neoptix

QUALITROL®

T/Guard™

Fiber Optic Thermometer Systems
For Industrial & Power Transformer Applications

1- to 16-Channel Systems
OptiLink Software Release 1.65
With Optional Modbus & Double-Calibration Support & TCPIP Bridge Support
T/Guard-DL, -DL+ & -I: includes Data Logging option

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Proprietary notice:

Part number: G1002R22 (April 2014)

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Warning

Permanent damage may be done to the thermometer if the power supply connections are not done correctly. In particular, do not connect the power input (18-24 VDC) to any of the analog output connectors. Note that the 20 mA analog output options are self-powered interfaces (by opposition to loop-powered interfaces), and thus do not require any external supply. Maximum loop impedance should be kept at 400 Ω; internal impedance is approximately 0.7 Ω.

With 0-10 volt analog outputs, avoid shorting output leads together; as this may destroy the electronic drivers inside the unit; external impedance must be kept at all-time at 10 kΩ or more. Unit must be returned to Neoptix for repair, not field repairable.

Fiber optic probes and extension cables are fragile, and will break if the bending radius becomes less than 1 cm, even temporarily. Furthermore, as T2 probe tips are fragile, exercise care to:
- **Make sure the last ~1 cm of probes is free standing, and not pressurized by any glue, or by the spacers**
- **Avoid bending the last 1 cm of probes.**

Furthermore, due to the unique construction of the Neoptix T2 type probes, it is important that you avoid applying glue to the last 1 cm of the probes during their installation in transformer windings.

Probe breakages are not covered under the standard Neoptix warranty.

To assure cleanliness of optical connectors, keep caps on unused connectors at all time. This is also required during operation, as parasitic light entering via unused connectors into the T/Guard module may cause false temperature readings, even on other channels.

The Neoptix T/Guard products are CE marking certified.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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1.1   T/Guard Family and Neoptix Probe Warranty Notice

Your *T/Guard* unit is guaranteed (Parts and Workmanship) for one full year from the date of purchase. Upon written notification of any defect, Neoptix will either repair or replace any faulty product or components thereof. A Return Authorization Number (RMA) must be obtained from Neoptix Canada LP or authorized distributor prior to any merchandise return.

Due to the unique nature of the fiber optic probes that are used with the Neoptix Conditioner system, probes are not warranted.

When using any electrical appliance, basic safety precautions should be followed, including the following:
- Do not operate in wet / damp environments
- Do not operate in explosive atmospheres
- Keep product surface dry and clean.

Always make sure all electrical installations are made in accordance with local authorities' regulations and laws.

2 INTRODUCTION

Congratulations on the purchase of your T/Guard™ thermometer product! Your new temperature sensing system will soon allow you to take full advantage of the benefits inherent to fiber optic sensing technology. It offers accurate and reliable temperature measurements, combined with extraordinary insensitivity to EMI/RFI, high voltage insulation and disturbance free sensing due to the non-electrical nature of the sensor element used.

Not only does the T/Guard family of products gives users' access to reliable measurements, but it also offers a simple user interface that makes the technology easy to use. Moreover, no special calibration is required when changing the fiber optic sensor elements.

The thermometer is packaged in a small splash proof package, which is ideally suited for industrial applications.

The standard configuration is offered with an RS-232 interface as well as an analog output feature (1 to 16 channels) that can be used for remote interfacing purposes. In addition, the standard LCD display makes it easy to see the temperature for all channels simultaneously, either in Celsius (^{o}C) or in Fahrenheit (^{o}F), even in dark areas (a backlight is included). It is a great product for rough industrial applications. RS-485 and Ethernet TCP/IP ready versions are also available. A convenient internal data logging option is also available as an option (models -DL, -DL+ and -I); this 1 Gbyte flash memory will provide years of data logging.

Update April 2014: If you are interested in an Ethernet interface, Neoptix highly recommends using the T/Guard-408XT; also this product as well as the new T/Guard-405 have built-in standard logging memory.

Information, January 2013: If Ethernet and data logging is required, the T/Guard-408XT is recommended.

The OptiLink (formerly NeoLink) software is included with all T/Guard products. (Note that OptiLink cannot be used when the Modbus option is enabled). OptiLink is compatible with Windows XP, Vista and Windows-7.

With the double-calibration feature enabled, the OptiLink software offers the support for it (these T/Guard systems are optimized for both Neoptix and older Nortech Fibronic Inc. probes).

This User Guide includes a description of the Modbus (standard feature) and data logging (T/Guard-DL) (option). The OptiLink software is not compatible with the Modbus option, when this option is enabled; in other words, OptiLink works only with the Neoptix native communication mode.

2.1 T/Guard product specifications

Resolution	0.1 °C
Accuracy	The Greater of 1 °C or 1% of reading
Calibrated Temperature Range	-40° to 200°C
Supported probes	Support for Nortech Fibronic inc. type probes
Usable Temperature Range	-80 ° to 250 °C
Number of channels*	1 to 8 (option: up to 16)
Probe length	1 to 500 meters
Response time	Typically 0.3 second per channel (probe configuration dependent)
Unit	User selection of °C or °F
Operating temperature	-30° to 7 0°C, non-condensing
Storage temperature	-40° to 80 °C
LCD display	Display of channel number and temperature readings
Power	14 to 28 VDC, 0.6 A (see note below, front panel)
Size	280L x 170W x 60D mm
Weight	1.5 kg
Standard interface*	RS-232C or RS-485 (2W or 4W), Modbus Analog output (4-20mA or 0-10V)
Data logging*	Up to 1 GB (fixed memory) DL+: With second RS-232 port
Optional interface	RS-485 TCP-IP (Ethernet)
Sensor	Dielectric epoxy or silicone tipped optical fiber

*: Selection must be specified at time of order.

The following figure gives a description of some probe configurations and options that are available from Neoptix.

Transformer Probe T2 (shown with feedthrough):

Temperature sensor inside transformer
Part number: T2-Mxx

Optical feedthrough onto transformer tank wall or plate
Part number: OFT

Extension cable up to Neoptix T/Guard System
Part number: EXT-Mxx

General Purpose Probe T2:

2.0 mm

Ø 400 microns sensitive area

ST connector

Ø 3.1 mm PTFE Teflon "spiral wrap"

1.15 mm

9.5 mm

3 cm standard (other length on demand)

Up to 25 meters
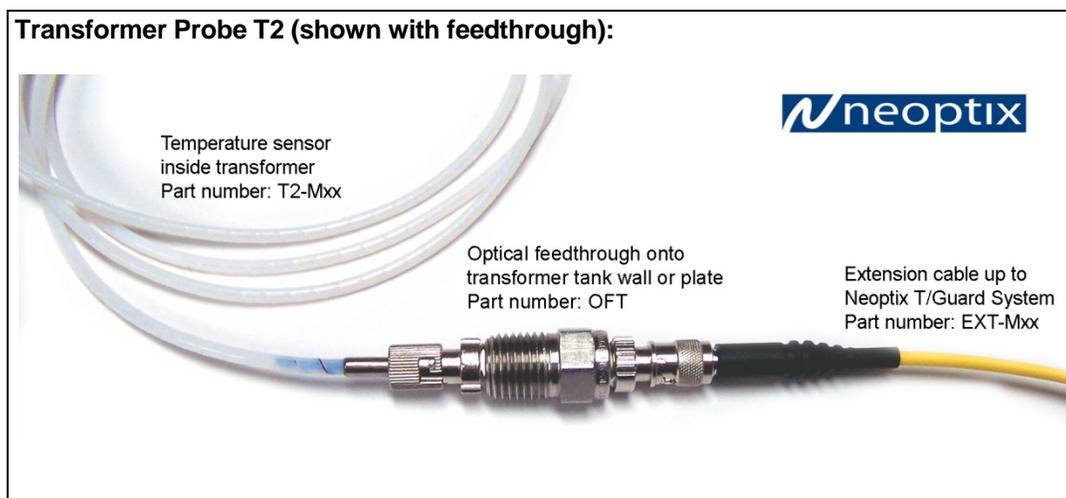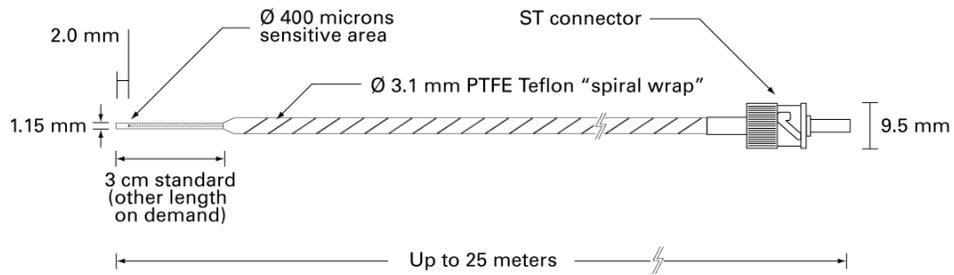
OFT Coupling (Feedthrough):
(for transformer wall application, and other similar applications)

16.0 mm

24.0 mm

53.0 mm
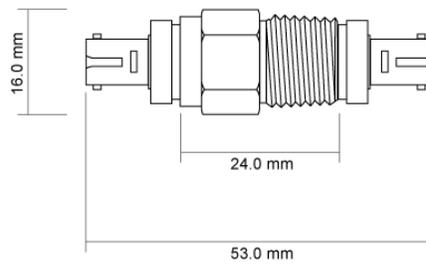
ST Coupling (also called ST-ST Mating
(for other general-purpose applications)

29.59
29.08
[1.165]
[1.145]

11.18
[.440] MAX DIA

12.67
12.42
[.499]
[.489]

7.01
[.276] MAX DIA TYP

PANEL

ST-ST Extension Cable

Ø 3 mm Polyurethane cable reinforced with Kevlar threading

9.5 mm

ST connector
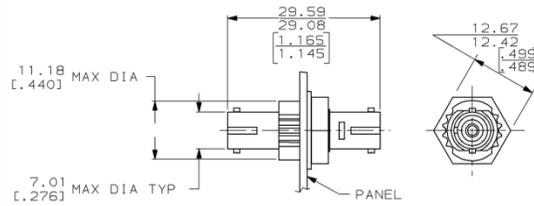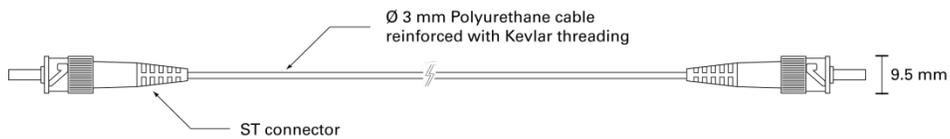
Other options and configurations are also possible; contact Neoptix for more information.

2.2   Calibration

Your T/Guard thermometer comes factory-calibrated. Experience has shown that re-calibration is not required over the whole product life; however, if your ISO rules state that an annual re-calibration is required, then it is your responsibility to comply with those rules. For laboratory applications, a new calibration is standard every 12 months or whenever performance verification indicates that calibration is necessary; NIST traceable calibration certificates are available. All calibrations are performed at the factory. Contact your Neoptix Representative for further information.

2.3   Transformer applications

One of the main applications for the T/Guard product is monitoring temperature of hot spots in power transformers. Since its inception, Neoptix has developed expertise in this application, and is considered as a world leader in this field. Sister products of the T/Guard, the T/Guard2, T/Guard-Link, T/Guard-408, are fully dedicated to the power transformer industry. Neoptix publishes a User Guide, called "Probe Installation Guide", totally dedicated to the power transformer industry; do not hesitate to ask for your copy if you are working in this field (Neoptix document G1009).

3 UNPACKING

Before using your T/Guard thermometer, check the box content to be sure all items have been included. Your package should normally contain:

- T/Guard signal conditioner unit
- Mating connectors for the power input and for the analog output
- RS-232C interface cable (2 meters)
- User manual (this manual) (paper copy not included, supplied as a PDF document on CD)
- Neoptix OptiLink™ Pro software on CD (supplied with an unlocking key to transformer OEMs only)
- Calibration Certificate.

Warning: NO AC power supply is included with this T/Guard unit; a power supply must be ordered separately, or supplied by the user.

Options:
- Fiber optic temperature sensor probes
- Fiber optic extension cables
- Fiber optic coupling and feedthroughs
- RS-485 communication interface
- TCP/IP bridge communication interface, with Lantronix CD (may be on same CD as OptiLink)
- Modbus communication protocol
- Data logging option (T/Guard-DL and –I only)
- RS-232 to RS-485 converter
- Power supply module (universal input: 100-240 VAC, 50/60 Hz). Table top and DIN mounted models are available
- Carrying case & accessories.

Make sure all listed items have been received and are in good condition. Note any evidence of rough handling in transit; immediately report any damage to the shipping agent. Should a part be missing or damaged, please contact your distributor immediately. Returns must be made with the original packaging, accompanied by an return authorization number (RMA). Your distributor will provide you with information concerning the return of merchandise.

The carrier will not honor damage claims unless all shipping material is saved for inspection. After examining and removing contents, save packing material and carton in the event reshipment becomes necessary.

