indicates RX data from a PLC,
MODBUS>> indicates communication or PLC errors.
```

Error numbers 101..108 may be displayed when the PLC\_ERR filter is enabled. Meanings of these errors are described in the relevant *SCADAPack E PLC Interface* manuals.

---

## 9.6 System Diagnostic Command

The **SYSDIAG** command is used by the SCADAPack E RTU to enable system level displays when in Diagnostic Mode (use DIAG at the command prompt to enter or return to diagnostic mode).

The format of SYSDIAG command is:

**SYSDIAG mode filter [filter ....]**

Where: mode = ENABLE DISABLE

Where: filter = \* MEM OVERRIDE TIME VT IO

Using RTU diagnostics can have some impact on system performance. It is suggested that diagnostics be disabled when not in use.

The following system diagnostic filters can be individually enabled or disabled, and are retained in non-volatile memory.

\* Filters enabled / disabled

MEM RTU system memory statistics display (updated in DIAG mode every 60 secs):

```
System Memory>>free: 2200392, size: 3163804
                    highest: 0x11e02b8, PDB Mem: 0x13efefc
                    total blocks: 467, free blocks: 9
                    bytes allocated: 952180, largest free block:
2175228
                    allocations: 139526, deallocations: 139068, diff:
458
```

The memory free and memory system size statistics are also available through RTU analog system points 50022 and 50021 (32-bit analogs).

The RTU automatically performs memory system diagnostics regardless of the state of diagnostic display session.

The RTU may restart under low memory conditions, setting appropriate Reset Reason masks. For more information see [Reset Reasons](#)<sup>163</sup>.

**highest:** indicates a high water mark of allocated memory. This does not necessarily correspond with available memory, due to possible memory fragmentation.

**PDB Mem:** indicates the lower boundary of the point database configuration memory. This is internal information. A more useful point database configuration size can be obtained through analog system point 50023.

**Total blocks** and **free blocks** can be used to gauge memory fragmentation.

**Allocations**, **deallocations** and **diff** (the difference) can be used to gauge memory activity

OVERRIDE Forces a configured **Cmd Line** port on the RTU into diagnostic mode at RTU start-up. Requires a SCADAPack E RTU port to be set in *Cmdline* mode. This is useful for capturing complete RTU start-up diagnostics and for capturing operational RTU diagnostics after an RTU restart.

SYSDIAG ENABLE OVERRIDE is equivalent to SCADAPack E Configurator's *Commands | Execute Command | Enable Startup Diagnostics*

When this mode is enabled, the output diagnostic display session indicates the following

text during start-up:

```
C:\>** Forcing Diagnostics **
```

- |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TIME | Displays RTU current time (once per minute) in the output diagnostic information:<br><br>Current Time is 14:52:36                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| VT   | Displays Virtual Terminal diagnostics for data transmitted to / and received from a <b>DNP VT Service</b> port. This diagnostic filter is useful for analyzing DNP3 Virtual Terminal transactions. These diagnostics specify the number of bytes transferred and the direction of the data transfer. A typical diagnostic is displayed as follows<br><br>DNP VT>> Port 0 ---> DNP (201 bytes)<br><br>Each transaction can be time-stamped if the <b>DNPDIAG</b> filter, <b>TIME</b> , is enabled. For more information see <a href="#">Time display for other Diagnostic messages</a> <sup>78</sup> .                                |
| IO   | Relevant for SCADAPack ER hardware only. Displays diagnostics corresponding to significant transactions between the main CPU and the I/O processor CPU, including I/O Card loaded events, and output controls.<br>For example:<br><br>IO_INTERFACE>> 'Startup' event detected on SCADAPack ER IO Interface<br>IO_INTERFACE>> Card Type 0x22 (version 3) detected on local rack (slot 5)<br>IO_INTERFACE>> Card Type 0x20 (version 2) detected on local rack (slot 9)<br>IO_INTERFACE>> Card Type 0x21 (version 2) detected on local rack (slot 11)<br>IO_INTERFACE>> 'IO Scan Completed' event detected on SCADAPack ER IO Interface |
| 5000 | Relevant for SCADAPack 300E hardware only. Displays statistics corresponding to 5000 Series I/O updates.<br>For example:<br><br>5000_IO>>Average scan time: 40, max 40, min 40 ms                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
-

## 9.7 TCP/IP COMMANDS

A range of command line facilities are provided by the SCADAPack E RTU for managing, configuring and diagnosing TCP/IP operation.

- [PPPECHO Command](#)<sup>[106]</sup>
- [Command Line PING](#)<sup>[107]</sup>
- [TCPDIAG Command](#)<sup>[108]</sup>

### 9.7.1 PPPECHO Command

To query the state of a single PPP interface on the SCADAPack E RTU, the **PPPECHO** command is provided at the command line. Similar to STATUS PPP, PPPECHO sends an LCP ECHO to a peer PPP device and reports the status of the PPP link.

It takes the following parameters:

**PPPECHO interface-port [timeout (ms)] [echo-size]**

Where:

|                |                                                                                                |
|----------------|------------------------------------------------------------------------------------------------|
| interface-port | is the interface port number listed in ROUTE PRINT                                             |
| timeout        | is an optional timeout in milli-seconds to wait for LCP ECHO response from the peer PPP device |
| echo-size      | is the number of bytes to send in the LCP ECHO                                                 |

Example:

**PPPECHO 2**

PPPecho Success

Sent a LCP ECHO request to PPP interface 2 and got a successful response

---

### 9.7.2 Command Line PING

The PING command issues an ICMP ECHO command to a remote IP address. The SCADAPack E RTU provides a command line ping interface.

Syntax for usage of PING from the RTU command line is as follows:

```
PING [-t] [-n count] [-l size] [-i TTL] [-w timeout] dest-ip
```

Where:

- t indicates continuous ping until interrupted by **<ESC>**
- n count indicates *number* of ping requests to send
- l size indicates size of ping packet in *bytes* (up to ~1400)
- i TTL indicates time-to-live in *seconds* for ping packet
- w timeout indicates timeout in *milliseconds* waiting for response
- dest-ip is the destination IP address to be pinged

Parameters are optional other than dest-ip, which is mandatory.

The ping request is sent out an interface on the RTU with a corresponding subnet, or according to routes in the RTU's IP Routing Table.

Example:

This example Pings address 192.168.0.57 five (5) times with 128 byte ping packets, waiting up to 300ms for each ping response.

```
PING -n 5 -l 128 -w 300 192.168.0.57
```

```
Pinging 192.168.0.57 with 128 bytes of data:
```

```
Reply from 192.168.0.57: bytes=128 time=120ms
```

```
Reply from 192.168.0.57: bytes=128 time=110ms
```

```
Reply from 192.168.0.57: bytes=128 time=130ms
```

```
Reply from 192.168.0.57: bytes=128 time=120ms
```

```
Reply from 192.168.0.57: bytes=128 time=120ms
```

```
Ping statistics for 192.168.0.57:
```

```
Packets: Sent = 5, Received = 5, Lost = 0 (0% loss),
```

```
Approximate round trip time in milli-seconds:
```

```
Minimum = 110ms, Maximum = 130ms, Average = 120ms
```

### 9.7.3 TCPDIAG Command

The **TCPDIAG** command displays diagnostics from the TCP/IP stack on the RTU. It takes the following parameters:

**TCPDIAG mode filter [filter...]**

Where mode = ENABLE or DISABLE

Where filter = \* ARP BOOTP DNP PPP SLIP SERVERS TCP TCP\_SERVICE RX  
GPRS/1xRTT

By default TCP/IP diagnostics are disabled. Filters, which are enabled for TCP/IP communications are stored in non-volatile memory & are retained by the SCADAPack E RTU when it restarts.

Enabling TCP/IP diagnostics may impact system performance. It is suggested that TCP/IP diagnostics be disabled when not in use.

The following filters can be individually enabled or disabled, and are retained in non-volatile memory.

|             |                                                                                                         |
|-------------|---------------------------------------------------------------------------------------------------------|
| *           | Filters enabled / disabled                                                                              |
| ARP         | Address Resolution Protocol messages, such as retries & timeouts                                        |
| BOOTP       | Bootstrap Protocol messages, such as loading IP addr to Ethernet device                                 |
| DNP         | DNP over IP messages including IP addresses, UDP/TCP transport, ports                                   |
| PPP         | Point-to-point protocol messages, including LCP & IPCP negotiation and hardware handshaking diagnostics |
| SLIP        | SLIP and CSLIP error messages                                                                           |
| SERVERS     | FTP, Telnet, Modbus/TCP & Web server messages, including connection, disconnection                      |
| TCP         | Other TCP/IP stack diagnostics including TCP transport errors                                           |
| TCP_SERVICE | TCP Service Port messages, including connections, disconnection                                         |
| RX          | Receive message information (eg. for TCP_SERVICE)                                                       |
| GPRS/1xRTT  | GPRS and 1xRTT dialler diagnostics, including modem responses.                                          |

Take care when enabling TCP/IP diagnostics for Telnet remote display (see Section [Telnet Command Line](#)<sup>114</sup>). Enabling TCP/IP diagnostics locally can also display large amounts of text, affect performance of the RTU, and reduce the effectiveness of the diagnostic display.

The following are examples of setting TCP/IP diagnostic filters:

**TCPDIAG ENABLE BOOTP PPP**

**TCPDIAG ENABLE TCP\_SERVICE RX**

## 9.8 TCP/IP ROUTE Commands

The SCADAPack E command line provides an interface to the IP Routing table.

While the RTU is not a complete TCP/IP router, it provides a series of packet forwarding and IP gateway services.

The supported routing table interface commands are:

|                             |                                                         |
|-----------------------------|---------------------------------------------------------|
| ROUTE PRINT                 | - prints IP interface information and active IP routes  |
| ROUTE ADD                   | - adds entries to the IP route table                    |
| ROUTE DELETE                | - removes entries from the IP route table               |
| ROUTE CYCLE-DEFAULT-GATEWAY | - cycles between multiple default-gateway route entries |

For more information on IP routing using SCADAPack E RTUs, see the *SCADAPack E TCP/IP Technical Reference* manual.

### 9.8.1 ROUTE PRINT

ROUTE PRINT displays the configured IP interfaces, and the current routing table entries. For example:.

C:\>route print

Interface List:

10: ETHERNET IP Addr: 172.16.15.200 Subnet-Mask: 255.255.0.0  
 11: ETHERNET 2 IP 0.0.0.0 Subnet-Mask: 0.0.0.0  
 Addr:

Routes:

| Type    | Destination-IP | Net-mask      | Gateway-IP    | I/face | Metric | TTL |
|---------|----------------|---------------|---------------|--------|--------|-----|
| NETWORK | 172.16.0.0     | 255.255.0.0   | 172.16.15.200 | 10     | 1      | 999 |
| GATEWAY | 10.10.10.0     | 255.255.255.0 | 10.10.10.4    | 10     | 1      | 999 |

Route Priority: HOST NETWORK GATEWAY DEFAULT-GW

The interface list indicates the following information:

- RTU interface number - same as RTU port number for serial ports (e.g. 0 - 7), 10 & 11 for Ethernet ports
- interface type (PPP, ETHERNET, etc.)
- IP address and sub-net mask for each interface.

The interface number is used in the route entry description and is the destination interface to which the routed IP packet is sent if the destination routing criteria are met.

The route list indicates the following information for each route:

- type of route
- destination IP address
- network mask
- gateway-IP (IP address of node through which these routed packets will be sent)
- interface number (as for the interface list)
- metric (cost of a route entry, lowest cost is chosen where there are multiple matching routes for a particular packet)
- time-to-live - lifetime of the route entry before it is removed from the route table

A TTL (time-to-live value) of "999" represents an infinite lifetime STATIC route. A number other than 999 indicates the remaining lifetime of a DYNAMIC route (in seconds). The dynamic route entry will be automatically deleted if the entry is not used to route a packet in that remaining time.

When routing IP frames, the routing priority order between overlapping entries is as shown at the end of the ROUTE PRINT display. I.e. a HOST entry has priority over a NETWORK entry, etc.

For more information on route types and meaning of fields for each route type see *SCADAPack E TCP/IP Technical Reference* manual.

### 9.8.2 ROUTE ADD

ROUTE ADD manually adds a route to the IP routing table.

Routes added manually using the ROUTE ADD command or IP\_ADD ISaGRAF function are not stored in the SCADAPack E RTU's non-volatile memory, and are lost upon RTU restart.

Routes that need to be retained permanently by the RTU should be entered in the RTU's IP Route Table using SCADAPack E Configurator.

The route added may be STATIC or DYNAMIC depending upon the value of the TTL time-to-live field. Leaving out the TTL parameter or setting TTL to 0 creates a STATIC route.

Where a TTL parameter is specified (in seconds) thereby creating a DYNAMIC route, the time-to-live timer is restarted for the route entry each time a new packet is routed by that entry. When the timer expires, effectively after routing inactivity, the route entry is automatically deleted from the routing table. The remaining time-to-live for route entries can be displayed using the ROUTE PRINT command.

The syntax of the ROUTE ADD command is:

ROUTE ADD dest-ip [MASK net-mask] [g/way-ip] IF interface-port [METRIC metric] [TTL time-to-live]

Examples follow for each of the route entry types:

Adding a HOST route entry:

```
ROUTE ADD 158.234.169.151 MASK 255.255.255.255 IF 2
```

(Host IP address specified with all 1's mask)

Adding a NETWORK route entry:

```
ROUTE ADD 158.234.170.0 MASK 255.255.255.0 IF 2
```

(Sub-network IP address specified with subnet mask)

Adding a GATEWAY route entry:

```
ROUTE ADD 192.168.10.0 MASK 255.255.255.0 192.168.0.247 IF 5
```

(Sub-network IP address and subnet mask specified with Gateway host IP address)

Adding a DEFAULT GATEWAY route entry:

```
ROUTE ADD 0.0.0.0 192.168.0.248 IF 5
```

(All 0's IP address specified with Gateway host IP address)

The destination IP address should be entered appropriately for the type of route that is being added. E. g. a NETWORK route entry with mask 255.255.255.0 should have a destination IP address of the format *nnn.nnn.nnn.0*. Use of an invalid destination IP address in a manually added route may result in the inability to manually delete the route entry!

The ISaGRAF function IP\_ADD is provided by the SCADAPack E RTU to provide an equivalent facility for adding route entries to the IP Routing Table.

For more information see SCADAPack E ISaGRAF Function Blocks Reference manual.

### 9.8.3 ROUTE DELETE & CYCLE-DEFAULT-GATEWAY

#### ROUTE DELETE

The syntax of the ROUTE DELETE command is as follows.