4 T/GUARD™ THERMOMETER HARDWARE REFERENCE

The following figure shows the T/Guard thermometer front panel[1]:
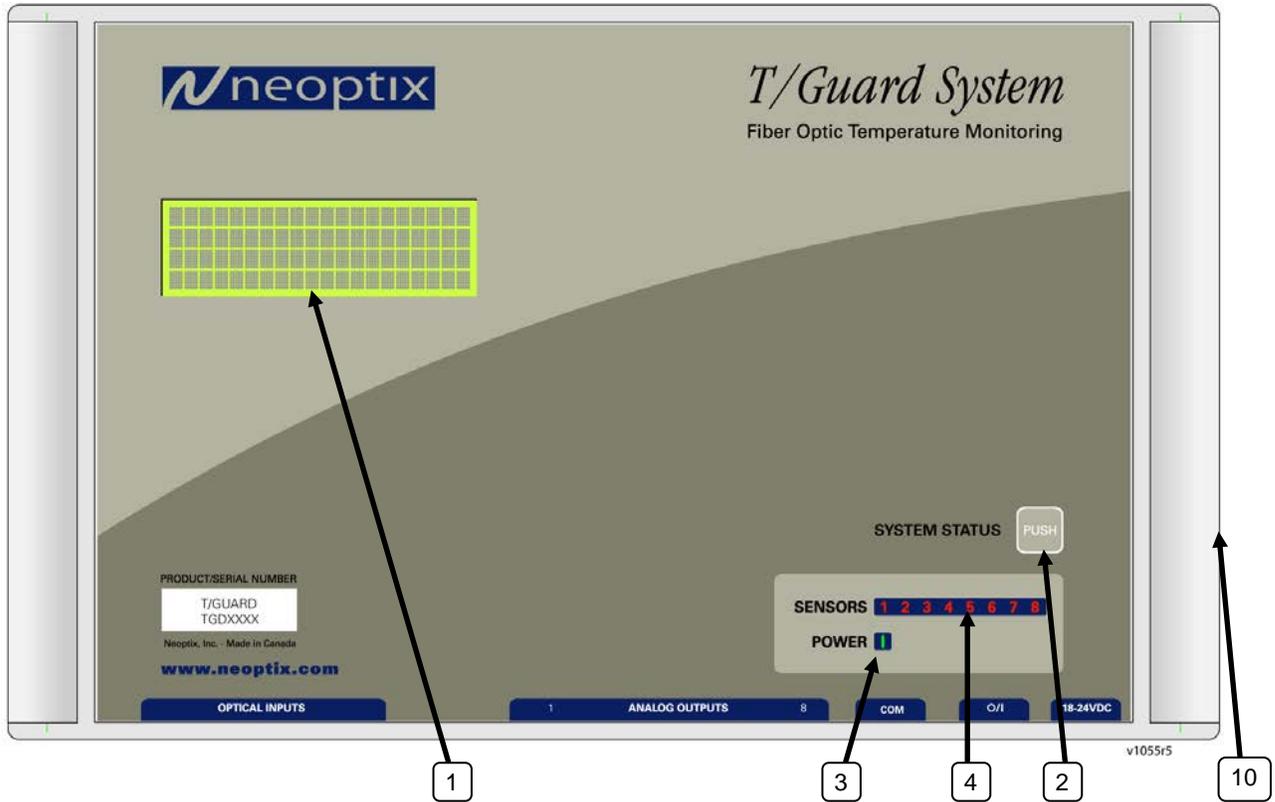
The T/Guard front (or bottom) panel is as follows (the version with more than 8 channels is different):

T/Guard System - Front view

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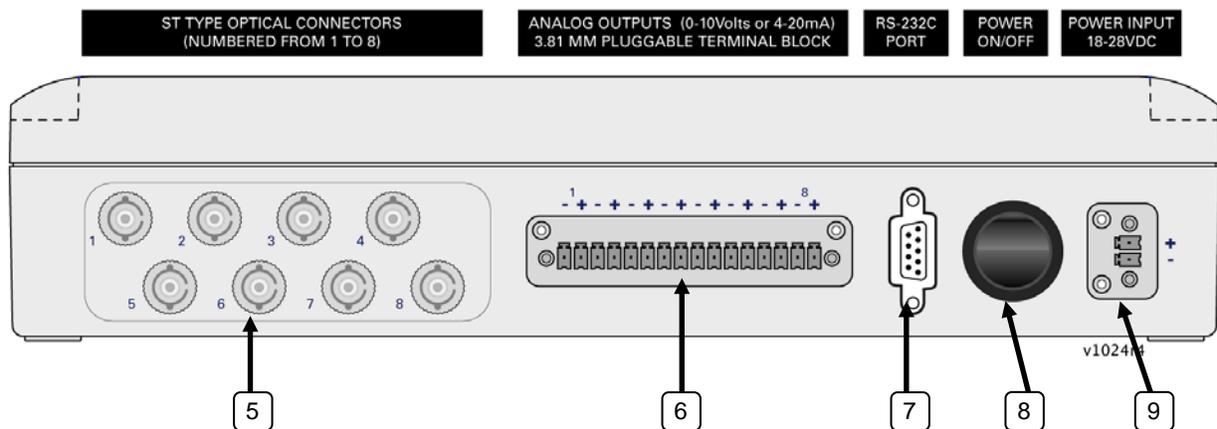
[1] For a view of the T/Guard-Link, please refer to Section 4.1.2.

For the T/Guard-I (with data logging, 2 connectors), the following front (or bottom) panel is as follows:

T/Guard System - Front view
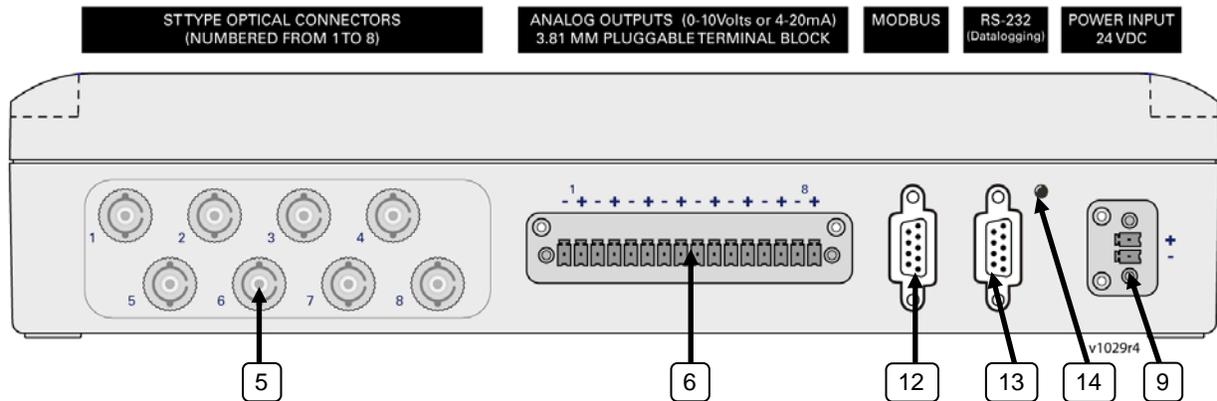
The following presents a full description of the user interface as well as detailed instructions on how to use the thermometer.

1a) 4 x 20 Display: For 1 to 8 channels: Under normal use, the display will show the temperature readings for the user selected channels; the temperatures are displayed in either ^{o}C or ^{o}F. Up to 8 temperature values can be shown simultaneously, as follows:

Line #	
1	1: 25.8 2: 25.3
2	3: 25.4 4: 26.0
3	5: 25.8 6: 26.1
4	7: 25.6 8: 25.7

1b) 10 x 20 Display: For 9 to 16 channels: The display will show the temperature readings for the user selected channels; the temperatures are displayed in either ^{o}C or ^{o}F. Up to 16 temperature values can be shown simultaneously, as follows (may differ due to installed options):

Line #	
1	NEOPTIX T/GUARD-16
2	01) +25.8C 02) +25.3C
3	03) +25.4C 04) +26.0C
4	05) +25.8C 06) +26.1C
5	07) +25.6C 08) +25.7C
6	09) +25.4C 10) +25.4C
7	11) +25.5C 12) +25.7C
8	13) +25.3C 14) +25.8C
9	15) +26.1C 16) +25.9C
10	25-JUN-2008 07:32:54

Note: The date and time can be set using the serial commands WD and WT respectively; see Section 6.4.1 for more details.

Update February 2014. T/Guard systems with 9 to 16 channels now have a different display, 4 x 40. The screen displayed at power on (for 4 seconds) is very similar to the one for 1-8 channel systems.

2) System Status key[2]**:** For 1 to 8 channels only. Furthermore, this function is not available with the **T/Guard-I**. This key can be used to temporarily display some probe related information. The following 4 information types will be sequentially displayed, by pressing this key multiple times. Normal display will return after 30 seconds of inactivity.

Max temperatures	Displays maximum temperatures, for each channel.
Min temperatures	Displays minimum temperatures, for each channel.
Power of probes	Gives the probe signal strength, for each probe. See Section 6.4.3 for more information.
CCD time	Gives the CCD integration time, for each channel. See Section 6.4.3 for more information.

Note: Holding the key pressed, while any of these values are displayed, can clear memorized minimum and maximum temperatures.

With the Modbus option, this key can be used to engage/disengage the Modbus option. To do this, hold this key down for a few seconds while the T/Guard is turned on[3]. See item 8 "Power Switch" below for more information.

With the **T/Guard-I**, this key can be used to toggle between the "Modbus" mode and the "Service" mode. These two modes are exclusive, i.e. they cannot be used simultaneously. Hold the switch down for at least 3 seconds to change mode, until the green led changes (the LED is lit in service mode, is *not* lit in Modbus mode). See items 12 to 14 below for more information.

3) Power status light.

4) Sensor status light(s): There are a total of up to 16 lights for this, one for each channel. These indicators inform you about the system status, as applicable to each channel. If any remains off, this indicates that either that channel is disabled (or not present for systems that have less than 8 channels) or there is a problem with that sensor (or with the optional extension cable connected to it). Check if all optical connectors are correctly mated or if the sensor fiber (or extension cable) is not broken.

A quickly flashing light indicates that the calibration table applicable to this channel is corrupted. If this happens, the integrity of the temperature readings for this channel is not guaranteed; please use precaution. Contact Neoptix for further information on how to resolve this issue.

5) Sensor connector(s): These are ST type connectors, mating to each of the 16 optical temperature sensors. If you need to extend a sensor fiber, you should use optional extension cables that are available from your Neoptix supplier.

> **Warning:** The fiber type that is used with your T/Guard thermometer is of a special type, and it is recommended that you get ALL of your extension cables from Neoptix or a Neoptix authorized distributor.

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[2] This key was previously called "LCD BACKLIGHT"; with this new software, its functionality has also changed as described above. On 9 to 16 channel T/Guard, the key is a black key mounted on the side of the thermometer.
[3] For 9 to 16 channel T/Guard units, the switch is a toggle switch (push-on and push-off); press on the switch once to change mode (Modbus to non-Modbus and vice-versa). Note that the switch is read only during power-on of the T/Guard; so you need to do a power off and on cycle for the T/Guard to confirm the change.

6) Analog output connector(s): There are a total of 8 connection pairs (16 connection pairs, if more than 8 channels), one pair for each channel. Prior to shipment, your T/Guard thermometer was factory set to one of the following configurations: 4-20mA or 0-10V output. The minimum analog output value corresponds to minus 100°C and the maximum analog output value corresponds to 300°C. The thermometer normal range is from minus 80°C to 250°C, so a minimum value indicates an under-range error; likewise, a maximum value indicates an over-range error condition. Note: T/Guard thermometers that have extended range, such as cryogenic version, may differ; contact Neoptix for more information. If there is a sensor problem for a given channel, the analog output may take one of the following 3 states (refer to the RS-232 "o" command, Section 6.4):

    a) It will toggle between the minimum and maximum values, at approximately 0.5 Hz; this indicates a sensor problem for that channel ("o0"). This is the default setting; to change it, you will need to use the RS-232 "o1" or "o2" command.

    b) The analog output is forced to its maximum value ("o1"); this would indicate a "too-hot" situation.

    c) The analog output is forced to its minimum value ("o2"); this would indicate a "too-cold" situation.

    Warning: 1- Do not connect any external voltages to these outputs; this may cause permanent damage to the thermometer unit. 2- Avoid shorting output leads together, as this may destroy the electronic drivers inside the unit.

Note: If the T/Guard unit is in "sleep" mode, the analog outputs will keep their values until the T/Guard acquires new temperature values.

16-position mating connectors are supplied with the T/Guard system. When using long wires to the analog outputs (4-20mA), it is recommended to use shielded twisted pairs, size AWG 24 or 22. The shield should be grounded at one end only, preferably the T/Guard end.

Update November 2013: All 6-channel systems are now programmed so analog output channel # 7 will output the maximum temperature read from optical channels # 1, # 2 and # 3; analog output # 8 will output the maximum temperature read from optical channels # 4, # 5 and # 6.

7) RS-232 or RS-485 communication interface: This port is used to configure and extract information for the instrument. This DB-9 connector uses the same pin-out as a COM port on a PC computer. Use a simple pin-to-pin wired cable (not a null modem cable) to connect to a computer. See Section 6.4 for a complete description of the serial commands that are available.

A RS-485 interface is also available. This option would normally be used when the Modbus option is desired. Refer to the Modbus Chapter 8 or contact Neoptix for more details. Optional RS-485 to RS-232 or to USB converter is available from Neoptix; contact your representative or Neoptix for more details.

For the T/Guard-Link, the DB9 connector pin-out is given in Section 4.1.2.

8) Power switch. Make sure the T/Guard power supply module is connected and powered.

At power on, a series of messages are displayed (actual information may slightly differ):

1 to 8 channel version (4 lines):

```
T/GUARD SYSTEM
4 CHANNEL VERSION
CAL: 05/12/25
WWW.NEOPTIX.COM
```

9 to 16 channel version (11 lines)[4]:

```
NEOPTIX T/GUARD-16[5]
01)  125.2C    02)   88.4C
03)  125.2C    04)   88.4C
05)  125.2C    06)   88.4C
07)  125.2C    08)   88.4C
09)  125.2C    10)   88.4C
```

---

[4] Systems built after February 2014 have a different display layout: it is very similar to the 1-to-8 version.
[5] Actual number represents the number of optical channels.

```
11) 125.2C  12)  88.4C
13) 125.2C  14)  88.4C
15) 125.2C  16)  88.4C
MB-⁶
04-MAR-2010  13:23:21
```

However, the first line may show different information depending on what options are included with your T/Guard system. The following table shows all the possibilities.