```
ROUTE DELETE dest-ip net-mask
```

The destination IP address and network mask need to be entered exactly as they were when the route was created (e.g. via ROUTE ADD, IP\_ADD ISaGRAF function or via SCADAPack E Configurator IP Routing Table).

Use ROUTE PRINT to determine the destination IP and network mask of the entry that is to be deleted.

If the route was incorrectly entered initially, it may not be possible to delete the route. In this case, reconfiguring the route correctly and/or restarting the RTU may be necessary to tidy up the route table.

Any route may be manually deleted from the RTU route table including routes added by:

- RTU interface configurations
- Automatic route configuration
- SCADAPack E Configurator IP route configurations
- Manual ROUTE ADD from command line
- ISaGRAF IP\_ADD function

The ISaGRAF function IP\_DEL is provided by the SCADAPack E RTU to provide an equivalent facility for deleting route entries from the IP Routing Table.

For more information see *SCADAPack E ISaGRAF Function Blocks Reference* manual.

Routes removed manually using the ROUTE DELETE command or IP\_DEL ISaGRAF function are not removed from the SCADAPack E RTU's permanent configuration as set by SCADAPack E Configurator, and may be restored upon RTU restart.

Routes that are to be removed permanently should also be removed from the RTU's IP Route Table using the SCADAPack E Configurator.

#### ROUTE CYCLE-DEFAULT-GATEWAY

The syntax of this command is as follows.

```
ROUTE CYCLE-DEFAULT-GATEWAY
```

Where multiple Default Gateway route entries are present in the routing table, this command results in manually cycling to the next default gateway. Where only a single, or no default gateway entries are present, this command has no effect.

An ISaGRAF function IP\_CYCGW is provided by the SCADAPack E RTU to provide an equivalent facility for cycling default gateway route entries.

For more information see *SCADAPack E ISaGRAF Function Blocks Reference* manual.

---

## 9.9 TELNET Operation

The SCADAPack E RTU provides a TELNET Server for connection to a user's TELNET terminal. The user's terminal is a TELNET Client.

When enabled using the RTU **Enabled IP Services** system point, the SCADAPack E RTU opens a Telnet server listener socket on TCP port number 23 and multiple TELNET sessions may be opened to different SCADAPack E RTUs across the same network link.

In addition, multiple TELNET sessions may be opened to an SCADAPack E RTU through the same inbound PPP-TCP/IP interface and/or Ethernet interface, and simultaneously on different inbound interfaces.

The SCADAPack E RTU Telnet Server supports simultaneous connection of up to 5 Telnet Clients to the one SCADAPack E RTU. Further connection requests beyond this limit are rejected.

The command line Diagnostics output may be displayed using TELNET. Diagnostics are provided on a best effort basis. The TELNET server might not keep up with the diagnostic data provided by other tasks. If this occurs, bytes are dropped by the server and do not appear in the diagnostic output in the TELNET client. Should this situation occur, it is suggested to reduce diagnostics output by filtering unnecessary messages. See the SCADAPack E Operational Reference manual for further details.

- [TELNET Command Line](#)<sup>[114]</sup>
- [TELNET Inactivity &](#)<sup>[115]</sup> [Exiting TELNET](#)<sup>[115]</sup>

### 9.9.1 TELNET Command Line

Upon successful connection of the TELNET client to the SCADAPack E TELNET server, the following banner is displayed:

```
RTU Telnet Monitor (DNP: xxxxx)
C:\>
```

Where (DNP: xxxxx) is the DNP3 node address of the SCADAPack E RTU that the Telnet Client has connected to.

Standard RTU Command line commands are available at the C:\> prompt. See Section [Telnet Command Line](#)<sup>114</sup>. The EDIT command is NOT supported by the remote TELNET command line.

While the SCADAPack E RTU supports multiple command line Telnet sessions simultaneously, the Diagnostic Display Session can only be connected to one user terminal at a time (either a local RTU port configured in Command line using DIAG, or one remote Telnet session using DIAG).

Where another command line has the Diagnostic Display Session connected, the following message is displayed on the requesting command line:

```
Diagnostic display already in use
Use RESTART DIAG to disconnect remote user
```

When it is desired to cancel the remote user's diagnostic display session (usually for the purposes of enabling it on the current session), use the **RESTART DIAG** command:

```
C:\> DIAG
Diagnostic display already in use
Use RESTART DIAG to disconnect remote user
C:\> RESTART DIAG
C:\> DIAG
Connecting to diagnostic display. Use <ESC> to disconnect
.....
<ESC>
Disconnected from Diagnostic Display
C:\>
```

### 9.9.2 TELNET Inactivity & Exiting TELNET

#### TELNET Inactivity

The SCADAPack E TELNET Server times-out user sessions following 5 minutes of consecutive inactivity on the telnet session. A remote disconnection message similar to the following may be displayed on the Telnet Client when this occurs.



Telnet inactivity disconnection is enforced when the user's Telnet session is in Command mode.

If the user's Telnet session is in Diagnostic Display mode, the inactivity timeout is not applied, and the user's session may continue indefinitely.

When using the PING command from a Telnet session in Command mode, the use of the "-t" option for continuous Ping operation is NOT regarded as Telnet user activity. The Telnet Server WILL disconnect the user's Telnet session after 5 minutes.

#### Exiting TELNET

To close a TELNET session with the RTU's TELNET Server, use the Command Line "BYE" command.

The following will be displayed on the TELNET terminal:

```
C:\> BYE  
Goodbye from RTU Telnet
```

The TELNET client is disconnected from the RTU TELNET server.

## 9.10 BOOTP Configuration

The SCADAPack E RTU provides a BOOTP Server for configuration of remote devices such as Ethernet I/O modules. The remote device needs to be a BOOTP Client to use this RTU facility.

The RTU can be configured so that it loads fixed IP addresses from the RTU to one or multiple remote Ethernet devices. Loading the IP address to a remote device is the only BOOTP facility supported by the SCADAPack E RTU.

When BOOTP server is enabled using the RTU's Enabled IP Services system point, the SCADAPack E RTU opens a BOOTP server listener socket on UDP port number 67. Multiple BOOTP client sessions may request a bootstrap configuration from a BOOTP server. When a configuration request is received by the RTU for a known matching Ethernet MAC address, the SCADAPack E RTU loads the corresponding IP address to that remote device.

A BOOTP configuration table is provided in the SCADAPack E RTU for up to 20 BOOTP records, each record containing 1 (remote) Ethernet MAC address, and 1 (remote) IP address. The BOOTP configuration table is held in non-volatile SCADAPack E RTU memory, enabling configurations to persist when the RTU is powered-down.

The SCADAPack E command line provides an interface to the BOOTP configuration table.

SCADAPack E Configurator also provides an interface to the BOOTP configuration. See Section [BOOTP DELETE & Configuration \(BOOTP Configuration\)](#)<sup>[118]</sup>.

Changes to the BOOTP configuration table take effect IMMEDIATELY not requiring a restart of the RTU.

The supported BOOTP configuration table interface commands are:

- BOOTP PRINT      - prints BOOTP active records
- BOOTP ADD        - adds or replaces records in the BOOTP route table
- BOOTP DELETE    - removes records from the BOOTP route table

For more information on BOOTP, see the *SCADAPack E TCP/IP Technical Reference* manual.

---

### 9.10.1 BOOTP PRINT & ADD

#### BOOTP PRINT

BOOTP PRINT displays the configured BOOTP records. For example:

BOOTP entries:

| Ethernet MAC Addr | IP Addr Loaded | Load Count |
|-------------------|----------------|------------|
| 000054100421      | 192.168.0.202  | 1          |

The Ethernet-MAC-Addr and IP-Addr-Loaded fields shown are as configured for the BOOTP Configuration table via the [BOOTP ADD](#) command or via SCADAPack E Configurator.

For user indication, the **Load Count** parameter increments each time the BOOTP server sends an IP address in a response to the remote device.

#### BOOTP ADD

BOOTP ADD adds a record to the BOOTP configuration table.

Configuration records that are added using this command ARE retained permanently by the RTU in non-volatile memory. Changes still should be read from the RTU's BOOTP Configuration Table (e.g. using SCADAPack E Configurator) as a record of the RTU's permanent configuration.

The syntax of the ROUTE ADD command is as follows.

BOOTP ADD remote-MAC remote-IP

The remote-MAC address should be labeled on the device for which the SCADAPack E RTU is going to load the corresponding remote-IP address. The remote MAC address may known by different terminology, such as **IEEE Global Address** or **Ethernet Address** for example.

Ethernet MAC addresses contain 12 hexadecimal digits. They may be entered for BOOTP, in any of the following example formats (case insensitive):

00:1A:2B:3C:4D:5E

00-1A-2B-3C-4D-5E

001A2B3C4D5E

IP address entry needs to be in the following format (leading zeroes not required):

192.168.1.97

If either the remote-MAC address or remote-IP corresponds exactly to those already in the BOOTP list, the BOOTP record is replaced with the new information. This mechanism can be used, for example, when a remote I/O device is replaced in the field, and the SCADAPack E RTU needs to know the device's new Ethernet MAC address in order to load its fixed IP address to continue its operation.

### 9.10.2 BOOTP DELETE & Configuration

#### BOOTP DELETE

The syntax of the ROUTE DELETE command is as follows.

BOOTP DELETE remote-MAC

or

BOOTP DELETE remote-IP

The remote address (either MAC or IP address) needs to be entered exactly as when the BOOTP record was created using the BOOTP ADD command or via the SCADAPack E Configurator BOOTP Configuration Table. Use BOOTP PRINT to determine the remote MAC or remote IP address of the entry that is to be deleted.

#### BOOTP Configuration

The SCADAPack E Configurator **Advanced TCP/IP** page provides a user interface for BOOTP server configuration.

The screenshot shows a window titled "BOOTP Server" containing a "BOOTP Table". The table has two columns: "Hardware Address" and "IP Address". It contains two rows of data and four empty rows for additional entries. A vertical scrollbar is on the right side of the table.

|   | Hardware Address | IP Address    |
|---|------------------|---------------|
| 1 | 000054100421     | 192.168.0.202 |
| 2 | 000054100755     | 192.168.0.203 |
| 3 |                  |               |
| 4 |                  |               |
| 5 |                  |               |
| 6 |                  |               |

Enter the BOOTP client details in the table, in the same format as described in the [BOOTP PRINT & ADD](#) <sup>[117]</sup> [\(BOOTP ADD\)](#) <sup>[117]</sup> command, above. The "Hardware Address" field is the Ethernet-MAC address in one of the three formats described. The configured "IP Address" is configured in the device with the specified hardware address.

Changes to the BOOTP Table in the SCADAPack E Configurator should be followed by WRITE RTU CONFIGURATION. BOOTP Table changes become active in the SCADAPack E RTU immediately upon configuration download (i.e. no need to restart the RTU).

## 9.11 NTPDIAG Command

The **NTPDIAG** command displays diagnostics from the NTP (Network Time Protocol) daemon. It takes the following parameters:

**NTPDIAG mode filter [filter...] [param]**

Where mode = ENABLE or DISABLE

Where filter = \* DEBUG [level] LOG

By default NTP diagnostics are disabled. Filters, which are enabled for NTP operations are stored in non-volatile memory & are retained by the SCADAPack E RTU when it restarts.

Enabling NTP diagnostics may impact system performance. It is suggested that NTP diagnostics be disabled when not in use.

The following filters can be individually enabled or disabled, and are retained in non-volatile memory.

\* Filters enabled / disabled

DEBUG [level] Sets NTP debugging level 0...9

LOG Stores NTP debugging information in a log file as well as displaying it to the RTU's diagnostic stream.

For more information on NTP diagnostics, debug levels and log files, see the *SCADAPack E TCP/IP Technical Reference* manual.

## 9.12 Remote Command Line (Virtual Terminal)

The SCADAPack E RTU provides a Remote Command Line (Virtual Terminal) to access the standard RTU command line interface.

This functionality is implemented using DNP3 virtual terminal objects and no additional configurations are required beyond a standard DNP3 connection.

One of the main benefits of the Remote Command Line interface is that it remotely extends the command line interface to outstations connected by DNP3 links.

A Remote Command Line (Virtual Terminal) window is available in SCADAPack E Configurator to access the RTU remote command line functionality.

[Figure 8.1](#) displays the SCADAPack E Configurator interface. Consult the **SCADAPack E Configurator Users Manual** for more information.

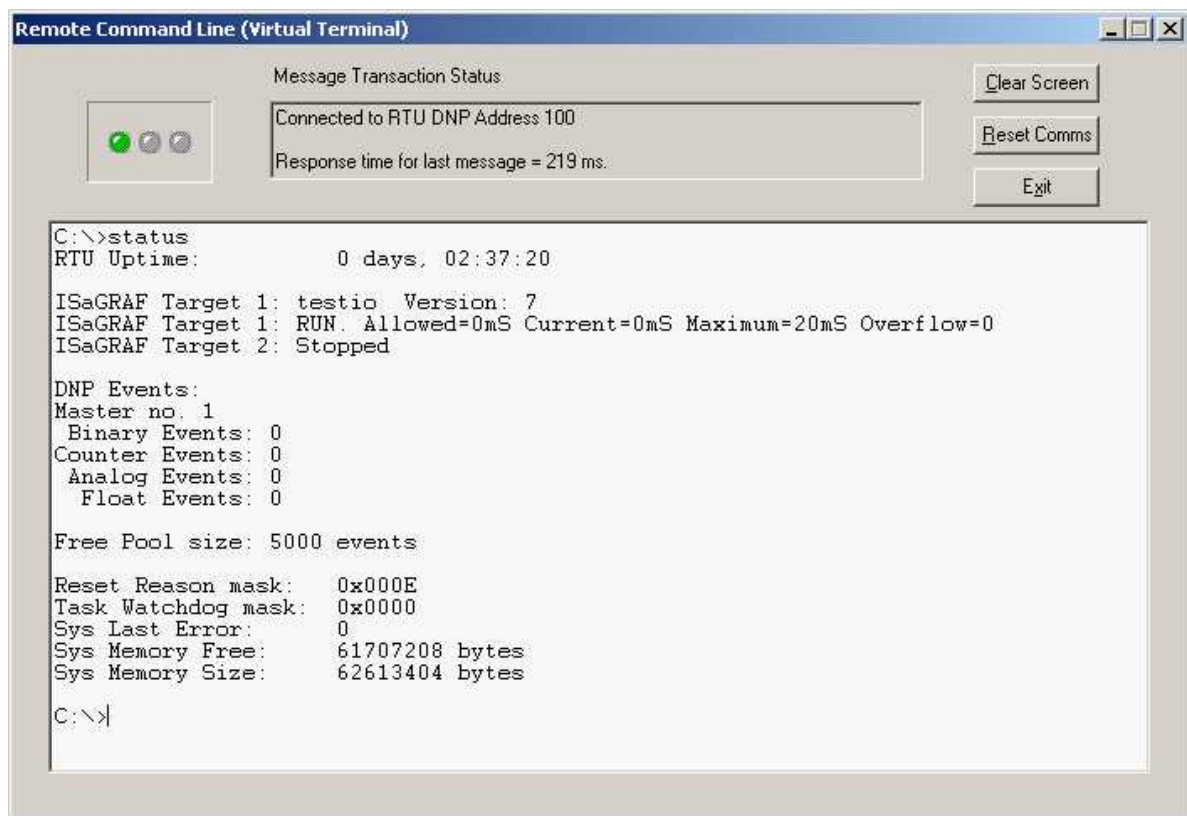


Figure 8.1: SCADAPack E Configurator Remote Command Line Window

The response to a Remote Command Line request is limited to a single DNP3 fragment. Therefore there is a response size limitation of approximately 2000 bytes. If the response data cannot be fully returned as a result of this limitation, the response is truncated and appended with the following text, **[Response Truncated]**.

### 9.12.1 Successful Connection Indicators & Unsupported Commands

#### Successful Connection Indicators

On a request to open a **Remote Command Line** session in SCADAPack E Configurator, a DNP Write request is sent containing a virtual terminal object 112 on virtual terminal port number 20. The content of this WRITE request is a **carriage return (ASCII 0x0D)**.

An RTU that supports the Remote Command Line functionality will respond to this request with a virtual terminal object 113 containing an appropriate prompt, **C:\>**.

For more information on DNP3 virtual terminal support in the SCADAPack E RTU, consult the *SCADAPack E DNP3 Technical Reference* manual.

The display of the prompt in the SCADAPack E Configurator Remote Command Line window indicates a successful connection has been made and that the RTU supports the remote command line functionality. The successful connection indicators are listed as follows

- The traffic light indicator goes Green.
- A valid prompt is displayed in the **text transfer** window
- The message transaction status window displays a successful response message indicating the DNP address of the RTU and the response transaction time (in ms).

The Red traffic light indicator and an appropriate error message in the message transaction status window indicate an unsuccessful transaction.

#### Unsupported Commands

Not every available SCADAPack E command-line command is supported via this interface.

In particular the DIAG command is not supported over a Remote Command Line session. Other interactive commands may also not be supported.

As DIAG mode is not supported, diagnostic output can be remotely acquired using the FILEDIAG command, which directs the diagnostic information to an SCADAPack E file in the RTU. This can be retrieved later using DNP3 file transfer.

See [Diagnostic File Logging \(FILEDIAG\)](#)<sup>[122]</sup> for more information on the FILEDIAG command.

### 9.13 Diagnostic File Logging (FILEDIAG)

The diagnostic display can be directed to an SCADAPack E file, **rtudiag.log** with the use of the FILEDIAG command.

The diagnostic display can only be directed to a single service at any given time, and so if the diagnostic mode is already enabled in the RTU, it will have to be disabled before diagnostic file logging can commence.

If the FILEDIAG command is invoked while a diagnostic display session is active, the following message will be displayed

Diagnostic display already in-use

Use RESTART DIAG to disconnect remote user

The available commands are as follows:

**FILEDIAG [filesize]** This command is used to enable diagnostic file logging. Note that filesize is an optional parameter. If not specified, there is no specified maximum limit for the size of the log file (rtudiag.log). If filesize is specified, the diagnostic file logging will be disabled by the operating system if the size of rtudiag.log exceeds the filesize. Activating diagnostic file logging will overwrite any previously acquired **rtudiag.log** file.

**FILEDIAG 0** This command is used to disable diagnostic file logging.

A *FILEDIAG* request with no maximum file size specified will be characterised by the following messages:

Diagnostic File Logging Commenced (c:\rtudiag.log). Max size not restricted

Use command FILEDIAG 0 to disable

A *FILEDIAG* request that specifies a maximum log file size, e.g. **FILEDIAG 12000**, will be characterised by the following messages:

Diagnostic File Logging Commenced (c:\rtudiag.log). Max size = 12000 bytes

Use command FILEDIAG 0 to disable

A **FILEDIAG 0** request to disable diagnostic file logging will be characterised by the following message

Diagnostic File Logging Disabled

---

The current status of diagnostic file logging can be determined using the STATUS command, i.e. if diagnostic file logging is active, the STATUS command will indicate this, along with the current size of the **rtudiag.log** file, similar to the following example. If diagnostic file logging is NOT active, there will be no reference to the rtudiag.log file in response to the STATUS command

```
C:\>status
```

```
RTU Uptime:      0 days, 02:59:39
```

```
ISaGRAF Target 1: testio Version: 7
```

```
ISaGRAF Target 1: RUN. Allowed=0ms Current=10ms Maximum=20ms Overflow=0
```

```
ISaGRAF Target 2: Stopped
```

```
DNP Events:
```

```
Master no. 1
```

```
Binary Events: 0
```

```
Counter Events: 0
```

```
Analog Events: 0
```

```
Float Events: 0
```

```
Free Pool size: 5000 events
```

```
Reset Reason      0x000E
```

```
mask:
```

```
Task Watchdog     0x0000
```

```
mask:
```

```
Sys Last Error:    0
```

```
Sys Memory Free: 61707176 bytes
```

```
Sys Memory Size: 62613404 bytes
```

```
Diagnostics currently logged to file rtudiag.log (341 bytes)
```

### 9.13.1 Sample Diagnostic Log File & Hardware Specific Conditions

In DNP3 diagnostic messages:

Inbound link messages are indicated as --->

Outbound link messages are indicated as <---

Inbound application layer information is indicated as ===>

Outbound application layer information is indicated as <===

Outbound user layer information is indicated as <+++

#### Sample Diagnostic Log File

The log file (**rtudiag.log**) includes both a header and footer that indicates the time at which logging was commenced / ceased, in addition to which service issued the enable / disable command. A sample rtudiag.log file is shown as follows

Logged file diags (rtudiag.log) started at 14:37:19 on 24-02-2004 (by Cmd Line)

```
----> [32000] APPLICATION HEADER - WRITE
          First:1 Final:1 Confirm:0 Sequence:03
```

```
<---- [32000] APPLICATION HEADER - RESPONSE TO REQUEST
          First:1 Final:1 Confirm:0 Sequence:03 IIN:0x9020
```

```
System Memory>> free: 1645683, size: 1906172
          highest: 0xb116f1, PDB Mem: 0xc9ffa7
```

```
----> [32000] APPLICATION HEADER - WRITE
          First:1 Final:1 Confirm:0 Sequence:04
```

```
<---- [32000] APPLICATION HEADER - RESPONSE TO REQUEST
          First:1 Final:1 Confirm:0 Sequence:04 IIN:0x9020
```

```
----> [32000] APPLICATION HEADER - WRITE
          First:1 Final:1 Confirm:0 Sequence:05
```

Logged file diags (rtudiag.log) stopped at 14:38:24 on 24-02-2004 (by VT Cmd)

The header and footer of this log file identifies which service had invoked the request to enable or disable logging. They are listed as follows

- Cmd Line (direct serial connection)
- VT Cmd (Remote Command Line over DNP3)
- SYSTEM (Operating System due to file size restriction)

#### Hardware Specific Conditions

The C: drive in the SCADAPack E RTU resides in FLASH memory and has a limited capacity, while the D: drive is a RAM drive with less capacity but higher performance. Because of the relatively slow access to the C: drive (FLASH), the active diagnostic log file is written to the **volatile** D: drive at run-time.

When the **FILEDIAG 0** command is issued to disable diagnostic file logging, the **rtudiag.log** file on the

D: drive is closed and copied to the root of the C: drive. The size limitation on the D: driver therefore limits the maximum size of the diagnostic file.

Actively collected **log file diagnostics** are volatile in the SCADAPack E RTU until explicitly saved to the C: drive by the user disabling log file diagnostics, or by the SYSTEM closing the file (e.g. when the RAM DRIVE is becoming full).

See [File System Overview](#)<sup>[68]</sup> for information on file system sizes.

## 9.14 IEC 60870-5-101 / -104 Diagnostic Command

The **S101DIAG** command is used to verify and diagnose IEC 60870-5-101 and -104 communications between the RTU (as a Slave) and the connected Master when in Diagnostic Session display mode (use DIAG to enter diagnostic mode).

The format of the S101DIAG command is:

S101DIAG mode filter [filter ....]

Where: mode = ENABLE DISABLE

filter = \* APPL BYTES LINK TIMESTAMP USER

Enabling IEC 60870-5-101 diagnostics can have some impact on system performance. It is suggested that these diagnostics be disabled when not in use.

For an example of a EIC 60870-5-101 / -104 diagnostics session see the [Link, Application and User Layer Diagnostics](#)<sup>[126]</sup> topic.

The command filters can be individually enabled or disabled (they are retained in NV memory).

|           |                                                                                                              |
|-----------|--------------------------------------------------------------------------------------------------------------|
| *         | All typically used filters enabled/disabled (excludes enabling BYTES, DBASE which can be enabled separately) |
| APPL      | IEC 60870-5-101 Application Layer information                                                                |
| BYTES     | Bytes displayed for enabled protocol layers (requires LINK and/or APPL filters to be enabled)                |
| LINK      | LINK 60870-5-101/-104 Link Layer packet header information                                                   |
| TIMESTAMP | Time of IEC 60870-5-101 message diagnostic                                                                   |
| USER      | user application response information                                                                        |

**9.14.1 Link, Application, and User Layer Diagnostics**

The following sections are examples of filtered diagnostic information where the RTU Link and ASDU (common) address is 21.

These example diagnostics are time-stamped (i.e. TIMESTAMP filter has been enabled).

Inbound link messages are indicated as --->

Outbound link messages are indicated as <----

Inbound application layer information is indicated as ~~~>

Outbound application layer information is indicated as <~~~

Outbound user layer information is indicated as <===

**Link Layer Diagnostics (including Bytes)**

...> PORT0      Primary Frame - Request User Data Class 2  
DIR(0) PRM(1) FCV(1) FCB(0) ADDR(21)

10 5b 15 00 70 16

<... PORT0      Secondary Frame - Respond Data Not Available  
DIR(0) PRM(0) DFC(0) ACD(0) ADDR(21)

10 09 15 00 1e 16

**Application Layer Diagnostics**

~~~> Master 1      Addr(21) Sector(21) Application Header, Clock synchronization command  
Quantity(1) SQ(0) COT(6, activation)

<~~~ Master 1 Addr(21) Sector(21) Application Header, Clock synchronization command
Quantity(1) SQ(0) COT(7, positive activation confirmation)

User Layer Diagnostics

<=== Master 1 Insert request in queue: Background Response

9.15 IEC 60870-5-103 Diagnostic Command

The **M103DIAG** command is used to filter IEC 60870-5-103 Master diagnostics when in Diagnostic Session display mode (use DIAG to return to diagnostic mode from the command line).

The format of the M103DIAG command is:

M103DIAG mode filter [filter]

Where: mode = ENABLE DISABLE

filter = * APPL BYTES DBAS LINK TIMESTAMP USER

Enabling IEC 60870-5-103 diagnostics can have some impact on system performance. It is suggested that these diagnostics be disabled when not in use.

The following filters can be individually enabled or disabled (they are retained in non-volatile memory).

| | |
|-----------|---|
| * | Filters enabled / disabled |
| APPL | 60870-5-103 Application Layer information |
| BYTES | 60870-5-103 Link Layer packet bytes (requires LINK filter) |
| DBAS | Displays data / object information included in slave response |
| TIMESTAMP | Time of 60870-5-103 message diagnostic |
| USER | user application request & response information |

9.15.1 Link & Application Layer Diagnostics

The following sections are examples of filtered diagnostic information for messages to / from Slave address 7.

These example diagnostics are time-stamped (i.e. TIMESTAMP filter has been enabled).

Outbound link layer messages are indicated as <...