Basic version, 1 to 8 channels:	`T/GUARD SYSTEM`
Basic version, 9 to 16 channels:	See above display
1 to 8 channel version, with Modbus option	`T/GUARD MB-` or `T/GUARD MBxxx`
1 to 8 channel version, with the Modbus and data logging options. Data logging is available using side DB9 connector, see item #10 below.	`T/GUARD DL+ MBxxx`
T/Guard Link (with no display) 1 to 8 channels.	Modbus mode always enabled, except if pins 6 and 7 on the DB9 connector are shorted together during the system boot-up (a few seconds while the T/Guard is turned on). In non-Modbus mode, you can use HyperTerminal and OptiLink as described in Chapters 6 and 7 below. Furthermore, section 11.2 for more information. See Section 4.1.2 also.
T/Guard -I (2 connectors, one RS-485 for Modbus, one RS-232 for data logging).	A LED (near the data logging connector) is lit when the Modbus option is disabled.

Toggling between the 2 modes (Modbus mode enabled or disabled) can be done by turning off the T/Guard system for a few seconds, and then by turning it on again but while holding down the System Status key for a few seconds. For the T/Guard-I model, mode can be changed at any time by pressing the System Status key for a minimum of 3 seconds (the led near the RS232 connector is off when in Modbus mode).

The third line gives the date of the last calibration, YY/MM/DD; this is for information only. When the double calibration feature is available, the 3rd line is modified to indicate which of the two calibrations is now active:

Or
```
CAL: 05/12/25 NE
CAL: 05/12/25 NO
```

Where "NE" indicates that Neoptix probes are now used, "NO" when Nortech Fibronic inc. probes are used.

For the 9 to 16 channel version, the calibration date information and calibration type can be verified only by using the OptiLink or HyperTerminal software. See Section 6.

---

⁶ "MB-" (Modbus disabled) or "MBxxx" (Modbus enabled) is displayed only if your T/Guard unit is equipped with the Modbus option. "xxx" represents the Modbus address (node address) for this T/Guard, as a decimal number. See item 2) "System Status key" above for instructions on how to switch mode (Modbus to non-Modbus, and vice-versa).

Then temperatures should then be displayed, assuming they are correctly connected, and so forth. If temperatures are unreadable, **-----** will be displayed.

9) 18-24 Volt DC power connector: You can use a DC power supply from 14V to 28V; note that at 15V or less, you will be unable to use more than one (1) 500Ω load at the analog output, for all current output configurations. There is an internal fuse, to protect the system in case of electrical problems; this fuse is *not* user changeable.

A 2-position mating connector is supplied with the T/Guard system. The provided Phoenix Contact connections are made to accept wire gauges ranging from 24 to 14 AWG. Optimal torque is 0.22 to 0.25 Nm.

10) RS-232 data logging port: This optional DB9 connector (located on the right side of the T/Guard-DL+ model) should be used to set the data logging parameters and to download the internal memory. The baud rate is fixed at 9600. Windows' HyperTerminal (or equivalent should be used) to control this port; see Section 6.4.1 for more information.

11) TCP/IP Ethernet RJ45 connector: This optional connector, not shown above, is located on the right side of the T/Guard enclosure. A recessed toggle switch is used to "switch" between the RS232 port and the TCP/IP port. When the TCP/IP port is enabled, four LEDs will turn on and off, to indicate the communication and Ethernet link status. For more information, see Section 9.

12) RS-485 Modbus port (T/Guard-I only): This DB9 connector should be used for permanent Modbus connection (2-wire is standard). The Modbus communication is enabled only when the green led (see item 14) is *not* lit.

13) RS-232 Service port (T/Guard-I only): This DB9 connector should be used to connect to OptiLink, program parameters, including data logging parameters, and to download logged temperature data (see Section 6.4.1 below for more information). This mode is only active when the green led is lit.

14) Mode status indicator (T/Guard-I only): In normal operation (Modbus mode), this green led should be off. In data-logging mode, it must be on. Please note that the two modes of operation are exclusive, i.e. only one can be active at any given time. Use "System Status" key (item 2 above) to toggle between modes.

4.1 Mechanical Installation

4.1.1 Standard T/Guard

The following drawing presents the mounting points available on the T/Guard system. The T/Guard system is designed to be fixed on a vertical surface using 4 screws (10-24 socket head cap screws are recommended, ¾" inch long or more).
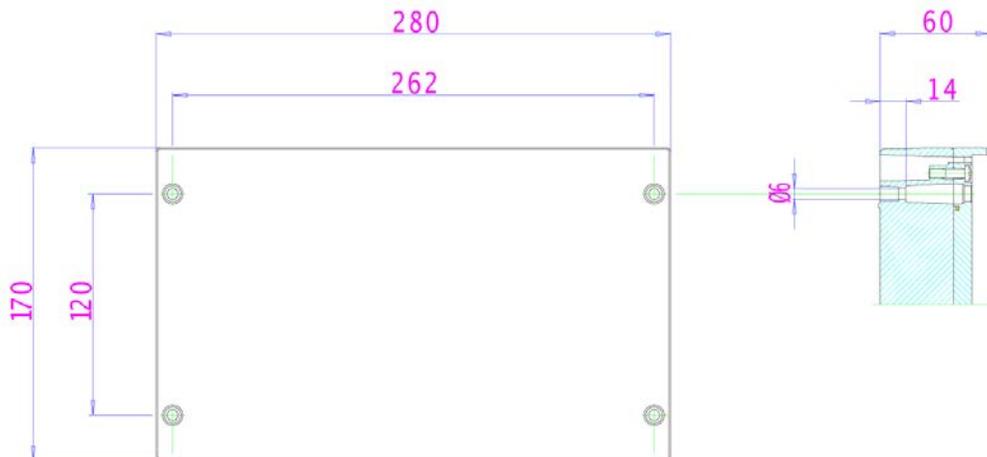
To gain access to the mounting holes, you need to remove the 2 side trims; these can be removed simply by pulling them out with your fingers, as shown below.

Note: The depth of the 9-16 channel version is 91 mm (compared to 60 mm for the 1-8 channel version).

4.1.2 T/Guard-Link

The T/Guard-Link layout is shown below. Please note that this T/Guard has limited user interfaces. It can communicate either in Neoptix native protocol mode or in Modbus mode; the Modbus mode is normally active after system power up; refer to Section 11.2 for instructions on how to do this.
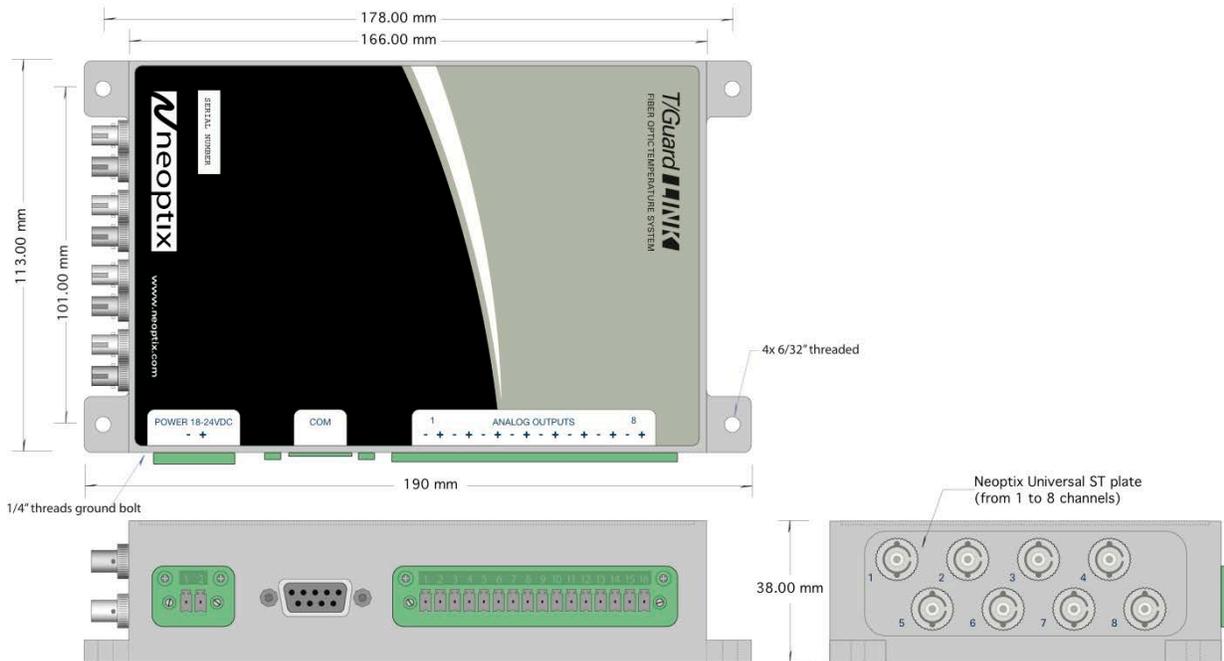
DB9 connector definition for the T/Guard-Link:

DB9		RS232	RS485 2W	RS485 4W
P I N O U T	1		GND	GND
	2	TX		
	3	RX		
	4			RX-
	5	GND	TXRX-	TX-
	6	*MB SW*	*MB SW*	*MB SW*
	7	*MB SW*	*MB SW*	*MB SW*
	8			RX+
	9		TXRX+	TX+

5 USING THE TEMPERATURE PROBES

5.1 Caution

Each time you connect a temperature probe to the unit, the probe **optical connector should be cleaned beforehand.** Otherwise, particles of grease or dirt may obstruct the device internal connector and affect the measurements by completely blocking the signal or by generating too much attenuation when using a long fiber length.

Never use a cloth other than the type recommended for fiber optic cleaning. Dampening the cloth with pure isopropyl alcohol ensures good cleaning.

Occasionally, clean the inside of the bulkhead connector (attached to the thermometer) with a wipe or cotton swab dipped in alcohol (2.5 mm mini foam swabs work best).

Locking nut

Ferrule key

Ferrule
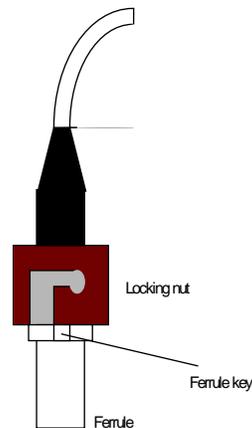
For very dirty connectors, acetone can also be used, but should be used very carefully, as it is a very strong solvent. Care should be exercised so you do not apply any on plastic materials, etc.

5.2 Description

The optical connector used is a standard ST type connector.

Device connector

Insert the Ferrule key here

Pins BNC type
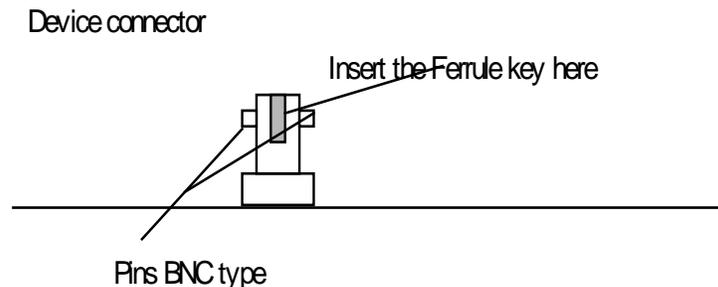
To install the connector,
Slide the ferrule key gently into the above key.
Then, turning, insert the two BNC pins into
The appropriate slots on the ST connector.

5.3 Warning

The T1 probe is quite fragile and it must be handled carefully. Please note that any probe damages are not covered by the standard warranty.

The probe tip is made of silicone rubber. Although silicone is resistant to a large number of chemical aggressors, strong acids or alkali may damage it, especially at high temperature and/or if used for extended periods of time. Warning: Solvents and fuel oils can cause problems for silicone rubber.

Neoptix also manufactures probes that have their tips made of epoxy. Just like silicone, epoxy resin is resistant to a large number of chemical aggressors, strong acids or alkali may damage it, especially at high temperature and/or if used for extended periods of time.

Contact your distributor for additional chemical compatibility information.

Do not expose your probes to temperatures that are higher than specified. Permanent damage can be caused to probes that have been exposed to temperatures that are higher than their limits.

5.4 Working with long probes

This note is important when using probes or extension cables that have a combined length of 100 meters or more. Working with long probes or extension cables may present special problems. To limit the amount of back reflection caused by the fiber optic connector located on the thermometer unit, you may have to use a matching gel optical couplant in the connector. This gel is a grease-like compound with high clarity, good resolution properties and a refractive index close to quartz. Apply the gel onto connector end faces.

Avoid disconnecting the connectors for which gel has been used. In other words, it is recommended to use the gel only for permanent installations. If the connectors are disconnected many times, you may have to clean entirely the connector assemblies that have had the gel; this may require opening the instrument enclosure to remove the excess gel.

Note that it is not required to use this gel with connectors that are far away from the thermometer electronic unit.

5.5 Working with cryogenic probes

The use of a cryogenic probe required special attention. In particular, the probes become more brittle at very low temperatures. Avoid cycling the probes quickly between cryogenic temp and ambient temperatures, as this may cause material fatigue at the probe tips.

Warning

Always wear protective gloves and clothing when working with cryogenic material.

Never use general purpose probes at cryogenic temperatures. Neoptix sells special probes that can be used at cryogenic temperatures.