Inbound link messages are indicated as ...>

Outbound application layer information is indicated as <~~~

Inbound application layer information is indicated as ~~~>

Link Layer Diagnostics

| | |
|--------------------------|--|
| 16:40:28.448: <... PORT1 | Primary Frame - Request User Data Class 2 |
| 16:40:28.448: | DIR(0) PRM(1) FCV(1) FCB(1) ADDR(7) |
| 16:40:28.498: ...> PORT1 | Secondary Frame - Respond Data Not Available |
| 16:40:28.498: | DIR(0) PRM(0) DFC(0) ACD(0) ADDR(7) |

Application Layer Diagnostics

| | |
|--------------------------|---|
| 16:46:14.634: <~~~ PORT1 | Addr(7) Sector(7) Application Header, General interrogation |
| 16:46:14.634: | Quantity(1) SQ(1) COT(9, general interrogation) |
| 16:46:14.734: ~~~> PORT1 | Addr(7) Sector(7) Application Header, Time-tagged message |
| 16:46:14.735: | Quantity(1) SQ(1) COT(9, general interrogation) |

9.15.2 Database & User Diagnostics

Database information is indicated as @@@>

Outbound user layer information is indicated as <===

Inbound user layer information is indicated as ===>

Database Diagnostics

```
16:48:05.150: @@@> PORT1      Addr(7) Sector(7) Store Type Id 3, Measurands I
16:48:05.150:                      Quantity(4) SQ(1) COT(1, spontaneous)
16:48:05.150:                      Measurands I type 128 number 148
16:48:05.151:                      measurand =      4095
16:48:05.151:                      measurand =      4096
16:48:05.151:                      measurand =         0
16:48:05.151:                      measurand =     2730
```

User Diagnostics

```
16:49:37.859: <=== PORT1      Insert request in queue: Time Synch Command Initiated By User

16:49:37.959: ===> PORT1      Addr(7) Sector(7) Result Of Request For
16:49:37.959:                      Time Synchronization Command Initiated By User
16:49:37.960:                      Quantity(1) SQ(0) COT(8, time synchronization)
```

9.16 TCP Service, NTP GPS Rcvr. Ports, & None

TCP Service Port

Any SCADAPack E RS232 serial port may be configured as a **TCP Service** port. Multiple TCP Service ports may be used simultaneously on the same RTU.

A TCP Service port can operate in either client or server mode.

Multiple TCP Service ports may operate in any mixture of client & server modes on the same RTU.

For more information about configuring and using TCP Service ports, see the *SCADAPack E TCP/IP Technical Reference* manual.

NTP GPS Receiver Port

"**NTP GPS Rcvr.**" ports may be assigned to any RTU port.

An RTU can receive information from a NMEA-0183 compatible GPS receiver via this port, and can synchronize its clock using NTP.

The RTU can then function as an NTP time server for other networked RTUs.

An NTP configuration file is required to be loaded to the RTU for NTP operations.

For more information consult the *SCADAPack ETCP/IP Technical Reference* manual document.

None

An RTU port configured as **NONE** will have no communication functions available.

10 ISaGRAF Operation

- [*ISaGRAF Status*](#)^[132]
- [*ISaGRAF Storage*](#)^[133]
- [*Target 5 Validation*](#)^[134]
- [*Transferring ISaGRAF Applications*](#)^[137]
- [*Removing ISaGRAF Applications*](#)^[142]
- [*ISaGRAF Retained Variable Storage*](#)^[143]

10.1 ISaGRAF Status

The status of IEC 61131-3 applications in a SCADAPack E Smart RTU can be viewed using the SCADAPack E Configurator Logic / IEC 61131-3 property page.

IEC 61131-3 Target

ISaGRAF Target Type: Target 5 (SCADAPack E Workbench)

IEC 61131-3 Resource 1 Status

Application Information

Name:

Version:

Size:

Start Time: --/--/----
--:--:--

Status:

Scan Times

Current (ms):

Maximum (ms):

IEC 61131-3 Resource 2 Status

Application Information

Name:

Version:

Size:

Start Time: --/--/----
--:--:--

Status:

Scan Times

Current (ms):

Maximum (ms):

The following RTU system points are provided to indicate the status of the ISaGRAF Target tasks and applications within the RTU.

| Point Type | Point Number | Description | User Access |
|----------------------|--------------|--------------------------------------|-------------|
| System Binary Points | 50100 | Target/resource 1 Application Halted | Read Only |
| | 50101 | Target/resource 2 Application Halted | Read Only |
| | 50104 | Target/resource 1 Task Started | Read Only |
| | 50105 | Target/resource 2 Task Started | Read Only |

| | | | |
|----------------------|-------|--|------------|
| | 50150 | Target/resource 1 Application Incorrect Checksum | Read Only |
| | 50151 | Target/resource 2 Application Incorrect Checksum | Read Only |
| System Analog Points | 52000 | Target/resource 1 Application Version | Read Only |
| | 52001 | Target/resource 1 Application Size | Read Only |
| | 52002 | Target/resource 1 Application Load Time | Read Only |
| | 52003 | Target/resource 1 current scan time | Read Only |
| | 52004 | Target/resource 1 maximum scan time since last reset | Read/Write |
| | 52005 | Target/resource 1 number of cycle overflows | Read Only |
| | 52006 | Target/resource 1 configured cycle time | Read Only |
| | 52007 | Target/resource 2 Application Version | Read Only |
| | 52008 | Target/resource 2 Application Size | Read Only |
| | 52009 | Target/resource 2 Application Load Time | Read Only |
| | 52010 | Target/resource 2 current scan time | Read Only |
| | 52011 | Target/resource 2 maximum scan time since last reset | Read/Write |
| | 52012 | Target/resource 2 number of cycle overflows | Read Only |
| | 52013 | Target/resource 2 configured cycle time | Read Only |
| System String Points | 50100 | Target/resource 1 Application Name | Read Only |
| | 50101 | Target/resource 2 Application Name | Read Only |

10.2 ISaGRAF Storage

The SCADAPack E RTU provides several storage mechanisms for ISaGRAF applications and application data.

Target 3 (ISaGRAF 3 Workbench)

ISaGRAF uses the SCADAPack E Smart RTU file system in Non-volatile memory and FLASH memory to store its applications. An application loaded from the Workbench Debugger will be stored in the following files:

RTU ISaGRAF Application File: **isa11** (first ISaGRAF kernel target)
RTU ISaGRAF Application File: **isa21** (second ISaGRAF kernel target)

Under some circumstances (e.g. for very large ISaGRAF application files) the RTU may store an additional copy of the ISaGRAF Application Files in the file system. These would be saved as a read-only file named "**isa11_backup**" and/or "**isa21_backup**". If these files are present, they should not be deleted by the user.

ISaGRAF application *Retained Variables* are also stored for each ISaGRAF target in Non-Volatile SCADAPack E RTU memory.

Target 5 (SCADAPack Workbench)

SCADAPack Workbench uses the SCADAPack E Smart RTU file system in Non-volatile memory and FLASH memory to store its applications. An application loaded from the SCADAPack Workbench will be stored in files in the ISaGRAF5 folder. Files in this folder may be in use and should not be deleted individually by the user. Deleting all files will erase both Resource 1 and Resource 2.

ISaGRAF application *Retained Variables* are also stored for each resource in Non-Volatile SCADAPack E RTU memory.

10.3 Target 5 Validation

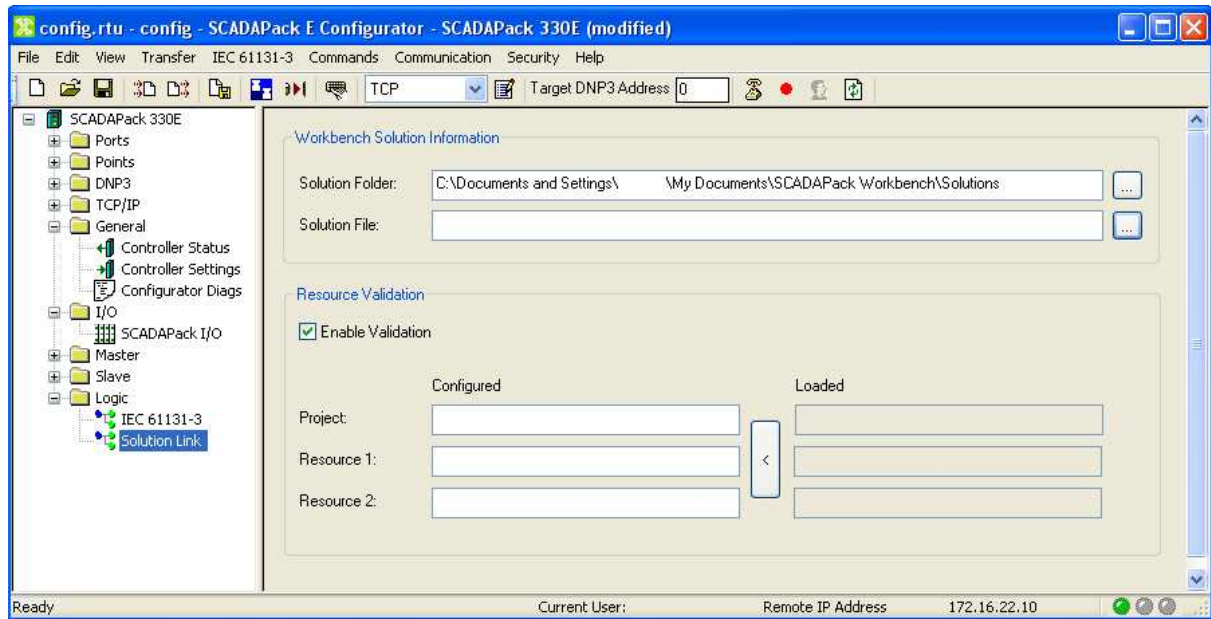
The Solution Link allows a closer coupling of both the operation of the RTU configuration and the IEC61131-3 logic application. The Solution Link Page contains the information required to link a solution file to configuration file and to validate the IEC 61131-3 (Target 5) resources based on both the configured project and resource names.

The solution link:

- Allows starting the logic editor and opening the application that matches the RTU configuration
- Validates that the correct application is loaded into the RTU prior to run-time

The Solution Link page applies to Target 5 projects only.

You can configure this validation feature in the RTU through the SCADAPack E Configurator in the **Logic/Solution Link Page** as shown below.



The Solution Link Page is divided into two groups, **Workbench Solution Information** and **Resource Validation**.

The **Workbench Solution Information** group contains two fields; the Solution Folder field accommodates different operating systems, and the Solution File field contains the relative path of the *.isasIn file. The default directory is C:\. . .<AppData>\SCADAPack Workbench\Solutions. Use the Browse icon to select a new directory and file path name.

Use the **Resource Validation** group in the Solution Link Page to ensure that the loaded Resources are identical to the configured Resources in the RTU.

- Checking the **Enable Validation** checkbox enables the Configured and Loaded Project names, and both the Resource 1 and 2 configured and loaded names
- The **Refresh** icon refreshes DNP3 requests through all corresponding system points
- Linking a Workbench Solution file to a configuration file is recommended practice

There are four Resource fields in the **Resource Validation** group of the Solution Link Page:

- Resource 1, Configured name
- Resource 1, Loaded name
- Resource 2, Configured name
- Resource 2, Loaded name

In addition, there are 2 Project name fields in the **Resource Validation** group of the Solution Link Page:

- Project, Configured name
- Project, Loaded name

The Target 5 configured Project and Resource names are verified against the Target 5 loaded Project and Resource names. In the **Workbench Solution Information** group, a Workbench file can be automatically linked to configuration file by providing a **Workbench Project name**. Together with the locally stored Workbench folder path, the full path of the Workbench solution can be derived to automatically open the Solution file when Workbench is launched from Configurator. In addition, it automatically detects the I5P package file when writing the IEC 61131-3 resource to the RTU from the Configurator.

Validation is performed when the RTU is restarted or reset, and upon execution of a RESTART ISAGRAF command. Validation is not performed when resources are downloaded from SCADAPack Workbench. Validation may be unsuccessful even if the resource was running after download from Workbench. It is recommended to test the validation by restarting the IEC 61131-3 Target 5 using the RESTART ISAGRAF command and verifying resources are running. Alternatively restart the RTU to test the validation.

WARNING

LOSS OF CONTROL

Execute the RESTART ISAGRAF command or restart the RTU and verify IEC 61131-3 resources are running.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Executing the RESTART ISAGRAF command or restarting the RTU will impact process control and RTU availability. Assess the impact prior to performing a restart operation.

WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment monitored and controlled by the SCADAPack E RTU prior to restarting.

Failure to follow these instructions can result in death, serious injury or equipment damage.

For further information, refer to the related topics and documents below:

- SCADAPack E [RTU System Error Code Values](#)^[152] topic in the SCADAPack E Operational Reference manual
- Logic Folder/Solution Page topic in the SCADAPack E Configurator User manual
- RTU System Points topic in the Configuration Technical manual

The following RTU system points are provided to indicate the resource validation of the Workbench Solution Information in the RTU.

| Point Type | Point Number | Description | User Access |
|----------------------|--------------|--|--------------------------|
| System Binary Points | 50160 | Resource Validation Enabled (binary)

IEC 61131-3 Resource Validation is enabled in the RTU when this point is 1; disabled if the point value is 0. When Resource Validation is enabled, the loaded target 5 project, Resource 1, and Resource 2 names are compared to the configured project and both resource names. If the names match, validation is successful; otherwise, validation fails and the IEC 61131-3 resources will not run. | Read/Write
(checkbox) |
| System String Points | 50110 | Configured Resource 1 Name (string)

The name of the configured Resource 1. This is the value that will be compared against the "Loaded Resource 1 Name" if Resource Validation is enabled (checked). | Read/Write |
| System String Points | 50111 | Configured Resource 2 Name (string)

The name of the configured resource 2. This value is compared against the "Loaded Resource 2 Name" if Resource Validation is enabled (checked). | Read/Write |
| System String Points | 50120 | Configured Project Name (string)

The name of the configured project. This value is compared against the "Loaded Project Name", if Resource Validation is enabled (checked). | Read/Write |
| System String Points | 50121 | Loaded Project Name (string)

This Read-Only point is the name of the project currently loaded in the RTU. | Read Only |
| System String Points | 50122 | Workbench Solution File (string)

The relative path of the SCADAPack Workbench solution file linked to the configuration file. The full path of the Workbench solution file can be derived from this point value along with the "Solution Folder" string stored locally on your PC. | Read/Write |

10.4 Transferring IEC 61131-3 Applications

Target 3 (ISaGRAF 3 Workbench)

A target application produced by the ISaGRAF Workbench for a SCADAPack E RTU is stored in the following file on the Workbench computer (for Intel targets):

C:\ISAWINIESeries\SMP\project_name\appli.x8m

The ISaGRAF application may be transferred to an RTU by one of several means:

- ISaGRAF Workbench Debugger via Serial port, TCP/IP, or DNP3 Virtual Terminal objects
- Using FTP file transfer and DNP3 commands
- Using SCADAPack E Configurator Write Application feature
- Using DNP3 file transfer and DNP3 commands

These mechanisms are described in detail in the *SCADAPack E ISaGRAF Technical Reference* manual. The following sections describe the operation of the last two mechanisms.

Following transfer of an ISaGRAF application to an SCADAPack E RTU the SCADAPack E Configurator Logic / IEC 61131-3 property page should be read to check version information and confirm the application is executing. The SCADAPack E Configurator REFRESH toolbar button can be used to update this information on demand.

Target 5 (SCADAPack Workbench)

The IEC 61131-3 project is stored in the file system of the Workbench computer. The I5P file is a package containing all the files needed to load the project. The I5P file is located in the project folder. For example:

C:\Documents and Settings\UserName\My Documents\SCADAPack Workbench\Projects\ProjectName\ProjectName\SCADAPack300E.I5P

The IEC 61131-3 project may be transferred to an RTU by one of several means:

- Using SCADAPack Workbench via Serial port or TCP/IP
- Using FTP file transfer and DNP3 commands
- Using SCADAPack E Configurator Write Application feature
- Using DNP3 file transfer and DNP3 commands

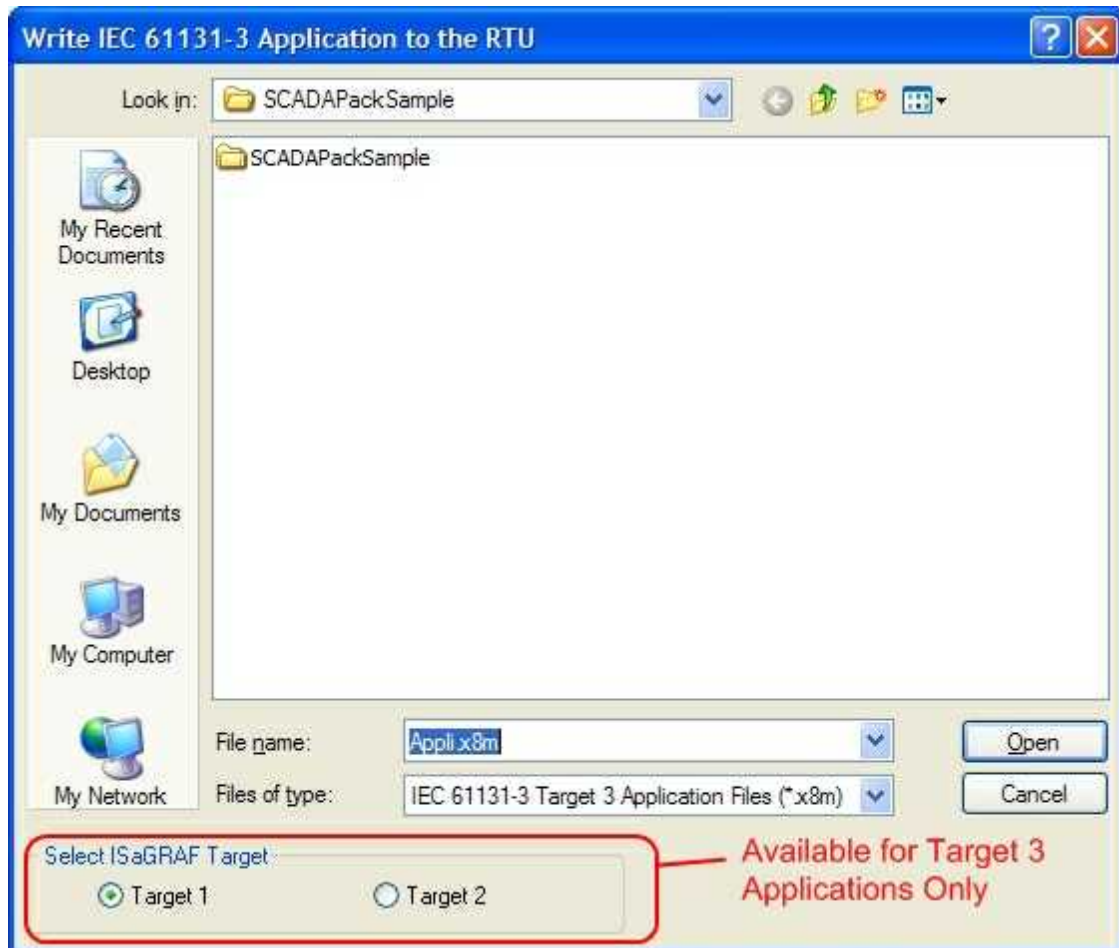
These mechanisms are described in detail in the *SCADAPack E Target 5 Technical Reference* manual. The following sections describe the operation of the last two mechanisms.

Following transfer of an IEC 61131-3 project to an SCADAPack E Smart RTU the SCADAPack E Configurator Logic / IEC 61131-3 property page should be read to check version information and confirm the application is executing. The SCADAPack E Configurator REFRESH toolbar button can be used to update this information on demand.

10.4.1 SCADAPack E Configurator Download ISaGRAF Application

The SCADAPack E Configurator provides an automated ISaGRAF application download facility. The result of using this facility is similar to downloading from Workbench. A significant difference is that the SCADAPack E Configurator mechanism permits a new application to be transferred whilst the original application continues to run in the SCADAPack E Smart RTU.

If there is insufficient free space in the RTU's file system, manual file manipulation, such as described in the following section, may be required. In this case the operation of the existing application is not affected.



Target 3 (ISaGRAF 3 Workbench)

The Write Application command transfers a file named appli.x8m, to the target RTU, renames the file in the RTU to isa11 or isa21 (depends on to which ISaGRAF target is being written), and the restarts the individual ISaGRAF kernel. When selected, the command opens the Download ISaGRAF Application to the RTU dialog.

The **Look in:** edit box specifies the folder location of the appli.x8m file to be written to the target RTU. ISaGRAF Workbench stores compiled application files as:

C:\ISAWIN\SMP\XXXXXXX\appli.x8m

Where XXXXXXXX is the project name of the ISaGRAF application.

For example the appli.x8m file for a project named MSTR_SFC would be found in the folder C:\ISAWIN\SMP\MSTR_SFC.

The **File name:** edit box specifies the compiled ISaGRAF application file appli.x8m.

The Select ISaGRAF Target section has two selections, Target 1 and Target 2. The SCADAPack E RTU supports the simultaneous execution of up to two ISaGRAF target kernels on the same RTU. This allows up to two independent ISaGRAF applications to execute simultaneously on the same RTU. For further information on ISaGRAF targets refer to the SCADAPack E ISaGRAF Technical User and Reference manual.

Select **Target 1** or **Target 2** as the destination target for the application download.

Select **Open** to select the file and begin the application download.

Select **Cancel** to close the dialog and cancel the Download Application command.

Target 5 (SCADAPack Workbench)

The Write Application command transfers on .I5P file to the RTU, unpacks one or two resources from the file into the ISAGRAF5 folder, and restarts the resources. When selected, the command opens the Download ISaGRAF Application to the RTU dialog.

The **Look in:** edit box specifies the folder location of the file to be written to the target RTU. SCADAPack Workbench stores compiled solutions as .I5P files. This file contains all the information for Resource 1 and Resource 2 (if present).

The **File name:** edit box specifies the compiled solution file *.I5P.

Select **Open** to select the file and begin the application download.

Select **Cancel** to close the dialog and cancel the Download Application command.

10.4.2 DNP3 File Transfer for ISaGRAF Applications

DNP3 File Transfer and File commands may be used to download ISaGRAF applications to a SCADAPack E RTU. This may be carried out by manually using facilities provided by SCADAPack E Configurator, or used by a Master Station to transfer ISaGRAF applications to a SCADAPack E RTU.

For Target 3 the APPLI.X8M file can be copied to a file called **isa11** or **isa21** and transferred across the DNP3 link using the DNP3 File Object into the SCADAPack E RTU using SCADAPack E Configurator or by a master station. **isa11** is used for ISaGRAF target 1, **isa21** is used for ISaGRAF target 2.

For Target 5 the I5P file contains both resources. The file does not have to be renamed to transfer it.

Once the file has been successfully transferred to the RTU, the ISaGRAF task(s) will need to be restarted in order for the new application to be activated.

With very large applications, and depending upon the available file system space in the RTU, it may not be possible to maintain the old application file while transferring the new application file. In this case delete the old file before transferring. This will not affect the operation of the existing application until the Restart ISaGRAF command is issued.

Saving the Previous Application

Particularly when using this method manually, it is often a good idea to rename (or keep a copy if RTU

file system space allows) of the old ISaGRAF application prior to loading a new one.

The following operations are suggested for Target 3.

```
Transfer > Write file                isawin\smpl\appl-name\appli.x8m
Commands > Execute Command > Other del isa.old
Commands > Execute Command > Other rename isa11 isa.old
Commands > Execute Command > Other rename appli.x8m isa11
Commands > Restart Services          Restart Target 1
```

The following operations are suggested for Target 5.

```
Commands > Execute Command > Other del FileName.old
Commands > Execute Command > Other rename FileName.I5P FileName.old
Transfer > Write file                FileName.I5P
Commands > Execute Command > Other Restart ISaGRAF FileName.I5P
```

Running the Application

Restarting services will impact process control and RTU availability. Assess the impact prior to performing a restart operation.



WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment monitored and controlled by the SCADAPack E RTU prior to restarting services.

Failure to follow these instructions can result in death, serious injury or equipment damage.

ISaGRAF can be restarted to use the new application by one of several means:

1. Restart the SCADAPack E RTU (hardware reset, DNP3 Cold Restart or command line RESTART RTU command)
2. Restart the ISaGRAF application from the Workbench Debugger using Stop Application/Start Application commands
3. Use a RESTART ISaGRAF command line instruction
4. Issue an SCADAPack E Configurator or host File Exec command with parameters RESTART ISaGRAF.

When the file is validated it is loaded into SCADAPack E RTU non-volatile memory and execution begins.

10.5 Removing ISaGRAF Applications

The SCADAPack E RTU maintains a FLASH memory copy of the ISaGRAF application(s) as well as the file system copy (isa11 for target 1, isa21 for target 2). To completely delete ISaGRAF applications from the RTU, perform one of the following steps.

CLEAR ISaGRAF Initialization

Using SCADAPack E Configurator Commands / Execute facility, or an RTU command line, issue a **CLEAR ISAGRAF** command. It may take one of the following forms:

| | |
|-----------------|---|
| CLEAR ISAGRAF | user applications stopped and removed for both ISaGRAF target kernels |
| CLEAR ISAGRAF 1 | user application stopped and removed for 1st ISaGRAF target kernel only |
| CLEAR ISAGRAF 2 | user application stopped and removed for 2nd ISaGRAF target kernel only |

RTU configurations, other than the ISaGRAF application, are not affected by this initialization.

To replace an ISaGRAF application with a new application does NOT require the existing application to be deleted.

For more information see *SCADAPack E ISaGRAF Technical Reference* manual.

F1 ISaGRAF Initializations (SCADAPack ES and SCADAPack ER only)

Place the SCADAPack ES or SCADAPack ER RTU hex switches in **F1** initialize mode, power the RTU Off & On, return the hex switches to their original value, and restart the RTU. This deletes the *isa** files in the SCADAPack E RTU file system and FLASH memory and initializes the retained variable area.

RTU configurations, other than the ISaGRAF application, are not affected by the **F1** initialization.

To replace an ISaGRAF application with a new application does not require the existing application to be deleted.

For more information see *SCADAPack E ISaGRAF Technical Reference* manual.

10.6 ISaGRAF Retained Variable Storage

ISaGRAF application **Retained Variables** are stored in Non-Volatile memory in the RTU and upon start-up of an ISaGRAF application, retained variable values are loaded from the NV-RAM retained variable area to initialize the ISaGRAF application variables. In addition, changes to the retained variable values made by the ISaGRAF application are copied to the NV-RAM retained variable memory area, at the end of each ISaGRAF application scan.

Retained variables also persist across a firmware patch, using the RESTART PATCH command.

For more information on ISaGRAF retained variables, in general, see the Retained Variables section in the *SCADAPack E ISaGRAF Technical Reference* manual.

The ISaGRAF storage in the retained variable memory area is in the following format:

Table 9.2: ISaGRAF Retained Variable memory requirements

| ISaGRAF data | Size |
|--------------------------------------|--------------------------------|
| ISaGRAF Application Symbol Table CRC | 4 bytes |
| Retained Analog Variables | 4 bytes per analog variable |
| Retained Boolean Variables | 1 byte per boolean variable |
| Retained Timer Variables | 4 bytes per timer variable |
| Retained Message Variables | 256 bytes per message variable |

Up to 4K of non-volatile memory is provided for the storage of retained variable space for each ISaGRAF kernel in the RTU.