Please note that your T/Guard thermometer will require a special factory calibration to be used at cryogenic temperatures (below -80°C). Consult Neoptix for more information.

5.6 Installing probes in power transformers

Neoptix offers a complete line of T2 type probes that are specifically designed to be installed inside transformer windings, to monitor temperatures of hot spots. Please refer to the Neoptix' "Probe Installation Guide Inside Power Transformers" (document G1009) for recommendations and instructions on how to install and handle these probes, to maximize your success rate for this application.

6   SERIAL COMMUNICATION DESCRIPTION

You can communicate with your T/Guard thermometer via the standard RS-232 link. A description of the cable requirements is given above, under front panel item # 7.

RS-232 functions (or commands) can be accessed with a simple terminal, or using OptiLink software package or simply with a computer and communication software (such as Windows Hyper Terminal). Your software should be set at 9600 Baud, 1 Stop-Bit and No-Parity.

With the **T/Guard-I**, make sure the module is in service, or non-Modbus, mode before attempting using Hyper Terminal or OptiLink.

6.1   Using OptiLink Console

The New OptiLink software package now includes a convenient console option that can be used to "exercise" your T/Guard serial communication protocol. With this console, there are almost no more reasons to use HyperTerminal or equivalent to use the serial commands that are described in this Section.

Refer to the next Chapter for instructions on how to use OptiLink.

6.2   Using HyperTerminal in Windows

Hyper Terminal is a standard Windows program (XP and previous versions[7]) that can be easily used to exercise your T/Guard thermometer. To use Hyper Terminal you first set its properties as follows:

1- In the "Connection Description" window, enter a name that suits you, such as "Neoptix-Reflex". Click OK.
2- In the next window, "Connect To", select COM1 (or another COM port, if you are planning to use another port than COM1) in the box called "Connect using". Click OK.
3- Then the COM1 Properties window will come up. As indicated above and as shown in the figure at right, set the port parameters to 9600 Baud, 1 Stop-Bit and No-Parity; Flow control must be set to None. Click OK.
4- You are ready to go. Type "h E   " to test your setup (see below). Warning: the characters that you enter are not echoed to you!

---
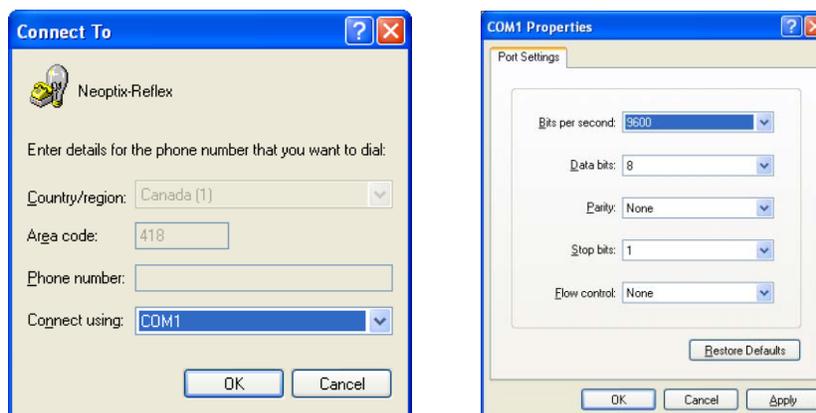
[7] Vista, Win-7 and Win-8 users: HyperTerminal is not included with Vista and subsequent Windows versions. However, an equivalent program (HTPE) can be downloaded (for a fee) at the following website: http://www.hilgraeve.com/htpe/download.html. Tera Term (freeware) has also given good results; see http://ttssh2.sourceforge.jp/.

6.3 RS-232 help menu

The following is the menu as displayed by the instrument when sending the "h" command. Note that the RS232 interface can also be used to upgrade the thermometer controlling firmware, without opening the thermometer case or changing any memory IC's. Instructions to perform an upgrade are normally sent with the upgrade program (NeoProg); an IBM-PC compatible computer will be required to perform such firmware upgrade.

Note: With the Modbus option enabled, this help menu is slightly different; see the Modbus chapter for more information. Furthermore, some commands may not be available on specific T/Guard models.

T/Guard-1	T/Guard-2, -4 or -8	Description
a	a	Ignore
b	b	Return enclosure temperature
c	c[i]	Ignore
N/A	e[1;2; ... ;n]	Enable channels to scan (if no argument, scan all)
f[j]	f[i;j]	Set point adjustment on channel [i] to [j]
gskip[i]	gskip[i]	Skip up to i marginal read cycles
h	h	Help menu (this screen)
H	H	Logging help menu (**Note**: Requires the data logging option)
i	i	Get factory and status information
n+o *or* n+e	n+o *or* n+e	Toggle calibration (n+e for Neoptix, n+o for Nortech Fibronic inc.)
o[i]	o[i]	Analog out, if error (0:Max-Min 1Hz, 1:Max level, 2: Min level)
p[i]	p[i]	Sleep mode (p+ to sleep, p- for continuous scanning)
q	q	Scanning rate (q+ for fast/quick, q- for slow)
r	r	Ignore
s[j]	s[i;j]	Specify analog output Span [j] for channel [i]
t	t[i]	Get Temperature reading channel [i]
ta[i]	ta[i]	Continuous output to serial port (+ to enable, - to disable)
tb[nnnn]	tb[nnnn]	Ignore
u[i]	u[i]	Unit (c = $^\circ$Celcius, f = $^\circ$Fahrenheit)
x	x	Ignore
wtune[i]	wtune[i]	Optimize CCD read time (wtune+ to enable, wtune- to disable)
y	y	Signal strength
z[j]	z[i;j]	Temperature [j] for analog output Zero on channel [i].

6.4 Detailed description of RS-232 commands

All commands must be terminated by a carriage return character (E   ). When more than one argument is required, each argument must be separated from the next one by a blank or space character. Characters are not echoed back to your controlling device. Commands are case sensitive; i.e., "h" is not the same command as "H". .

Every time a command is executed successfully by the thermometer, the "*" prompt character is automatically sent, except in case of failures when the "Errx" error code is sent instead. Do not send your next command before receiving either the "*" or the "Errx" prompt. The "[" and "]" characters must not be typed in; they are used here for ease of reading only.

Most commands are applicable to all T/Guard models (different number of channels). When using one-channel model, the channel number [i] must not be typed in. Logging commands (T/Guard-DL and T/Guard-DL+) are described in the next Section, 6.4.1.

"a" Ignore.

"b" This command returns the internal temperature of the enclosure. The temperature is returned in $^{\circ}$C or $^{\circ}$F unit, as specified by the "u" command.
Ex: "b:32.2 E   "

"c" or **"c[i]"** Ignore.

"e[[-]1 [-]2 ... [-]n]" This command is not recognized by the one-channel model. Specify which channels are enabled and read by your T/Guard. Preceding a channel number with the minus sign "-" will disable that particular channel. This command is useful to ignore channels that are not currently used. Enter the channel numbers that you would like to use, each one separated by a blank character.
Ex: "e-1 2 3 E   ", to enable only channels 2 and 3 and at the same time to deactivate channel 1.

"f[j]" or **"f[i j]"** This command forces an actual temperature reading (j) for channel # i; any resulting offset will be applied to all future measurements for that channel. This is useful to compensate for small temperature deviations that may occur between sensors. This is also called a one-point calibration correction. A maximum offset of +/-5°C is recommended; if it is required for you to force a larger offset, your thermometer probably requires a new factory calibration; consult your distributor or factory for more information. This command can also be used to force older Nortech Fibronic inc. probes to read similar temperatures as the newer Neoptix probes. This command alters the internal calibration of the instrument. Always follow the recommended procedure, as given below.

Force temperature procedure:

   I.   Apply a stable and known temperature to the sensor tip
   II.   Check the display reading for abnormal deviation from the known temperature
   III.   Send the "f" command followed by channel number, a blank character and the reference temperature value (example "f2 27.0 E   "). Temperatures must be entered in units as specified by the "u" command
   IV.   Wait a few seconds
   V.   Confirm that the readings correspond to the known temperature.

Note: You can revert at any time to the factory calibration using the "f" (or "f[i]") command (ex: "f2 E   "). This will in effect clear any offset that you may have entered.

Note: Always make sure you are reading a valid temperature value before using the "f " command; otherwise, your thermometer may display a random value for a channel where the "f" command has been used.

"gskip[i]" This command is useful to eliminate annoying dropouts that can happen when using "weak" probes. The parameter "i" indicates the number of scans that the T/Guard system will perform before actually indicating that it cannot read the probe on a specific channel. The range of i is from 0 to 9; a value of 0 indicates that the T/Guard makes no attempt at removing dropouts. A value of 3 to 5 is recommended, especially for transformer applications. This command is active even when the sleep command is valid, but is limited to a timeout of 2 minutes.

"h" Displays a help menu screen (see above).

"H" Displays a help menu that is specific to the data logging option. See Section 6.4.1 below.

"i" Returns general information regarding the instrument, as well as some parameters that have been programmed previously in the thermometer, usually using RS-232 commands:

Ex:	Model:		T/Guard*	
	Option:		NB Channel: 4	
	Mode:		Continuous Scanning Mode (0x0B)	
	Scanning rate:		Fast	
	Calibration type:		Neoptix probe	
	Serial:		TGD120A	
	Internal Software:		0.2.05d	
	Last Factory Calibration:		05/02/04 (YY/MM/DD)	
	Unit		^{o}C	
	Analog out, if error		Toggle Max-Min 1Hz	
Channel	Zero	Span	Enabled	Temperature offset**
1	xxx.x	xxx.x	Yes/No	±xxxx.x
2***	xxx.x	xxx.x	Yes/No	±xxxx.x
3***	xxx.x	xxx.x	Yes/No	±xxxx.x
4***	xxx.x	xxx.x	Yes/No	±xxxx.x

*:   T/Guard-DL is displayed when the data logging option is installed.
**:   Temperature differential that is a consequence of the "f" command.
***:   Only for multi-channel models.

"n+o" or "n+e" This command can be used to change the calibration type that is active at any give time. "n+o" should be used to enable the Nortech Fibronic inc. calibration, while "n+e" should be used for Neoptix probes.

"o[i]" This command can be used to change the behavior of the analog output(s) when the T/Guard thermometer cannot read a temperature for this channel. "i" can take one of three values:
a)   i=0. This is the default value, to assure compatibility with older Nortech Fibronic inc. Reflex thermometers. With this setting, the analog output will oscillate between its maximum and its minimum value at a rate of approximately 1Hz.
b)   i=1. In case of a probe problem, the analog output for this channel will be forced to its maximum possible value (e.g., 10V or 20mA).
c)   i=2. In case of a probe problem, the analog output will be forced to its minimum possible value (e.g., 0V or 4mA).

"p[i]" This command allows the user to force the T/Guard thermometer to enter in sleep mode (p+) or to exit it (p-). Once in sleep mode, the thermometer will acquire new temperature values ONLY when the "t" or "t[i]" command is received; when the t command is received, the thermometer will immediately scan all enabled channels, and the new temperature values will be displayed and sent through the RS-232 link, after which it will return again in sleep mode (there is no need to resend the p+ command again).
a)   When the thermometer is powered on, the sleep mode is always disabled.
b)   When new temperature values are acquired, these new values will be shown on the display (if present) for about 120 seconds, after which "Sleep mode" will be displayed.
c)   The analog outputs will keep the last temperature readings, until new ones become available (for a maximum of 120 seconds).
d)   The front panel led status lights will keep their values until new readings are acquired.
When the "gskip" command is active, and that the temperature is read using the "t" command during sleep mode, a non-valid temperature indication will be returned after a maximum of 2 minutes following the last good temperature reading.

"q" "q" allows for selecting the fast (q+) or the slow (q-) acquisition mode. In slow mode, the last few temperatures are smoothed before being displayed or sent to the RS-232 port; this provides a better reading at the expense of being slower.

"r" Ignore.

"s[j]" or **"s[i j]"** This command will set the analog output span for the analog channel # i (if using a multi-channel thermometer, the "i" parameter specifies the channel to which the command is addressed). The "j" parameter specifies the span that can range from 1.0 to 1000.0, in temperature units that are defined by the last "u" command.

"t" or **"t[i]"** Returns the current temperature reading for channel # i. "---.-" is displayed if the specified channel number is not currently enabled or when no valid temperature is available for the requested channel. For multi-channel instruments, if the "t" command is received without parameter, the temperatures for all channels are returned. All temperatures are returned in ^{o}C or ^{o}F unit, as specified by the "u" command.

Ex: "t4 E   " will return the temperature for channel # 4.

         "t E   ", with the T/Guard-4 thermometer, will return:

         +24.3<CR>
         +24.5<CR>
         +24.7<CR>
         +24.4<CR>
         *

The "t" command is also available in a special "**ta**" version, that can be useful for continuously and automatically monitoring all enabled channels. This special mode is recommended when automatically acquiring temperature readings with a suitable data-logging software, and can be activated by issuing the "ta+" command, or deactivated with the "ta-" command. Once activated, the following information is automatically sent when the temperature on a channel has been acquired:

         `"C:I;T:  ±xxx.x<CR>"`

Where i is the channel number, and xxx.x is the temperature reading (signed number). For the T/Guard-1 model, i is always 1.

The "t" command can also be used when the sleep mode is active: When the t command is received, the T/Guard will temporarily get out of sleep mode to read the temperatures on all channels, and then return the values of these temperatures.

"tb[nnnn]" Ignore.

"u[i]" Set units of measurements to either Celsius (i=c) or Fahrenheit (i=f).
Ex: "uc E   ", to select ºC (Celsius).

"x" Reserved for service and maintenance purposes.