To determine if the retained variable values in memory are consistent with the ISaGRAF application, the **ISaGRAF Application Symbol Table CRC** is checked. If the ISaGRAF application variable database is altered then the application CRC will not match the retained variable memory CRC. In this case the retained variables are not used, and cleared. Therefore, if the ISaGRAF application variable database is modified, the retained variables are initialized.

When the SCADAPack E RTU loads an ISaGRAF application for example after RTU start-up, after remote RESTART ISaGRAF command or after a new program is loaded from the workbench the RTU diagnostic display session indicates the following information:

```
I SaGRAF Anal og r et ai n si ze: xxxx
I SaGRAF Bool ean r et ai n si ze: xxxx
I SaGRAF Ti mer r et ai n si ze: xxxx
I SaGRAF Message r et ai n si ze: xxxx
```

The xxxx indicates the size in bytes for each of the retained variable data types in memory. If there are no retained variables for a particular variable type, then no retain space is allocated, and no message is displayed.

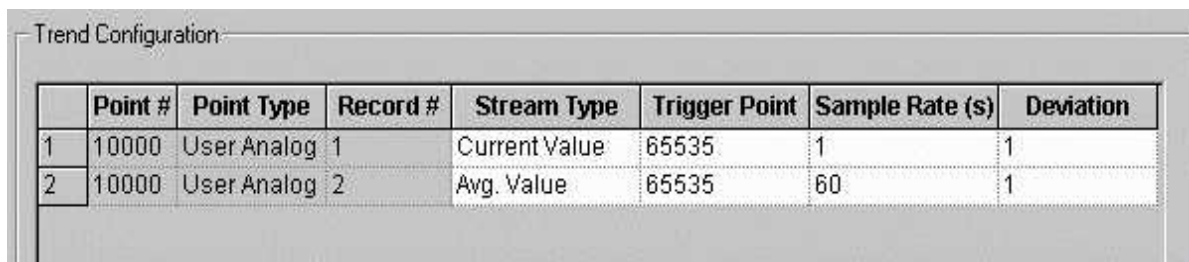
11 Data-Logger Operation

The SCADAPack E RTU provides facilities for logging of data into the RTU's file system. This data logger functionality is controlled by the Trend Sampler, and operates independently of other data communication facilities on the RTU.

- [Data-logger Configuration](#)^[145]
 - [Extracting Logged Data](#)^[146]
 - [Logged Data Format](#)^[147]
-

11.1 Data-logger Configuration

SCADAPack E Configurator provides a **Trend List** property page where configurations setup the data to be logged.



| | Point # | Point Type | Record # | Stream Type | Trigger Point | Sample Rate (s) | Deviation |
|---|---------|-------------|----------|---------------|---------------|-----------------|-----------|
| 1 | 10000 | User Analog | 1 | Current Value | 65535 | 1 | 1 |
| 2 | 10000 | User Analog | 2 | Avg. Value | 65535 | 60 | 1 |

A comprehensive description of the required configurations for logging trend data is provided in the *SCADAPack E Trend Sampler Technical Reference* manual.

11.2 Extracting Logged Data

A DNP3 Master Station may extract logged data automatically from the SCADAPack E RTU.

The procedures for this operation are described in the *SCADAPack E Trend Sampler Technical Reference* manual.

Logged data may also be extracted manually using SCADAPack E Configurator.

The **Transfer** menu's **Retrieve Trend Data** or the *Retrieve Trend Data* Toolbar Button is provided in the SCADAPack E Configurator for this purpose.

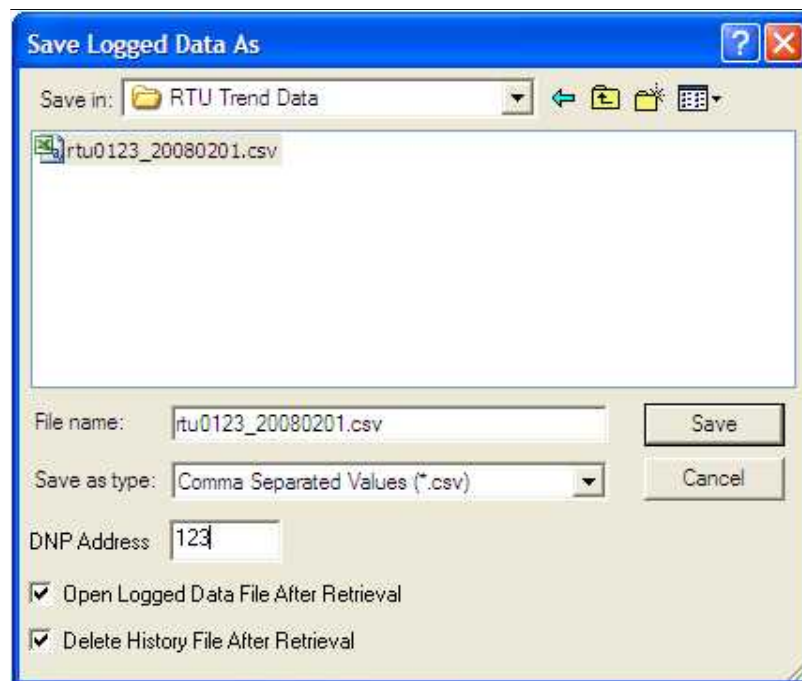
When activated, SCADAPack E Configurator retrieves the logged data from the RTU and stores the sorted data in CSV file format on the User's computer.

A dialog is displayed for user selections and permits the user to:

- Selects the directory & filename for the CSV file
- Optionally open the CSV Logged Data File after it is loaded.

A file progress indicator is displayed while SCADAPack E Configurator loads the logged data from the RTU.

Automatically launching an application to view the Logged Data requires that the user's PC have an application registered for the ".CSV" file format. Typically this could be a spreadsheet or graphing application.



Logged data will be deleted from the RTU after it is successfully loaded by SCADAPack E Configurator if the **Delete History File After Retrieval** option is selected. This selection should not be made if another device, such as a Master Station, requires the RTU's logged data.

11.3 Logged Data Format

The CSV file generated on the user's PC by SCADAPack E Configurator for the logged data contains a group of columns for each Trend Record. Data from multiple trend records appears as consecutive groups of columns. The group of columns for a single trend record are:

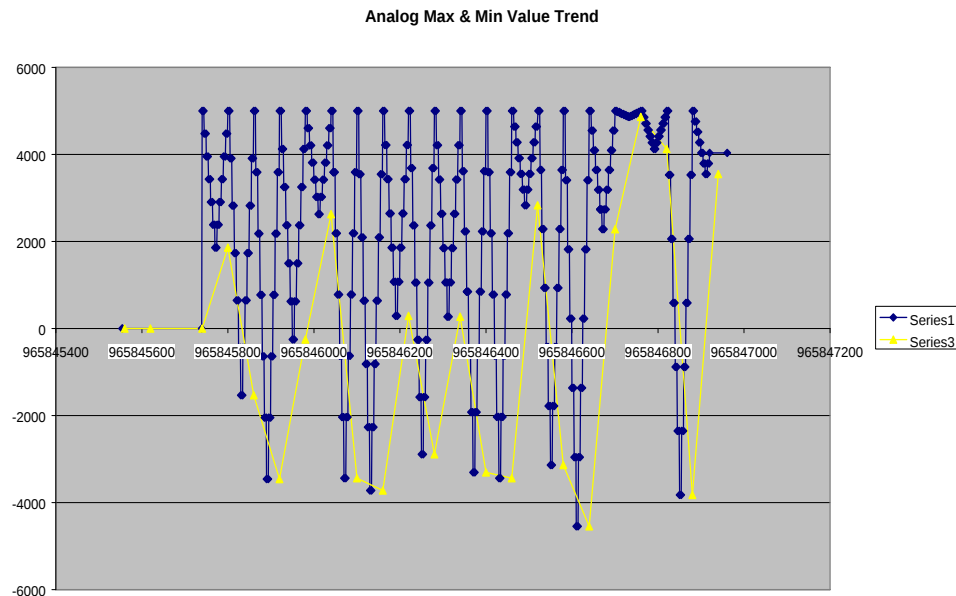
Point-number, date time, value, quality, (empty column)

For example, the following is CSV logged data for 2 trend records on points 10000 & 10001:

```
10000,15/02/02 16:29:00,4080,0,,10001,15/02/02 16:29:00,3060,0
10000,15/02/02 16:30:00,4160,0,,10001,15/02/02 16:30:00,3150,0
10000,15/02/02 16:44:00,4110,0,,10001,15/02/02 16:44:00,3120,0
10000,15/02/02 16:45:00,4240,0,,10001,15/02/02 16:45:00,3180,0
```

The format of the quality field is described in detail in the *SCADAPack E Trend Sampler Technical Reference* manual.

Once imported into a spreadsheet or other application, logged RTU data can be graphed, analysed, manipulated, etc.



12 SCADAPack E RTU Error Codes

The SCADAPack E RTU reports error codes from various RTU facilities.

RTU error codes fall into the following major categories:

- [*DNP3, PLC Device, & TCP/IP Communication Errors*](#)^[149]
 - [*SCADAPack E System Error Points*](#)^[150]
-

12.1 DNP3, PLC Device, and TCP/IP Communication Errors

DNP3 Communication Errors

DNP3 communication errors are reported by the SCADAPack E RTU through the Diagnostic Display session as DNP3 driver diagnostic information. These error codes are also reported through the ISaGRAF Peer Communication function blocks in the output STATUS variable.

The DNP3 communication errors are not reported via the SCADAPack E System Error Point.

See *SCADAPack E DNP3 Technical Reference* manual - *Appendix A* for a complete list of DNP3 Communication Error Codes

PLC Device Communication Errors

Error codes reported from PLC Device drivers on the SCADAPack E RTU are through Analog System Points 53300, 53302, 53304, 53398.

Each system point represents an error code resulting from communication between an ISaGRAF PLC Device I/O Board and a PLC Device.

These error codes are detailed in the following manuals:

SCADAPack E ISaGRAF Technical Reference manual

SCADAPack E Modbus Communication Interfaces manual

TCP/IP Communication Errors

Error codes reported from the TCP/IP sub-system on SCADAPack E RTUs are described in the *SCADAPack E TCP/IP Technical Reference* manual.

TCP/IP Error codes may be reported through RTU diagnostics or through the command-line as abbreviated text errors, through ISaGRAF function block status codes, or through the SCADAPack E RTU System Error point.

Error codes 2001 – 2999 are used for TCP/IP sub-system errors.

12.2 SCADAPack E System Error Point

The SCADAPack E RTU provides a system error code through an RTU Analog System Point:

RTU system errors are reported through the System Error Point.

SCADAPack E SYSTEM ERROR CODE: Analog System Point **50020**

The recent error is retained as the value of the system error code.

DNP3 event reporting may be configured for the system error code point to provide a time-stamped history of error codes.

The SCADAPack E System Error Code may be cleared (0) at any time by issuing a RESTART MASK command from the RTU command line, or from SCADAPack E Configurator using the **Commands | Execute Command | Other** command.

- [ISaGRAF & User Error Codes](#)^[151]
- [SCADAPack E RTU System Error Code Values](#)^[152]

12.2.1 ISaGRAF & User Error Codes

ISaGRAF Error Codes

ISaGRAF target kernel errors are reported using the following RTU facilities:

- To the ISaGRAF Workbench Debugger if connected to the SCADAPack E RTU
- Through the SCADAPack E System Error Point
- Via the SCADAPack E RTU Diagnostic Display session.

The format of ISaGRAF user application errors is as follows:

ISaGRAF Warning: XXX:YYY

Where XXX is the ISaGRAF error code number, and YYY is an information number provided to the Workbench.

This meaning of the information number depends on the particular error code, and indicates the ISaGRAF Target number for some error codes.

See the *SCADAPack E ISaGRAF Technical Reference* manual for a complete list of ISaGRAF Application Error Codes.

User Error Codes

An ISaGRAF user application may generate SCADAPack E RTU system error codes by using the RTUPARAM function block with SYS_ERR_CODE parameter type. The value of user error codes is undefined, but need to be in the range 100-999.

For more information see *SCADAPack E ISaGRAF Function Blocks Reference* manual.

12.2.2 SCADAPack E RTU System Error Code Values

The following table details the SCADAPack E system error code values.

Table 11.1: SCADAPack E RTU System Error Point Codes

| Error Code | Name | Description |
|------------|--|---|
| 0 | Normal Operation | Normal operation on SCADAPack E RTU |
| 1-99 | ISaGRAF Target Errors | See <i>SCADAPack E ISaGRAF Technical Reference manual</i> |
| 100-999 | User defined Errors | Set from RTUPARAM Function Block using SYS_ERR_CODE parameter
See <i>SCADAPack E ISaGRAF Function Blocks Reference</i> |
| 1001 | ISaGRAF Application 1 Load Error | Error loading file ISA11 or FLASH application for ISaGRAF Target 1 |
| 1002 | ISaGRAF Application 2 Load Error | Error loading file ISA21 or FLASH application for ISaGRAF Target 2 |
| 1005 | ISaGRAF IO Board Error | SCADAPack ER input board specified in ISaGRAF without any configuration points mapped to physical inputs |
| 1006 | ISaGRAF Application Backup save failed | There was an error saving a backup copy of the ISaGRAF application into flash. This does not affect the main copy and the RTU should continue to function normally. |
| 1007 | IEC 61131-3 Target 5 validation mismatch | The configured validation strings do not match the validation strings in the IEC 61131-3 Target 5 application |
| 1010 | Binary Attribute Point Config Error | A Binary point has already been assigned as an attribute for a different point – see CONFIG.LOG file for details, and use a different Binary point number |
| 1011 | Config File Invalid Error | Configuration File format is invalid |
| 1012 | Config File Attribute Error | Configuration File contains an invalid point attribute – see CONFIG.LOG file for details |
| 1013 | Configuration Point Create Error | A write record exchange to a non-existing point failed to add point to database |
| 1014 | Configuration Point Delete Error | A write record exchange requesting to disable / delete a point has failed. |
| 1015 | Flash File Write Error | Error writing file to FLASH memory |
| 1016 | Invalid Point Map Record | Error in Data Concentrator “Remote Point” table entry |

| Error Code | Name | Description |
|------------|--|--|
| 1017 | Invalid Remote Device Record | Error in Data Concentrator "Remote Device" table entry |
| 1018 | IED Status Point Create Error | Data Concentrator failed to create a block of status points for a remote device |
| 1019 | Unlicensed Configuration Detected | e.g. Data Concentrator configuration detected where the Data Conc. has not been licensed. |
| 1020 | Bad Profile File-name | A Profile file has a file-name that is not in the correct format |
| 1021 | Bad Profile Data | A Profile file contains invalid profile data – see RTU diagnostic output |
| 1022 | Profile Format Mismatch | A profile is attempting to set an attribute not valid for the point type |
| 1023 | Profile Daily / Weekly Error | A profile has both Daily and Weekly files – remove the incorrect file(s) |
| 1024 | Missing Profile File | An RTU point is configured to use profile files that are not loaded in the RTU |
| 1025 | Profile Write Error | Error occurred writing profile data to a point attribute – see RTU diagnostic output |
| 1026 | Profile Initialization Error | Error initializing profile (general error) – see RTU diagnostic output |
| 1030 | Event Threshold Exceeded | Warning only: The RTU has buffered events exceeding the event threshold limit (80%) |
| 1031 | Event Data Lost | An RTU event buffer has overflowed resulting in missing of data |
| 1032 | Trend Threshold Exceeded | Warning only: The RTU has trend sample files exceeding the 80% trend threshold limit (see <i>SCADAPack E Trend Sampler Technical Reference</i> for more details) |
| 1033 | Trend Data Lost | The RTU trend file storage has overflowed resulting in the missing of trend sample data |
| 1034 | Invalid Trend Config Record | A trend record has field with an invalid configuration – see RTU diagnostic output |
| 1035 | Virtual Terminal Event Data Lost | The RTU Virtual Terminal event buffer has overflowed resulting in missing VT data |
| 1040 | Integer Over-run Error | I/O data processing from large floating point number has caused integer overflow or integer underflow |
| 1041 | Data Processing External Queue Unavailable | Operating System inter-task communication warning. May result in incomplete point data processing |

| Error Code | Name | Description |
|------------|--|---|
| 1042 | Data Processing Internal Queue Unavailable | Operating System inter-task communication warning. May result in incomplete point data processing |
| 1050 | Remote I/O O/S Firmware Mismatch | The O/S firmware version in the main RTU differs to that in the remote I/O. |
| 1051 | Remote I/O Boot Loader Firmware Mismatch | The Boot Loader firmware version in the main RTU differs to that in the remote I/O. |
| 1052 | Main unit OS Firmware RTU Model Mismatch | OS Firmware patch attempted on main RTU with firmware of the incorrect model type |
| 1053 | Main unit Boot Monitor RTU Model Mismatch | Boot Monitor firmware patch attempted on main RTU with firmware of the incorrect model type |
| 1054 | Main OS Firmware Patch Failure | Reported from the Boot Monitor to the main OS firmware if firmware patch file could not be applied. |
| 1055 | Main OS Firmware Patch Incompatible | This hardware requires version 7.85 or later firmware. |
| 1060 | SCADAPack ER I/O Error – Event FIFO Error | Reported by the main Operating System firmware. Indicates FIFO overflow / overrun |
| 1061 | SCADAPack ER I/O Error – DEA Error | Reported by the main Operating System firmware. Indicates invalid request into I/O Data Exchange Area (DEA) |
| 1062 | SCADAPack ER I/O Error – Static I/O Error | Reported by the main Operating System firmware. Indicates indexing into Static I/O Area of the DPRAM. |
| 1063 | SCADAPack ER I/O Error – I/O Config Overlap | Reported by the main Operating System firmware. Indicates indexing into Static I/O Area of the DPRAM. |
| 1064 | SCADAPack ER I/O Error – I/O Card Config Error | Reported by the main Operating System firmware. Indicates I/O Card could not be configured (Card status point also updated). |
| 1065 | SCADAPack ER I/O Error – I/O Card RTC Error | Reported by the main Operating System firmware. Indicates Real Time Clock could not be set on a given I/O Card (Card status point also updated). |
| 1066 | SCADAPack ER I/O Error – I/O Card Checksum Error | Reported by the main Operating System firmware. Indicates repeated failure detected on data transactions for a given I/O Card (Card status point also updated). |
| 1100 | SCADAPack ER I/O Error – Too many DI Cards Allocated | Reported by the I/O Interface processor. Indicates that more than 144 x 32DI cards configured. |
| 1101 | SCADAPack ER I/O Error – I/O Card Event Data Loss | Reported by the I/O Interface processor. Indicates that event buffers on the I/O CPU have overflowed. |
| 1102 | SCADAPack ER I/O Error – | Reported by the I/O Interface processor. Indicates that |

| Error Code | Name | Description |
|------------|--|--|
| | Unknown I/O Card ID | I/O Card type specified in the configuration is unknown by the I/O processor CPU. |
| 1103 | SCADAPack ER I/O Error – Out of Memory Error | Reported by the I/O Interface processor. Indicates that the I/O CPU has run out of available memory. |
| 1104 | SCADAPack ER I/O Error – Event Data Corrupt | Reported by the I/O Interface processor. Indicates data in I/O CPU event buffers has been corrupted. |
| 1105 | SCADAPack ER I/O Error – Analog Data Lost | Reported by the I/O Interface processor. Indicates that the static AI area in the DPRAM is full and some data has been lost. |
| 1106 | SCADAPack ER I/O Error – Counter Data Lost | Reported by the I/O Interface processor. Indicates that the static Counter area in the DPRAM is full and some data has been lost. |
| 1200 | Invalid Calibration | Indicates invalid calibration settings on an RTU I/O board |
| 2001-2999 | TCP/IP sub-system Errors | See <i>SCADAPack E TCP/IP Technical Reference manual – Appendix C</i> |
| 3000 | Data Concentrator License Count Exceed | A Data Concentrator configuration contains either more <i>remote devices</i> OR more <i>mapped points</i> than the licensing allows. The limitations are documented in the <i>SCADAPack E Data Concentrator Technical Reference</i> manual. |
| 3001 | Trip Close Partner Point configuration error detected. | An invalid <i>Trip Close Partner Point</i> attribute for a digital point has been detected in the configuration, e.g. the nominated partner point does not exist. |
| 3002 | IED DNP Session Create Error | Indicates a DNP3 Slave configuration error in the Data Concentrator whereby the corresponding DNP3 session could not be created for that DNP3 slave address. |
| 3003 | Remote Device Session Create Error | Indicates that DNP3 session for the configured Remote I/O address could not be created. |
| 3004 | IEC 60870-5-101 Configuration Error | The IEC 60870-5-101 / -104 Slave task has detected a 101 or 104 configuration error on startup (or restart) of the task. The causes of these configuration errors are detailed in the <i>SCADAPack E IEC 60870-5-101 / -104 Slave Technical Reference Manual</i> . |
| 3005 | Conitel Configuration Error | A Conitel configuration error has been detected on an RTU licensed for Conitel Slave Operation. |
| 3006 | Baker Configuration Error | An Invalid Data Type has been detected for a BAKER configuration, on an RTU licensed for Conitel Slave Operation. |

| Error Code | Name | Description |
|------------|--------------------------------------|--|
| 3007 | 5000 Series I/O Configuration Error | This error is reported when there is an issue detected with any 5000 series I/O configurations in a configuration file. This error is also reported when 5000 series I/O configurations are detected in RTUs NOT having the required I/O Bus hardware installed. |
| 3008 | 5000 Series I/O Point Creation Error | This error code indicates that the status configuration points for a 5000 series I/O could not be created in the RTU point |

13 Additional Diagnostics

A range of additional diagnostic information is provided by the SCADAPack E RTU's in order to facilitate trouble-shooting.

- [Diagnostic Display Session](#)^[158]
- [Start-Up Diagnostics](#)^[159]
- [RTU Status Points](#)^[161]
- [Reset Reasons](#)^[163]
- [Task Watchdog Errors](#)^[165]
- [Communication Statistics](#)^[167]

13.1 Diagnostic Display Session

The SCADAPack E RTU, through the Diagnostic Display session, can indicate RTU operating conditions. This is available from a **Cmd Line** command line port on the RTU using the **DIAG** command.

A Command Line shell through an RTU ISaGRAF port can also provide access to the diagnostic display session when IEC 61131-3 Target 3 is enabled. Command line shell is not available with Target 5. For more information see Section [Port Assignments](#)⁵⁷.

In addition, TELNET can be used to attach to the diagnostic display session. For more information see **SCADAPack E TCP/IP Technical Reference**.

SCADAPack E RTU diagnostics indicates operational information that assists in trouble shooting.

To sort these diagnostics from normal operational messages, it may be advantageous to disable DNP, PLC and SYSTEM diagnostics using DNPDIAG, PLCDIAG, TCPDIAG and SYSDIAG commands from the command-line.

Other RTU diagnostics use the following format to assist in identifying messages from various SCADAPack E RTU tasks:

Task-name>>diagnostic text

13.2 Start-Up Diagnostics

At start-up the SCADAPack E RTU can display information about its start-up sequence and configuration. If a **Cmd Line** command line port is configured on the RTU, ASCII text is displayed through this port as the RTU starts up. After completion of the RTU start-up, the SCADAPack E RTU usually terminates the diagnostic session and enters command mode. The entry to command mode after start-up can be optionally disabled, leaving the SCADAPack E RTU in the diagnostic display session. For information on the SYSDIAG OVERRIDE command see Section [System Diagnostic Command](#)^[103].

A typical SCADAPack E RTU start-up diagnostic output is shown as follows (SCADAPack ES example shown)

```
SCADAPack E Firmware 8.05.3
Build 5.3.146
Copyright (C) Control Microsystems Inc. and licensors
```

```
Controller          : SCADAPack ES Model (586)
CPU speed           : 100 MHz
Firmware version    : 8.05.3.146
ISaGRAF 3 version   : 3.55
ISaGRAF 5 version   : 2010.5.23.710_(100908)
RTOS                : GL1.13
TCP/IP version      : 4.1
BOOT MONITOR version : 2.15
RTU PAL version     : 2.0
Serial Number       : 65535
Ethernet MAC Addr   : 00-03-74-01-FF-FF
Ethernet MAC Addr 2 : 00-03-74-02-FF-FF
```

```
Start up at: 13/11/2012 14:39:14.169
Reset Reason mask   : 0x0006
Task Watchdog mask  : 0x0000
```

```
TCPIP>>Ethernet IP addresses not configured
IO_PROCESSOR>>Task Starting
SAMPLER>>Task Started
PROFILER>>Task started
PROFILER>>Initialising...
PROFILER>>Initialisation complete
CMDLINE>>Task started
DNP3>>Task Started
<+++ [30000]      Build DNP3 Message: NULL Response
```

<+++ [30000] Insert request in queue: NULL Response

<=== [30000] Application Header, Unsolicited
 FIR(1) FIN(1) CON(1) UNS(1) SEQ# 0 IIN(0x2090)

<=== [30000] IIN Bits:
 IIN1.7 Device Restart
 IIN1.4 Time Synchronization Required
 IIN2.5 Configuration Corrupt

DNP>>Building Event lists...

DNP>>Free Event Pool size: 5000

SAMPLER_CHILD>>Task Started

IO_PROCESSOR>>Task Started

ISaGRAF>>Application File isa11 NOT FOUND

ISaGRAF>>Application File isa21 NOT FOUND

ISaGRAF>>Version 3.55 installed comms task on PORT0

ISaGRAF>>Version 3.55 installed comms task for DNP3

C:\>

13.3 RTU Status Points

The following system points are provided by the SCADAPack E RTU to indicate status of various aspects of RTU operation.

Where indicated “Configurable”, points may be added to RTU point database for the addresses shown complete point configuration attributes available, including remote access from a Master Station via DNP3 protocol.