"wtune[i]" This command can be used to increase the optical integration time of each channel (each of the 1 to 8 channels are treated independently) to force the T/Guard system to read temperatures when the optical signal is weak, at the expense of a slower response (slower temperature update frequency). This command (wtune+) enables this feature for all channels (individual channel cannot be enabled or disabled). It should be noted that in general the scanning rate of the system would slow down when this command is enabled. It is highly recommended for power transformer applications.

Warning: When wtune is enabled, and that a probe is inserted, or removed, it may take some time (several seconds, when multiple channels are being optimized at the same time) for the T/Guard to detect the probe, due to the optimization process that takes place.

"y" The "y" command can be used to confirm the "signal strength" or "power" of a probe and/or its connection. It can be used as a diagnostic tool to confirm the good operation of a probe and its extension cable (if applicable) connected to a channel. The returned value can be between 1.00 to approximately 3.00; a higher value is better. A minimum of 1.25 is normally required for a channel to return a valid temperature reading. See Section 6.4.3 for more information on how to interpret the command results. .

Ex: "y E   ", with the T/Guard-4 thermometer, will return:
```
CH1: 85%, ratio:1.91, lamp:110, CCD:150ms (auto*) +24.7 <CR>
CH2: 76%, ratio:1.97, lamp:120, CCD:130ms (auto) +25.3 <CR>
CH3: 0%, ratio:1.06**, lamp: 105, CCD:400ms (auto) ---.-- <CR>
CH4: 66%, ratio:1.78, lamp: 90, CCD:180ms (auto) +24.9 <CR>
```

*: Value: Auto (when wtune+ is active) or Fixed (when the wtune command is disabled).
**: 0.3 to 1.1 indicates that no probe is detected for this channel.

 z[j[or **z[i;j]]** This command is used in conjunction with the "s" command, as it sets the temperature that corresponds to the analog zero (minimum value of analog output). For multi-channel models, the "i" parameter specifies the channel to which the command is addressed; valid values are 1 to 8 (the maximum is the number of channels for your specific unit). The "j" parameter specifies the zero temperature value, and can range from -100.0 to 1000.0, in units that are defined by the last "u" command. Factory default is –100.0; T/Guard thermometers that have been factory calibrated for cryogenic temperatures have a lower setting.

6.4.1 Temperature logging commands

When the data logging option is installed (T/Guard-DL), the following help sub menu is available. This special help menu can be invoked using the "H" command.

Windows' HyperTerminal is required to issue these commands and to download the logged data (OptiLink does *not* support this data logging format).

For model T/Guard-DL+ (-D1 option in latest release), where a special RS-232 serial port is installed on the right side of the T/Guard system, the data logging commands are only accessible via this special port. Baud rate is fixed at 9600.

Warning: With this RS232 data-logging DB9 connector, you MUST use a software such as HyperTerminal or Tera Term. You MUST NOT use NeoLink or OptiLink! If you inadvertently use NeoLink or OptiLink, this will block all communication on this data-logging connector, and the only way to recover from this is to reset the T/Guard (by turning its power off and then on after a few seconds).

The following is the menu that appears when the H command is issued.

Logging help menu (case sensitive)	
D:xxxxxxxx	Download file xxxxxxxx*
E:xxxxxxxx	Erase file xxxxxxxx
FORMAT	Erase all files**
L	List all files
RD	Read date (dd-mmm-yyyy)
RR	Read logging rate
RS	Read logging status
RT	Read time (24h format)
SP	Stop logging
ST	Start logging***
WD:yyyy/mm/dd	Write current date
WR:n n 1, 2 3, 4, 5, 6, 7, 8	Write logging rate Logging rate, as follows: 10, 30 seconds 1, 2, 5, 10, 30 minutes, 1 hour
WT:hh:mm	Write current time (format 23:59).

*: Default file extension is always .neo; this extension is automatically added to the file name. Thus, there is no need to specify any extension.

**: This will delete ALL files. Must be used with care!
***: Logging filenames are always automatically assigned, see next Section.

"D:xxxxxxxx" This command will download file xxxxxxxx. All filenames must have 8 characters; extension (.neo) is optional. See next section for file naming conventions. A file can be downloaded while logging is active; however, you cannot download a file that is currently open for logging. See Section for downloading instructions.

"E:xxxxxxxx" This command will erase file xxxxxxxx; extension (.neo) is optional. File is erased permanently. **Warning**: this will delete the file without further request; make sure file name is correctly entered before finishing the command with a E .

"FORMAT" This command will format the internal T/Guard permanent memory. All files will be erased without further request…, must be used with care!

"L" This command lists all files currently present in permanent memory (internal SD card). Please note that the files are listed according to the order they are in memory, which is not necessarily alphabetical. If a file is currently open (i.e., logging is active), that file will be listed as well. The size of each file is given, in Kbytes, for information. The last line indicates how many files were listed, along with the total memory size used by these files. An example follows:

```
List of files:
>07043001.NEO    1 KB
>07043002.NEO    1 KB
>07043003.NEO    8 KB
>07050101.NEO    1 KB
>07050102.NEO   10 KB
>07050103.NEO    1 KB
>07050104.NEO   23 KB
>07050105.NEO    1 KB
>07050106.NEO    2 KB
>07050107.NEO    1 KB
>07050108.NEO    1 KB
>07050109.NEO    1 KB
Total: 12 files, 47 KB
```

"RD" Return current date. Format is dd-mmm-yyyy.

"RR" Return current logging rate status. See command "WR" for more details.

"RS" Return logging status. Will return either:
> Logging to file xxxxxxxx.neo, if logging is active
> Not logging, if currently not logging.

"RT" Return current time. Format is hh:mm:ss.

"SP" Stop logging, if active. Operation can be confirmed with the RS command.

"ST" Start logging. Operation can be confirmed with the RS command. In case of a power failure, logging will always resume (irrespective of its previous setting) when power to the T/Guard-DL returns; in this case, the minimum logging rate is set to 1 minute (to avoid filling unduly the memory).

"WD:yyyy/mm/dd" Write new date.

"WR:n" Write logging rate, where n can have a value ranging from 0 to 8, as per the following table:

N	Logging rate
1, 2	10, 30 seconds
3, 4, 5, 6, 7	1, 2, 5, 10, 30 minutes
8	1 hour

"WT:hh:mm" Write new time. Format is 24hr system, i.e., 23:59.

6.4.1.1 File naming convention

File names are structured as follows: YYMMDDXX.NEO, where:
- YY represents the current year (e.g., 06)
- MM represents the current month
- DD represents the current date
- XX is a sequence number that starts at "01", and can go up to "99"
- .NEO is a fixed file extension.

Furthermore, file sizes are limited to 65500 lines, to ease their import to spreadsheet such as Microsoft Excel. When the 65500 limit is reached, a new file is open using the next available file sequence number. Typical file content may look like this:
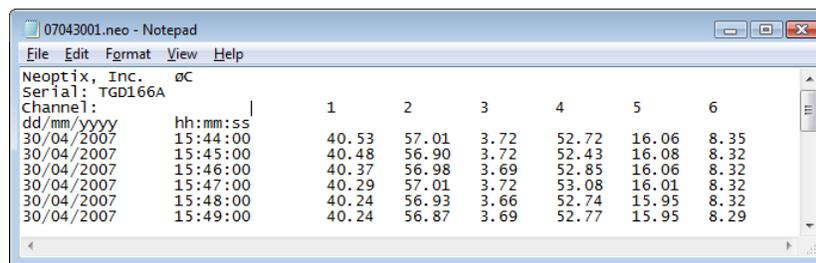
A timestamp accompanies each temperature entry (24 hour time format). File format is tab delimited, offering an easy import path by Excel.

As the sequence number is limited to 99, you are limited to a total of 99 logged files per day. Also, if you are logging temperatures when the clock reaches midnight on any given day, the next file that will have its name constructed based on the new date, and the sequence number will be reset to "01".

6.4.1.2 File downloading instructions

A file can be downloaded using the Xmodem file transfer protocol. HyperTerminal (with Vista and Win-7, use HTPE) supports this file transfer format. Follow the following instructions step by step.

Warning: The OptiLink console cannot be used to download files.

1- Make sure HyperTerminal is open and correctly configured.

2- Make sure data logging is stopped. The command "SP" can be issued for this.

3- Issue the download command, including the file name you want to download. Example: D:07043001.neo E   (.neo extension in optional).
   Note: You cannot download a file that is currently open for logging.

4- From the HyperTerminal main menu, select Transfer, then Receive File. The following window will open:

Receive File

Place received file in the following folder:
C:\Program Files\Neoptix\NeoLink   [Browse...]

Use receiving protocol:
Xmodem

[Receive] [Close] [Cancel]
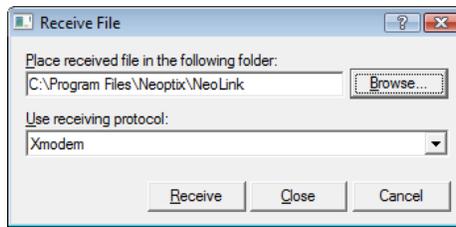
5- Select Xmodem as the receiving protocol, and make sure the folder is correctly set. You will need to set a proper receiving file name when the next window opens. Click OK.

6- Click Receive. The following window opens, giving feedback on how the downloading is proceeding.

Xmodem file receive for Neoptix_Com4

Storing as: C:\Program Files\Neoptix\NeoLink\07043001.neo

Packet: 8   Error checking: CRC

Retries: 0   Total retries: 0   File: 1K

Last error: Throughput:

Elapsed: 00:00:01

[Cancel] [cps/bps]
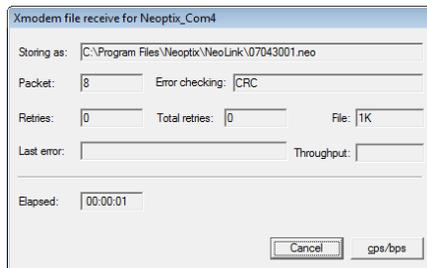
Warning: As files are transferred using a 9600 baud serial protocol, large files can take considerable time to transfer to your PC. The following table gives approximate download time for some file sizes (transfer rate is about 640 bytes per second):

File size	Description	Download time
4.8 Mbytes	File for 8 channels and 65500 lines	~129 minutes
1.7 Mbytes	File for 1 channel system and 65500 lines	~46 minutes

7- You need to repeat this process for all the files you want to download.

The downloaded files can be easily read using Excel, or equivalent.

6.4.1.3   Internal memory capacity

The total capacity of the internal permanent memory reserved for data logging is 1 Gbyte. Although this is a very large memory, some considerations should be taken to avoid overflow problems. As information, the following table gives approximate logging periods, given various channel numbers and logging rate.

Logging rate	Number of channels	Logging autonomy
1 second	8	164 days
1 minute	8	26.8 years
10 minutes	8	268 years
1 second	1	460 days
1 minute	1	75 years
10 minutes	1	756 years

Warning: The T/Guard-DL will *not* automatically delete older files when the internal memory becomes full. Files *must* be deleted "by hand", using either the FORMAT or the E:xxxxxxxx command.

6.4.2 Recommended configuration, for transformer applications

For transformer applications, it is recommended that the following parameters be set as follows:

Feature	Benefit description	Command
Ignore bad scans	This allows for better stability of the analog outputs, when working with "weak" or "marginal" probes.	gskip5
Fast scanning rate	Precision of readings obtained with the fast scanning mode is enough for this application.	q+
Auto-tune CCD	Optimize the CCD operation, especially useful when working with "weak" or "marginal" probes. Has the advantage also to lower the voltage on the internal lamps, thus improve long-term system reliability.	wtune+
Analog output zero	Adjust the analog output zero setting, for each channel. Warning: this command must be sent individually for each channel.	z1 -50 z2 –50, etc.
Analog output span	Adjust the analog output span setting, for each channel. Warning: this command must be sent individually for each channel.	s1 200 s2 200, etc.
Analog output, if no probes	Adjust the analog output behavior, when no probe is detected. Warning: this command must be sent individually for each channel.	See "o" command description, above
No sleep mode	Sleep mode should be disabled (it is not required)	p-

Most of these command settings can be confirmed with the "i" command. The "wtune" command can be confirmed with the "y" command.

6.4.3 Interpretation of "y" command results

The Neoptix T/Guard systems are fitted with a function that gives an evaluation about probe signal strength or signal power; in Neoptix jargon, this is called the "y" command. The easiest method to access this command is to use Windows' HyperTerminal, or OptiLink' Console; the Nomad, when in Engineering mode, can also be very useful to display this information.

Typically, the "y" command will return the following information:
```
CH1: 85%, ratio:1.83, lamp:90, CCD:150ms (auto) +24.5
```
CH1 indicates the channel number (typically 1 to 8, for an 8 channel T/Guard system)
1.83 is a signal strength (power) indicator that can span from about +0.3 to +2.7. You can interpret it approximately as follows:
- 0.3 to 1.07: no probe is detected
- 1.07 to 1.25: a probe is probably present, but exhibits a very weak signal; its reading is usually rejected, as it is considered as unreliable
- 1.25 to 2.7: a good probe is present (the higher the power the more healthy the probe).

Lamp attenuation: gives an indication about the white light lamp intensity for this channel. It ranges from 210 (weak lamp) to 100 (intense lamp[8]). A weak lamp is usually preferred and indicates a "healthy" probe.
CCD time: this is the CCD (charge couple device) optical integration time in millisecond; it can range from 50 to 500 ms. A weak probe will normally have a long integration time.

The "%" number gives an approximate compounded power value that takes into consideration the ratio, the lamp attenuation and the CCD time.