Table 12.1: RTU Status System Points

| Type | Number | Description | User Access |
|----------------------|--------|--|--------------------------|
| System Binary Points | 50200 | RTU Initialised | Read Only / Configurable |
| | 50201 | RTC Time Synchronised | Read Only / Configurable |
| | 50202 | RTC Time Invalid | Read Only / Configurable |
| | 50203 | DNP3 Protocol Driver Running | Read Only / Configurable |
| | 50204 | Engineering Mode – see Engineering Mode ^[23] | Read Only / Configurable |
| | 50205 | Local I/O Module Failure (SCADAPack ES only) | Read Only / Configurable |
| | 50206 | Local Input Power Supply Low (not supported by SCADAPack ER) | Read Only / Configurable |
| | 50207 | Local On-Board Battery Low | Read Only / Configurable |
| | 50208 | Local Calibration Parameters Invalid | Read Only / Configurable |
| | 50300 | Hex Switch Settings Changed | Read Only |
| | 50301 | Task Software Watchdog – see Task Watchdog Errors ^[165] | Read / Write |
| | 50302 | Time Zone Modifier – see RTU Shutdown ^[22] | Read / Write |
| | 50303 | Configuration Corrupt – see RTU LEDs ^[11] | Read Only |
| | 50304 | Stop Data Storage if Full – see <i>SCADAPack E Trend Sampler Technical Reference</i> and <i>SCADAPack E DNP3 Technical Reference</i> | Read / Write |
| System Analog Points | 50000 | RTU Type | Read Only |
| | 50001 | Firmware revision | Read Only |
| | 50002 | Switch Setting – see RTU Hex Switch Settings ^[30] | Read Only |
| | 50003 | Processor Board PAL revision | Read Only |
| | 50004 | Processor Board Boot Monitor revision | Read Only |
| | 50005 | I/O Board Firmware revision | Read Only |
| | 50006 | Hardware Revision ID | Read Only |
| | 50010 | RTU Up Time (Secs) | Read / Write |
| | 50011 | RTU Up Time Delta (0-1000 ms) | Read / Write |

| | | | |
|---------------------|-------|---|-----------------------------|
| | 50012 | Reset/Error Reasons Mask – see Reset Reasons ^[163] | Read / Write |
| | 50013 | Task Watchdogs Mask – see Task Watchdog Errors ^[165] | Read / Write |
| | 50014 | Engineering Timer – see Engineering Mode ^[23] | Read / Write |
| | 50016 | RTU Restart Count | Read / Write |
| | 50020 | System Error Code – see SCADAPack E RTU System Error Code Values ^[152] | Read / Write / Configurable |
| | 50021 | RTU Dynamic System Memory Free | Read Only / Configurable |
| | 50022 | RTU Dynamic System Memory Size | Read Only / Configurable |
| | 50023 | Configuration memory Size | Read Only / Configurable |
| | 50024 | Configuration memory Slack | Read Only / Configurable |
| | 50025 | File System Number of Files Used | Read Only / Configurable |
| | 50026 | File System Bytes Used | Read Only / Configurable |
| | 50027 | File System Bytes Free | Read Only / Configurable |
| | 50028 | NTP Task State (see <i>SCADAPack E TCP/IP Technical Reference</i>) | Read Only / Configurable |
| | 50029 | IRIG Time Quality (SCADAPack ER - P620 only) | Read Only / Configurable |
| | 50050 | RTU Configuration Major Revision | Read / Write |
| | 50051 | RTU Config. Minor Revision – see RTU Configuration Revisions ^[28] | Read / Write |
| | 50080 | RTU Ethernet 1 MAC address (high 32-bits) | Read Only |
| | 50081 | RTU Ethernet 1 MAC address (low 16-bits) | Read Only |
| | 50082 | RTU Serial Number (SCADAPack ES & SCADAPack ER) | Read Only |
| | 50083 | RTU Ethernet 2 MAC address (high 32-bits) (SCADAPack ES & SCADAPack ER) | Read Only |
| | 50084 | RTU Ethernet 2 MAC address (low 16-bits) (SCADAPack ES & SCADAPack ER) | Read Only |
| System Float Points | 50090 | CPU ID (low 32-bits) | Read Only |
| | 50091 | CPU ID (high 32-bits) | Read Only |
| | 50060 | Input Supply Voltage | Read Only / Configurable |
| | 50062 | RTU Internal Temperature (Deg. C) | Read Only / Configurable |
| | 63200 | Low Volts Alarm Level | Read / Write |
| | 63201 | Local Time Offset from UTC – see Time Conversion ^[24] | Read / Write |

The SCADAPack ER includes a range system points that represent the I/O card status on per slot basis. These system points are detailed in [SCADAPack ER I/O Card Status Points](#)^[54]

13.4 Reset Reasons

The SCADAPack E RTU maintains a non-volatile indication of previous reasons causing significant system diagnostics or RTU reset. During an RTU shutdown sequence, or as a result of an RTU restart, the SCADAPack E RTU sets a **reset reason** when it is possible to do so.

The following analog system point is used as a mask of values to indicate reason(s) for the RTU restart.

RESET REASONS: Analog System Point **50012**

The value of the system point is an additive sum of the following masks.

The system point is not automatically cleared by the RTU and any new reasons are indicated by the addition of the relevant mask.

* **Reset Reason Mask** is displayed in RTU start-up diagnostics, by command line STATUS command, on SCADAPack E Configurator **Status** property page, and is also available in SCADAPack E RTU analog system point 50012 for access via DNP3 or ISaGRAF.

It is recommended that prior to using the Reset Reason mask for diagnostic purposes that the system point is written by the user with the value "0" or cleared with the SCADAPack E Configurator Controller Status Page **Clear Errors** button.

Table 12.2: RESET Reasons

| Mask value (Hex)* | Description |
|-------------------|--|
| 0x0001 | Non-volatile RAM initialized |
| 0x0002 | Hardware reset |
| 0x0004 | Operating System firmware changed |
| 0x0008 | Externally commanded reset |
| 0x0010 | ISaGRAF application TIC code error ⁺⁺ |
| 0x0020 | TCP/IP DCUs exhausted |
| 0x0040 | System memory exhausted |
| 0x0080 | I/O Calibration Invalid ⁺⁺ |
| 0x0100 | Switch settings changed |
| 0x0200 | Task software watchdog
(see Task Watchdog Errors in Section Task Watchdog Errors ^[165]) |
| 0x0400 | Processor Exception (see below ^[164]) |

⁺⁺ These reason codes are applicable on older firmware versions only. Alternate System Error Code values are applicable in current releases.

Getting Processor Exception Information

A processor exception occurs when an unexpected code path is executed by the controller's operating system firmware.

Additional information should be collected if this reset reason is reported, and provided to Schneider Electric [Technical Support](#)^[5].

Use the SCADAPack E Configurator Point Browser to read the following 18 analog system point values: 63600 - 63617

| Type | Point # | Hex |
|--------------|---------|-----------|
| Analog Input | 63600 | Hex value |
| Analog Input | 63601 | Hex value |
| | | |
| Analog Input | 63617 | Hex value |

Please include the following information (from the SCADAPack E Configurator Controller Status page) in the report to [Technical Support](#)^[5]: It may be convenient to take a screenshot of the Controller Status and Point Browser pages showing this information. If not, please record the following:

- RTU Type
 - CPU ID (Hex)
 - Firmware Version name
 - Firmware Revision number
 - Boot Monitor revision number
 - System Status Code
 - Reset Reason
 - Task Watchdogs
 - System point values 63600 through 63617 as detailed above
 - RTU Configuration file.
 - A short description of what was happening when the reset occurred.
-

13.5 Task Watchdog Errors

The SCADAPack E RTU maintains a non-volatile indication of operating system tasks that have previously caused a **Task Software Watchdog** RTU reset.

If Task Software Watchdogs activate, it may mean that the configuration and/or application in use is loading the SCADAPack E RTU beyond its processing capability.

If a Task Watchdog occurs as a result of the RTU recording no operating system activity for an internal task, the SCADAPack E RTU does the following:

- Sets the “Task Software Watchdog” reset reason mask (see Section [RTU Status Points](#)^[161])
- Sets the “Task Software Watchdog” system binary point (see Section [RTU Status Points](#)^[161])
- Sets a mask value in the TASK WATCHDOG analog system point for the inactive task
- Causes a hardware reset of the RTU

The following analog system point is used as a mask of values to indicate software watch task error(s) for the SCADAPack E RTU:

TASK WATCHDOG ERRORS: Analog System Point **50013**

The value of the system point is an additive sum of the following masks. The system point is not cleared by the RTU and any new task watchdogs are indicated by the addition of the relevant mask.

Where multiple instances of tasks of the same type are started, there is no indication of which individual task instance caused the Task Software Watchdog error. Examples of this include: ISaGRAF Target (execution) task, ISaGRAF Communication task and the Communications Driver task (Keyed RS-232, PSTN Modem, etc.)

It is recommended that prior to using the Task Watchdog Errors mask for diagnostic purposes that the system point is written by the user with the value “0” or cleared using the SCADAPack E Configurator Controller Status Page **Clear Errors** button.

If the SCADAPack E RTU diagnostic display session is being used to monitor the RTU, a task software watchdog is indicated by the display of a “!” character prior to the RTU performing a hardware reset.

Table 12.3: TASK Watchdog Errors

| Mask value (Hex)* | Description |
|-------------------|----------------------------------|
| 0x0001 | RTU Calibration task |
| 0x0002 | ISaGRAF Target (execution) tasks |
| 0x0004 | TCP/IP tasks |
| 0x0008 | RTU background task |
| 0x0010 | Data Processor task |
| 0x0020 | ISaGRAF Communication tasks |

| Mask value (Hex)* | Description |
|-------------------|-----------------------------------|
| 0x0040 | PLC Device Cache task |
| 0x0080 | DNP3 task |
| 0x0100 | Command Line task |
| 0x0200 | Profiler task |
| 0x0400 | Trend Sampler task |
| 0x0800 | Hardware Watchdog service task |
| 0x1000 | PPP driver task |
| 0x2000 | Ethernet driver task |
| 0x4000 | Communications driver task |
| 0x8000 | Unknown task |
| 0x10000 | Reserved |
| 0x20000 | TCP Service Port task |
| 0x40000 | NTP task |
| 0x80000 | Modbus Slave task |
| 0x100000 | DNP Virtual Terminal Service task |
| 0x200000 | IEC 60870-5-103 Master task |
| 0x400000 | Conitel Slave task |
| 0x800000 | IEC 60870-5-101 / -104 Slave task |
| 0x1000000 | Sampler Child task |
| 0x2000000 | 5000 Series I/O Bus task |
| 0x4000000 | USB driver task |
| 0x80000000 | SLIP or CSLIP driver task |

* **Task Watchdog Error Mask** is displayed in RTU start-up diagnostics, by command line STATUS command, on SCADAPack E Configurator **Controller Status** page, and is also available in SCADAPack E RTU analog system point 50013 for access via DNP3 or ISaGRAF.

13.6 Communication Statistics

A variety of communication statistics are provided by the SCADAPack E RTU via System Analog points. These analog points may be read from the SCADAPack E RTU using specific DNP3 point range read requests. Alternatively they may be read into an ISaGRAF user application via Input Boards, or Function Blocks.

Communication Statistic point values may be reset at any time by controlling the relevant System Point value and setting it to 0. This may be done by an ISaGRAF user application or via DNP3 point controls.

The Communication Statistics System Analog points cannot be directly added to the RTU point database and returned in DNP3 Class data polls. To map Communication Statistic points to a SCADA Master, the values may be imported in to an ISaGRAF user application, manipulated (if required), then exported to a derived point, which can be configured for access by a SCADA Master.

There are two types of communication statistic points provided by the SCADAPack E RTU.

- SCADAPack E RTU (global) communication statistics
- Port communication statistics

Communication Statistics System Analog points may be accessed as 16-bit or 32-bit Analog Input points.

Table 12.4: RTU Communication Statistics

| Description | System Analog Point Number |
|--|----------------------------|
| Total DNP3 Master 1 Fragments Received | 53000 |
| Master 1 Unsolicited Fragments Transmitted | 53001 |
| Master 1 Unconfirmed (timed-out) Unsolicited Responses | 53002 |
| Total DNP3 Master 2 Fragments Received * | 53003 |
| Master 2 Unsolicited Fragments Transmitted * | 53004 |
| Master 2 Unconfirmed (timed-out) Unsolicited Responses * | 53005 |
| Total DNP3 Master 3 Fragments Received * | 53006 |
| Master 3 Unsolicited Fragments Transmitted * | 53007 |
| Master 3 Unconfirmed (timed-out) Unsolicited Responses * | 53008 |

Table 12.5: Serial Port Communication Statistics

| System Analog Point Description | Port 0 | Port 1 | Port 2 | Port 3 | Port 4 |
|------------------------------------|--------|--------|--------|--------|--------|
| Raw Received Bytes | 53009 | 53023 | 53037 | 53051 | 53065 |
| Raw Transmitted Bytes | 53010 | 53024 | 53038 | 53052 | 53066 |
| DNP3 Frames Received | 53011 | 53025 | 53039 | 53053 | 53067 |
| DNP3 Frames Transmitted | 53012 | 53026 | 53040 | 53054 | 53068 |
| DNP3 Master Frames Received | 53013 | 53027 | 53041 | 53055 | 53069 |
| DNP3 Link Confirm Timeout | 53014 | 53028 | 53042 | 53056 | 53070 |
| DNP3 Frame Receive CRC Error | 53015 | 53029 | 53043 | 53057 | 53071 |
| Number of Dial In Connects (Modem) | 53016 | 53030 | 53044 | 53058 | 53072 |
| Successful Dial-outs (Modem) | 53017 | 53031 | 53045 | 53059 | 53073 |
| Failed Dial-outs (Modem) | 53018 | 53032 | 53046 | 53060 | 53074 |
| Number of DCD Drop-outs (PPP) | 53019 | 53033 | 53047 | 53061 | 53075 |

Table 12.6: For SCADAPack ER - P620

| System Analog Point Description | Port 5 | Port 6 | Port 7 | Port 8 |
|---------------------------------|--------|--------|--------|--------|
| Raw Received Bytes | 53107 | 53121 | 53135 | 53149 |
| Raw Transmitted Bytes | 53108 | 53122 | 53136 | 53150 |
| DNP3 Frames Received | 53109 | 53123 | 53137 | 53151 |
| DNP3 Frames Transmitted | 53110 | 53124 | 53138 | 53152 |
| DNP3 Master Frames Received | 53111 | 53125 | 53139 | 53153 |
| DNP3 Link Confirm Timeout | 53112 | 53126 | 53140 | 53154 |
| DNP3 Frame Receive CRC Error | 53113 | 53127 | 53141 | 53155 |

Table 12.7: Ethernet Port Communication Statistics

| System Analog Point Description | Ethernet 1 | Ethernet 2* |
|---------------------------------|------------|-------------|
| DNP3 Frames Received | 53081 | 53095 |

| | | |
|------------------------------|-------|-------|
| DNP3 Frames Transmitted | 53082 | 53096 |
| DNP3 Master Frames Received | 53083 | 53097 |
| DNP3 Link Confirm Timeout | 53084 | 53098 |
| DNP3 Frame Receive CRC Error | 53085 | 53099 |

* SCADAPack ES and SCADAPack ER only