To summarize, a very good probe is characterized by a good power indicator (>1.8), then by a high lamp attenuation (>150) and finally by a short integration time (<200ms). Also, dirty connectors will contribute to lower probe strength; always assure that all fiber connections are clean before evaluating probe performance.

---

[8] Some T/Guard+ uses a different nomenclature: "4v" corresponds to a strong lamp, while "2v" corresponds to a weak lamp.

Warning: After a power-on or after changing (or exchanging) probes or extension cords, allow sufficient time for the T/Guard optimization process to complete before invoking the y command; it most cases, it may take as much as 1 minute for this optimization to complete, especially when the number of enabled channels is high, e.g., 8.

6.5   Typical temperature reading sequence

Once all parameters have been set, the following sequence should normally be followed to extract temperature information from your Neoptix thermometer. 2 procedures can be used for this purpose. The first method consists in using the "ta" command (preferred), while the second sequence would be:

d)   The host computer should send the "t" (or "t[i]") command, followed by an E   character.

e)   The thermometer responds by echoing the requested temperature values, as indicated above; the transmission is terminated by a "*" character.

f)   When the "*" character is received, it is suggested to immediately terminate the dialog session by having the host computer issue the "r" command followed by a E   character.

6.6   Error Codes

The following error messages are displayed under certain error conditions:

RS-232	Display	Analog Out	Description
Err2	Err2		Internal memory checksum error. Memory corruption. When a channel has its calibration table corrupted, the corresponding front panel LED will continuously flash to indicate the corruption problem. Contact Neoptix.
"- - . -"	"- - - - -"	Hi-Lo, 0.5 Hz*	Temperature out of maximum instrument limits or no signal
Err5			Argument out of range
Err6			Unrecognized command
Err7			Internal error (slave module). T/Guard-DL only
Err8			Internal memory problem (not detected, not present, etc.). T/Guard-DL only
Err9			Cannot access an open file. T/Guard-DL only

*: The exact analog output behavior is a function of the command "o"; see previous Chapter.

Note that these error codes are not applicable when using the OptiLink software package. This high-level software package is programmed to automatically handle all types of errors, as outlined in the next section.

7   OPTILINK SOFTWARE PACKAGE

The OptiLink™ software package (formerly NeoLink) option allows using your thermometer system in a highly flexible manner. The built-in functions allow for temperature displaying and data logging, as well as exporting to a variety of standard spreadsheet packages.

Update March 2014: Neoptix is also offering the OptiLink-II software package, which will eventually replace this OptiLink package. This new software now supports the T/Guard system.

7.1   The "Lite" vs. the "Pro" version

OptiLink is now offered in two versions. The "Lite" version is now shipped as a standard item with every Neoptix thermometer. The "Pro" version includes more features and support more instruments and/or channels simultaneously. Contact your Neoptix Representative or the Neoptix factory to buy an unlocking code.

Note: The T/Guard system is normally supplied with OptiLink Pro.

7.1.1   Differences between the 2 versions

The "Lite" version exhibits the following limitations:

- Only one instrument is supported (when scanning the COM ports (going from 1 to 32), the first instrument that is detected by OptiLink will be the active instrument).
- Only 1 channel is supported.
- No DDE temperature data logging is supported.

The remaining of this Chapter describes the "Pro" version.

7.2   Getting started with OptiLink

OptiLink was designed to acquire temperature readings from all models of the Neoptix T/Guard thermometer family. This versatile software package is designed to work with Microsoft Windows operating system; to fully exploit the capabilities of OptiLink, it is recommended to use it in conjunction to commercial spreadsheet software, such as Microsoft Excel.

With the **T/Guard-Link** and **T/Guard-I**, make sure the module is in service or ASCII, or non-Modbus, mode before attempting using OptiLink.

7.2.1   Hardware and software requirements

The following list includes the minimum requirements for running the OptiLink software:
- A Pentium class or higher CPU
- SVGA or higher resolution display system supported by Windows
- 512 MB of RAM memory (operating system dependent)
- At least 40 MB of hard disk space
- A CD/DVD disk drive (to load software); software is also available for down load from Neoptix website (contact Neoptix if required)
- A mouse or other Windows pointing device
- A RS-232 interface (COM1 to COM32). Up to 4 thermometer units are supported, each one requiring its own COM port
- Windows XP or later, including Vista and Windows 7.

OptiLink works correctly with both half-duplex and full-duplex Neoptix thermometers. OptiLink is not compatible with older Nortech-Fibronic thermometers and with Neoptix thermometers that have been manufactured before August 2005.

7.2.2 Installing OptiLink

Before opening the CD and installing the software, please refer to the **License and Limited Warranty Agreement** at the beginning of this manual.

You must have at least one, or more, properly installed T/Guard thermometer unit(s). OptiLink should as well detect other Neoptix thermometers, such as the Nomad, the Reflex and even the T/Guard+ (in "non-OPC" or "test" mode).

1- Start Windows, and make sure you are not running any other Windows program.
2- By inserting the CD in your computer, the SETUP application should automatically start; if not, manually start it.
3- Follow the instructions that are displayed.
4- Restart your computer.

7.3 A quick tour of OptiLink

1- Connect your T/Guard unit(s) to free COM port(s).
2- Start OptiLink, if not already running.
3- The thermometers that are turned on and connected to your PC through a proper RS-232 connection should normally be automatically detected by OptiLink[9] (this process takes a few seconds, for a typical installation).
4- If a thermometer is connected after OptiLink is started, you should click the "Refresh" button so OptiLink rescans the COM ports (1 to 32). If a thermometer is not automatically detected, make sure your RS-232 port and cable is correctly configured and that the unit is turned on.

> **NOTE**: Some RS-232C connections may cause transmission failures. Particularly, we have experienced problems with the use of DB09 to DB25 converters and other similar so-called gender changers. Also, some USB to RS-232 converters/adapters are known to cause problems; Neoptix recommends B&B converters (http://www.bb-elec.com/Products/USB-Connectivity/USB-to-Serial-Converter/In-line.aspx); they are available from Neoptix. Limit your cable length to 10 meters.

You should normally see a window similar to this (acquisition window):

---
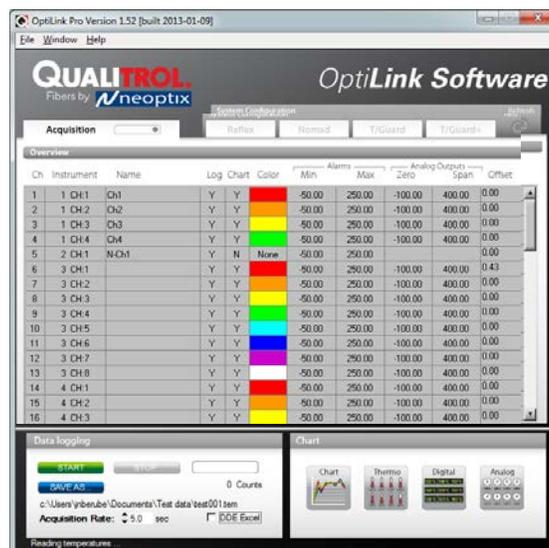
[9] If the automatic COM port scanning is causing problems with some of your other programs, specific COM port can be excluded from being scanned. Refer to Section 7.6.1.3 for more information.

In this example, we see that OptiLink has detected 4 thermometers: a Reflex, a Nomad, a T/Guard and a T/Guard+ (in test mode only; OPC mode is not supported by OptiLink).

OptiLink is now properly installed and ready to use!

7.3.1 Working with the Configuration Window

OptiLink starts with the "Acquisition" window active, as shown in the figure above. To switch to the "System Configuration" window, you need to click on one of the instrument names that have been detected; for example, by clicking on "Reflex", you will get the following window:
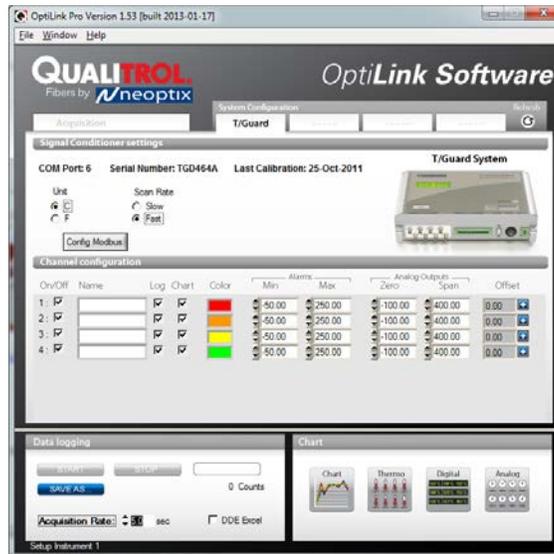
For each instrument, this configuration window gives some information about this particular information and allows you to set some parameters.

The top portion of the window gives information about the specifics of the thermometer, such as:
- COM Port number
- Serial Number
- Calibration date.

Description of the parameters that can be set:

- Unit: You can select ^{o}C or ^{o}F.

- Scan Rate: Fast (recommended for most applications) or Slow. .

- For Modbus-enabled T/Guard system: A special "Config Modbus" button appears to allow for setting up Modbus parameters. See Section 8.1 below for more information.

Furthermore, for each channel, you can set the following parameters:

- On / Off: You can turn on or off the temperature for each channel.

- Name: Up to 16 characters. You can enter a probe name here that suits your application.

- Log: If checked, the temperature data for this channel will be logged, when data logging is active.

- Chart: If checked, the temperature data for this channel will be displayed when one of the 4 chart windows is open.

- Color: This is the color of the curve that will be used when the Chart window is open.

- Alarms, Min and Max: Allows setting alarm limits. When one of more alarms are detected, a message is given at the bottom of the main window (must be in Acquisition mode). For a given channel, alarms are monitored only when its corresponding "Chart" *or* "Log" checkbox is checked, in the Configuration window pane. Alarms are monitored only when Acquisition is active.

- Analog Outputs: Allows configuring the analog output parameters, Zero and Span. See Section 6.4 for a complete description of these parameters.

- Offset: Allows adding an offset to this channel. See below.

7.3.1.1 Adjusting a temperature offset

OptiLink allows you to add an offset to the temperature readings that are returned by a thermometer. This feature is equivalent to the "f" serial command, as described in Section 6.4, although its implementation in OptiLink is somewhat different than it is for the serial command.

An offset can be useful for the following two cases:

1- To temporarily change the reading of a probe that is believed to be in error (one-point calibration procedure). This usually requires that a good temperature reference be available.

2- To force an offset to a reading, for example may want to monitor a temperature variation from a given set temperature. In this case, you can simply enter the "0" value as a forced temperature setting, and the resulting reading will give you a + or – deviation from the set temperature point.

Warning: Doing a temperature offset adjustment on a channel will alter its reading. In effect, it alters the thermometer own calibration. It must be used with care!

To perform an offset adjustment, follow these instructions:

1- Click the "Offset Adjust" button ( ) that is just next to the channel number you want to calibrate.
   The following menu window is available:
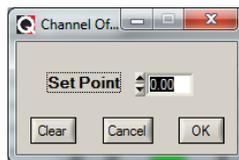
2- Type in the "Set Point" box the actual temperature that you would like to force for this channel (this temperature is normally obtained using an accurate NIST-certified primary temperature reference).

3- Press the "OK" button to activate the reference temperature. The "Offset" value will reset to its new value, as a result of your new forced temperature; this new offset is now displayed in the main window.

4- To reset this forced temperature setting, go back to the "Channel Offset" window, and click the Clear button.

5- Repeat the same procedure for the other channels that you want to modify.

7.4 Acquiring and viewing temperature data

Once all your thermometers are properly connected and configured, you may want to log data to a file, or to display their values on screen. A number of tools are available for that.

To view or acquire data, the "Acquisition" pane must be active.

7.4.1 Logging temperature data to a file

OptiLink offers the possibility to log temperature values to an Excel compatible file. The default file extension is .tem; this file can be subsequently open using Excel, which should open it and automatically recognize as an Excel compatible file (tab delimited).

Furthermore, OptiLink Pro offers the possibility to log directly to an .xls Excel file, using the Microsoft DDE data transfer protocol. This is described in Section 7.4.1.2 below.

The parameters that are useful to control the logging are shown in the lower left portion of the window, as shown here:
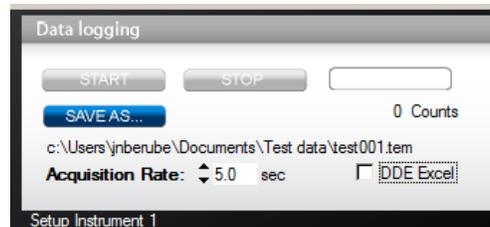
- To set the logging filename, click on "SAVE AS…"; this allows you to enter a file name. For information, the current filename is displayed just below this button. Default file location is "My Documents", for Windows 7 and above.

- To set the acquisition rate, enter a number, in seconds, in the appropriate text box. Rate can be set from 0.2 to 3600 seconds (1.0 to 3600 seconds if logging to an Excel file).

- To start acquiring data, click the "START" button. Conversely, to stop the acquisition, click the "STOP" button.

A convenient record counter is provided, confirming that logging is actually active.

7.4.1.1 Logging to a .tem file

When subsequently trying to opening the *.tem file, it is possible that you may get the following message:
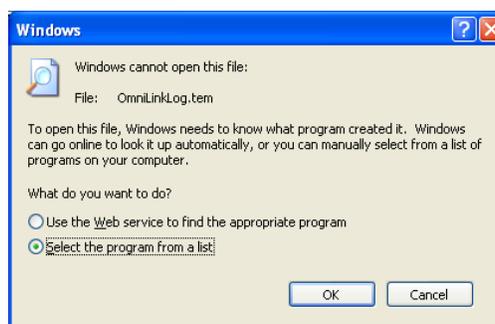
Select "Select the program from a list", and click OK. In the next window, you should instruct Windows to always open this type of file with Microsoft Excel.

If you get the following message, you should select "Read Only".
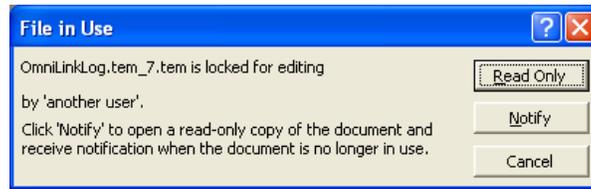
In Excel, the data file should look like this:

Notes: 1) If a column shows "#######", this means that this column is too narrow to display the data; use your mouse to widen this column.
2) If you open a logging file during acquisition, the Excel window is not refreshed as the acquisition is taking place. To get a more recent version of the file, close the Excel program, and start Excel again.
3) A value of -999.xx indicates that no reading is available for this channel. Check the probe connection.

If you stop the acquisition, and start it again with the same file name, the new values will simply be appended to the existing file content. However, a new 5-line header is inserted first, as shown here:

When logging temperatures for a very long time, one needs to note that a standard Excel sheet is limited to 65535 lines. If this limit is reached, the logging process will close the current data-logging file, and will open a new one, with the same name but with "_1" appended to the file name, and so on ("_2" …), until the application is stopped or your disk becomes full.

7.4.1.2   Logging to a .xls (or .xlsx) file

This logging method requires the Microsoft Excel application, which must be already installed. This logging method has some advantages over the previously described logging method, namely:
- Temperatures are directly stored in a genuine .xls file; no intermediary file is used.

- It allows the user the look at the data as it is written in real time in the .xls file.
- It allows the user to write comments directly in the .xls file, as the data is being acquired.

Warning: An English language Excel is required; logging using Excel in other languages may work, but is not guaranteed by Neoptix. Furthermore, it is highly recommended that you do not use Excel for other purposes when DDE data logging is taking place; failure to respect this may result in lost data (your data or temperature data).

Before you can use this logging method, you must set it up on your PC. This needs to be done only once.

DDE logging setup

Click the DDE Excel checkbox, as illustrated here:
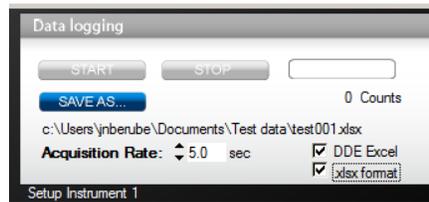
Then, you will get an invitation to specify the location of your Excel application (excel.exe). Once the Excel location and language selection[10] are confirmed (look into "C:\Program files\Microsoft Office\OfficeXX"), logging will start as described below.

If you are using Office 2007 or later, make sure to check the box ".xlsx format". With Office 2007 or later, files can be saved only in the new format .xlsx.

DDE logging

Click the START button to start the logging process. The Excel application will open, and you will be able to see the data being written to the file. **Do not close this Excel sheet**; however you may minimize it without any problem.

To stop logging, click the STOP button in OptiLink; this will automatically close the Excel sheet and application. Do not close the Excel application yourself!

Otherwise, the DDE logging is very similar to logging to a .tem file, as described above. Acquisition rate is limited to 1 second.

7.4.2 Viewing temperature data

Temperature values can be displayed on your computer screen in a number of ways. Click one of the four "Chart" button to active one or more of these windows.

---
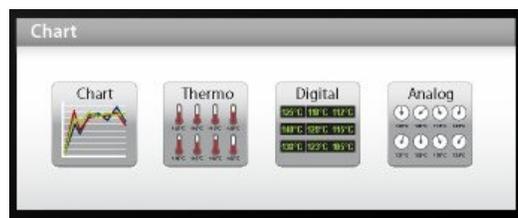
[10] You have two choices: English or French. If you are using Excel in another language, you must select English.

Note that more than one window type can be displayed simultaneously; in addition, you can log temperatures to a file independently from these display windows. Note that each of these 2 modes have each then own acquisition time base.

7.4.2.1 Displaying temperature trends

Click the "Chart" button to get the following window.
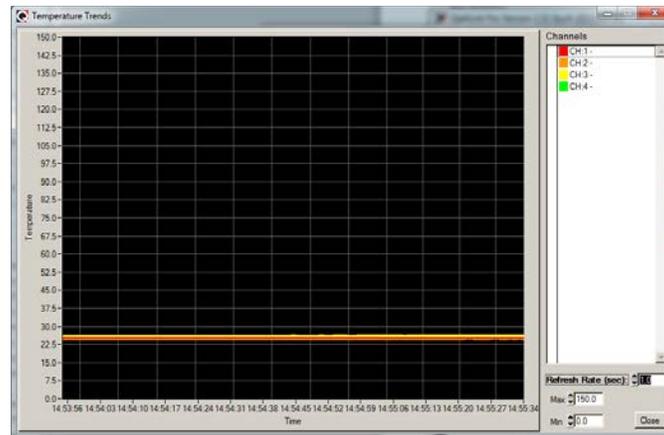
Adjust the "Refresh Rate" (minimum is 0.2 sec) and Min / Max to suit your viewing needs.

Note that the setting of curve colors and other parameters must be done in the "System Configuration" window pane. Up to 64 trends can be displayed.

7.4.2.2 Displaying analog thermometers

Click the "Thermo" button; the following window will appear.
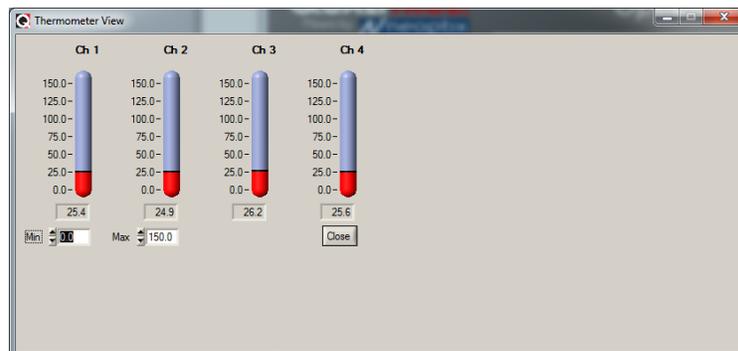
All thermometers share the same Min / Max reading setting. Refresh rate is fixed at 1.0 sec. The size of this window will change depending on the number of channels to display. Up to 16 thermometers can be shown; if you want to display more than 16 channels, only the first 16 detected channels will be shown (note that any channel that has its "Chart" checkbox unchecked, in the main window, will not be shown).

If an alarm is active for a channel, the corresponding thermometer numbers will change color: blue for a low temperature alarm, or red for a high temperature alarm.

7.4.2.3 Displaying digital values

To display digital temperatures, click on the "Digital" button. The following window will appear.

The size of this window will adapt to the number of channels to display. Up to 32 values can be shown. Refresh rate is always 1.0 sec.

If an alarm is active for a channel, the corresponding display will change color: blue for a low temperature alarm, or red for a high temperature alarm.

7.4.2.4   *Displaying analog values (dials)*

To display analog temperatures (using dials), click on the "Analog" button. The active window becomes this:
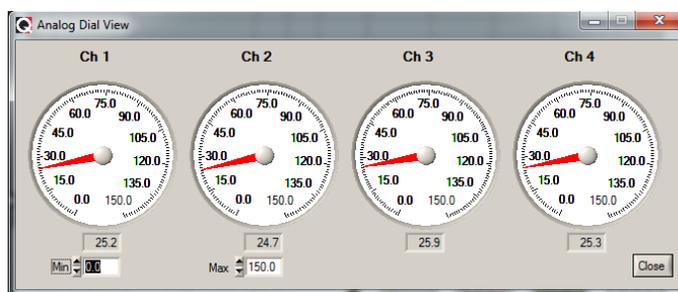
All dials share the same Min / Max reading setting. Refresh rate is always 1.0 sec. The size of this window will adapt to the number of displayed channels. Up to 16 dials can be shown; if you want to display more than 16 channels, only the first 16 detected channels will be shown (note that any channel that has its "Chart" checkbox unchecked, in the main window, will not be shown).

If an alarm is active for a channel, the corresponding dial numbers will change color: blue for a low temperature alarm, or red for a high temperature alarm.

7.5 The OptiLink Console

You must be in "System Configuration" mode to use the console.

The console, which can be invoked through the Window and then Open Console from OptiLink main window menu bar, is useful to manage each Neoptix thermometer in details. Take note that the console can only be open when no temperature acquisition is taking place. It can be useful also to understand problems and malfunctions that a module may exhibit. It operates in a similar fashion as Windows HyperTerminal, which Neoptix suggests to use with all thermometer models (such as the Reflex or T/Guard).

The console can be used to get information such as:

- Information on calibration date, serial number, etc.

- Enable / disable channels

- Set the analog output parameters (zero and span)

- Control operational features, such as fast/slow scanning more, wtune, etc.

- Calibration type, Neoptix or Nortech Fibronic, Inc.

- And so forth.

The following illustrates the OptiLink Console:
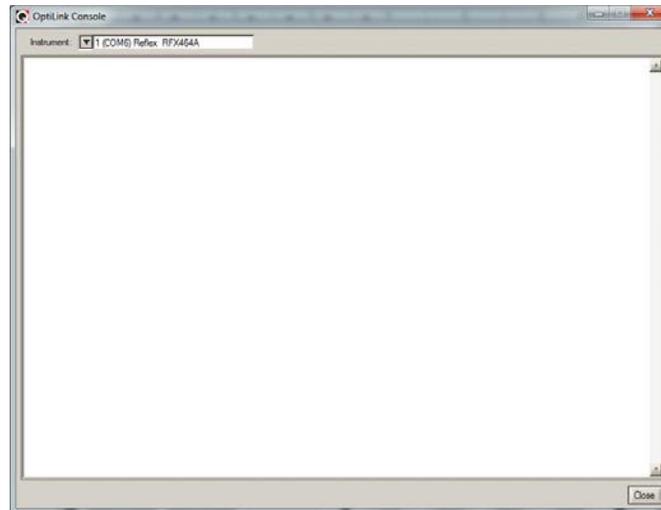
Before sending commands and receiving information from a specific module, it is necessary to select the instrument you want to interrogate. Please note that only ONE instrument can be selected at a time; if the same command is to be sent to all thermometers, then, it is necessary to repeat the command for each individual module.

You can use "Copy and Paste" Windows commands (such as the following shortcuts: ctl-c and ctl-v) to copy selected content of the console content to other Windows programs, such as Notepad, etc.

7.5.1 Console help menu

The following is the menu as displayed by the instrument when sending the "h" command. This help menu can be used as a reminder of all available commands, for this specific instruments.
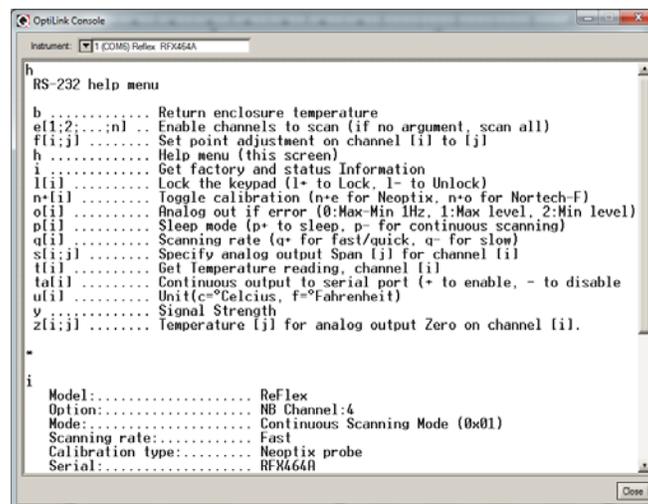
For a complete description of all commands, refer to Section 6.4 above.

7.5.2 Switching between calibration types

The OptiLink Console is a very useful tool that can easily be used to change the calibration types, for T/Guard system that have the double calibration feature enabled (Neoptix and older Nortech Fibronic, Inc. probes). One can simply enter the "n+o" to enable the Nortech-Fibronic calibration, or "n+e" for the Neoptix calibration. This is illustrated in the figure below:
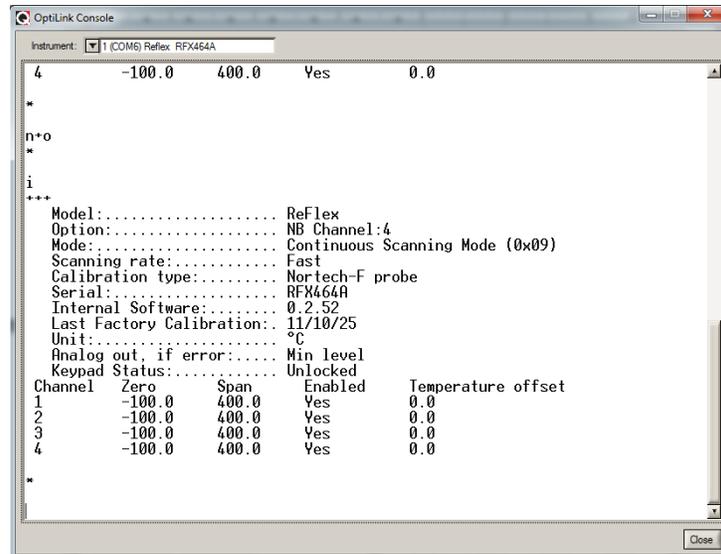
7.6 OptiLink functions

This section explains in details each one of the functions provided by the menus of the OptiLink software package. This Section only gives a brief overview of the commands that are possible; for operational details, please refer to the above Sections.

7.6.1 The File menu

The *File* menu provides the user with basic functions to handle Configuration files.

7.6.1.1 Find Instruments (Refresh)

This is equivalent to the "Refresh" button, found on the main window.

7.6.1.2 Disconnect Instruments

This will release all COM ports, select this menu item. OptiLink becomes idle, and to bring it to life again requires you to click the "Refresh" button (or to select the Find Instruments (Refresh)" menu item

7.6.1.3 Advance serial port setting

This command allows the user to force the exclusion of one or more COM ports from being scanned when clicking the "Refresh" button. This may be useful when one finds that the automatic COM port refresh feature of OptiLink is interfering with equipment that are using defined COM ports. You can check all ports that you want to exclude from the automatic scanning process. This window looks like this:
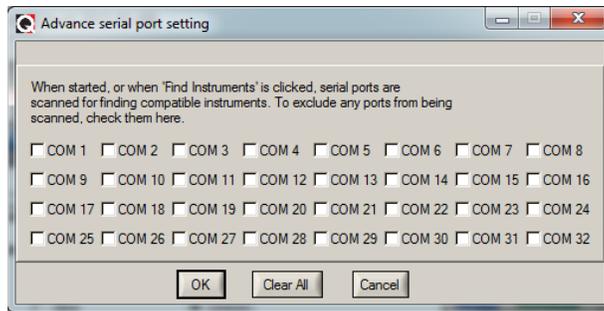
7.6.1.4 *Quit*

Select *Quit* from the *File* menu to exit OptiLink. Any configuration or setting that you might have done to any parameters is automatically saved, so the same configuration will be available the next time you open OptiLink.

7.6.2 The Window menu

From this menu, you can open the following 5 windows:
- Console view
- Trend view
- Thermometer view
- Digital view
- Analog (dial) view

7.6.2.1 *Open Console*

Open Console can be very useful for developers and other users who want to interrogate the "internal" parameters of a Neoptix thermometer. It should be used only by experienced users.

7.6.2.2 *View Trends*

Select this menu item to open a window that gives you a graphical representation of your temperature readings, as a function of time. Up to 64 curves can be simultaneously displayed. The sampling time base is adjustable.

7.6.2.3 *View Thermometers*

Select this menu item to display thermometers that will give you temperature data on up to 16 channels. Sampling rate is fixed at one reading per second.

7.6.2.4 *View Digital meters*

Select this menu item to display digital readouts that will give you temperature data on up to 32 channels. Sampling rate is fixed at one reading per second.

7.6.2.5 *View Analog Dial meters*

Select this menu item to display analog dials that will give you temperature data on up to 16 channels. Sampling rate is fixed at one reading per second.

7.6.3 The Help Menu

This is a standard Windows Help menu.

From this menu, you can also enter an unlocking code to convert OptiLink from a "Lite" version to the "Pro" version.

8   THE MODBUS PROTOCOL

The MODBUS protocol is a messaging structure developed by Modicon in 1979, used to establish master-slave / client-server communication between intelligent devices. It is a de-facto standard, truly open and the most widely used network protocol in the industrial manufacturing environment. The Modbus protocol provides an industry standard method that Modbus devices use for parsing messages. The Neoptix Modbus option has been developed to support Modbus over a Serial Line protocol.

A master-slave type system has one node (the master node) that issues explicit commands to one of the "slave" nodes and processes responses. Slave nodes (such as the T/Guard system) will not transmit data without a request from the master node, and do not communicate with other slaves.

At the physical level, Modbus over Serial Line systems may use different physical interface (RS485, RS232). RS485 two-wire interface is the most common. As an add-on option (contact Neoptix), RS485 four-wire interface may also be implemented. Furthermore, the Neoptix Modbus option has been successfully tested over a TCP/IP network, using a Lantronix device server. A RS232 serial interface may also be used as an interface, but when only short point-to-point communication is required, and this with only one slave device.

Neoptix has experienced some communication problems when configuring multiple Modbus-RS-485 systems together. This is usually caused by unstable grounding problems, such as what can be encountered when dealing with power transformers. To solve these problems, your RS-485 lines should be opto-isolated before connecting them to the master Modbus bus. Refer to Section 8.10 for more information.

For T/Guard's that have more than 8 channels, there is a special register table, which is given in section 8.5 below.

8.1   Configuring the Modbus option

Enabling and configuring the Modbus option must be done when the T/Guard system is *not* in Modbus communication mode. When the Modbus option has been purchased, the help menu (see Section 6.3) is slightly modified, as the following line is added:

 mb: Modbus configuration tool, type: 'mb:?' for help;

Typing "mb:?" gives:
Modbus configuration tool

   mb:t,b,p,a<CR>

   Where   t (type)   : 0=RTU (default), 1=ASCII
           b (baud)   : 0=9600, 1=19200
           p (parity) : 0=even (default), 1=odd, 2=none
           a (addr)   : 1 to 247 (dec)

   Example: mb:0,1,0,21
   For RTU mode at 19200, even parity, Modbus address 21 (15hex)

   Current configuration is mb:0,1,0,45

Note for OptiLink software users: The Modbus parameters can also be set up using OptiLink. A special "Config Modbus" button appears (shown below) when OptiLink is connected to a Modbus-enabled T/Guard system.
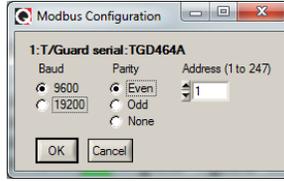
Once configured correctly, you can enter into Modbus mode by turning off the T/Guard for a few seconds and then turning it on but by holding down the System Status[11] switch at the same time. Modbus mode should be confirmed if "MBxxx" is briefly displayed on the LCD display (xxx is the currently active Modbus node address, 1 to 247). You are now ready to connect the T/Guard to your Modbus enabled network.

8.2 Supported serial transmission mode

The transmission mode defines the bit contents of the message bytes transmitted along the network, and how the message information is to be packed into the message stream and decoded. The current implementation of Neoptix-Modbus supports only the RTU mode; ASCII mode is a future option.

8.3 RTU transmission mode

Coding system	8 bit binary
Number of data bits per character	10 bits 　　　　　start bits –1 　　　　　data bits – 8 　　　　　parity bits – 0 or 1(even or odd) 　　　　　stop bits – 1 (2 if no parity bit used)
Parity	Not used *or* even *or* odd parity
Bit transfer rate	9600 or 19200 Baud
Duplex	Full or Half
Error checking	CRC (cyclic redundancy check)
Polynomial	(CRC-16 101000000000001
Bit transfer order	LSBit first, MSByte first
End of message	Idle line for 3.5 or more characters.

The link layer includes the following properties /behaviours:
- Slave address recognition
- Start / End of Frame detection
- CRC-16 generation / checking
- Transmit / receive message time-out
- Buffer overflow detection
- Framing error detection
- Idle line detection.

8.4 Modbus function code and register addresses (1-8 channels)

Warnings:
- This section is applicable only to the T/Guard's that have 1 to 8 channels; for models that have 9 to 16 channels, please refer to Section 8.5 below.
- Registers can only be read in groups of up to 16 registers.
- Multiple write to more than one register is not supported.

---

[11] On older T/Guard system, this switch was called "LCD Backlight". On 9 to 16 channel T/.Guard's, the switch is a toggle switch; see page 14.

8.4.1 Read/Write, bit access

Function codes: 0x01 (read coils), 0x05 (write single coil) or 0x0F (write multiple coils).

Address	Register (hex)	Name	If 0	If 1
00001[12]	0x00	Channel 1 enable	Disable	Enable
00002	0x01	Channel 2 enable	Disable	Enable
00003	0x02	Channel 3 enable	Disable	Enable
00004	0x03	Channel 4 enable	Disable	Enable
00005	0x04	Channel 5 enable	Disable	Enable
00006	0x05	Channel 6 enable	Disable	Enable
00007	0x06	Channel 7 enable	Disable	Enable
00008	0x07	Channel 8 enable	Disable	Enable
00009	0x08	Scan speed	Slow	Fast
00010	0x09	Calibration type	Neoptix	Nortech Fibronic inc.
00011	0x0A	Unit	C	F
00012	0x0B	Sleep mode	Scanning	Sleep (lamps off)
00013	0x0C	Wtune	Disable	Enable (optimize CCD time)
00014	0x0D	Reserved	Valid	Invalid
00015	0x0E	Reserved	Valid	Invalid
00016	0x0F	Reserved	Valid	Invalid

Writes can be made in "broadcast" mode or "unicast" mode.

8.4.2 Read only, bit access

Function code: 0x02 (read discrete inputs).

Address	Register (hex)	Name	If 0	If 1
10017	0x10	Channel 1 status	No signal*	Probe detected
10018	0x11	Channel 2 status	No signal	Probe detected
10019	0x12	Channel 3 status	No signal	Probe detected
10020	0x13	Channel 4 status	No signal	Probe detected
10021	0x14	Channel 5 status	No signal	Probe detected
10022	0x15	Channel 6 status	No signal	Probe detected
10023	0x16	Channel 7 status	No signal	Probe detected
10024	0x17	Channel 8 status	No signal	Probe detected
10025	0x18	Reserved	Valid	Invalid
10026	0x19	Reserved	Valid	Invalid
10027	0x1A	Reserved	Valid	Invalid
10028	0x1B	Reserved	Valid	Invalid
10029	0x1C	Reserved	Valid	Invalid
10030	0x1D	Reserved	Valid	Invalid
10031	0x1E	Reserved	Valid	Invalid
10032	0x1F	Reserved	Valid	Invalid

*: No probe detected, or defective probe.

8.4.3 Read only, 16 bit access

Function code: 0x03 (read holding register). These registers can be read only (writing to them is not allowed, except for "zero" and "span" registers, see next Section).

---

[12] Left-most digit indicates data type.

Address	Register (hex)	Name	Value
40033	0x20	Channel 1 temperature	Signed 16 bit integer (temperature 1 * 10)[13]
40034	0x21	Channel 2 temperature	Signed 16 bit integer (temperature 2 * 10)
40035	0x22	Channel 3 temperature	Signed 16 bit integer (temperature 3 * 10)
40036	0x23	Channel 4 temperature	Signed 16 bit integer (temperature 4 * 10)
40037	0x24	Channel 5 temperature	Signed 16 bit integer (temperature 5 * 10)
40038	0x25	Channel 6 temperature	Signed 16 bit integer (temperature 6 * 10)
40039	0x26	Channel 7 temperature	Signed 16 bit integer (temperature 7 * 10)
40040	0x27	Channel 8 temperature	Signed 16 bit integer (temperature 8 * 10)
40041	0x28	Internal temperature	Signed 16 bit integer (temperature T/Guard * 10)
40042	0x29	T/Guard number of channels	Signed 16 bit integer
40043	0x2A	Internal firmware version	Signed 16 bit integer
40044	0x2B	Internal firmware revision	Signed 16 bit integer
40045	0x2C	Device type[14]	Signed 16 bit integer
40046	0x2D	ModeA[15]	Signed 16 bit integer
40047	0x2E	ModeB	Signed 16 bit integer
40048	0x2F	Reserved	0x0000
40049	0x30	Channel 1 power	Signed 16 bit integer (ratio * 100)
40050	0x31	Channel 2 power	Signed 16 bit integer (ratio * 100)
40051	0x32	Channel 3 power	Signed 16 bit integer (ratio * 100)
40052	0x33	Channel 4 power	Signed 16 bit integer (ratio * 100)
40053	0x34	Channel 5 power	Signed 16 bit integer (ratio * 100)
40054	0x35	Channel 6 power	Signed 16 bit integer (ratio * 100)
40055	0x36	Channel 7 power	Signed 16 bit integer (ratio * 100)
40056	0x37	Channel 8 power	Signed 16 bit integer (ratio * 100)
40057	0x38	Channel 1 lamp attenuation	Signed 16 bit integer
40058	0x39	Channel 2 lamp attenuation	Signed 16 bit integer
40059	0x3A	Channel 3 lamp attenuation	Signed 16 bit integer
40060	0x3B	Channel 4 lamp attenuation	Signed 16 bit integer
40061	0x3C	Channel 5 lamp attenuation	Signed 16 bit integer
40062	0x3D	Channel 6 lamp attenuation	Signed 16 bit integer
40063	0x3E	Channel 7 lamp attenuation	Signed 16 bit integer
40064	0x3F	Channel 8 lamp attenuation	Signed 16 bit integer
40065	0x40	Channel 1 CCD time	Signed 16 bit integer
40066	0x41	Channel 2 CCD time	Signed 16 bit integer
40067	0x42	Channel 3 CCD time	Signed 16 bit integer
40068	0x43	Channel 4 CCD time	Signed 16 bit integer
40069	0x44	Channel 5 CCD time	Signed 16 bit integer
40070	0x45	Channel 6 CCD time	Signed 16 bit integer
40071	0x46	Channel 7 CCD time	Signed 16 bit integer
40072	0x47	Channel 8 CCD time	Signed 16 bit integer
40073	0x48	Reserved	0x0000
40074	0x49	Reserved	0x0000
40075	0x4A	Reserved	0x0000
40076	0x4B	Reserved	0x0000
40077	0x4C	Reserved	0x0000
40078	0x4D	Reserved	0x0000
40079	0x4E	Reserved	0x0000
40080	0x4F	Reserved	0x0000

---

[13]Real temperatures can be calculated by dividing the integer numbers by 10. If probe has no signal, the value of –9996 is returned (or –999.6°); if channel is disabled, the value of –9995 is returned (or –999.5°).
[14] T/Guard should return 2 or 11. T/Guard-Link should return 14.
[15] For more information on ModeA and ModeB, contact Neoptix.

Address	Register (hex)	Name	Value
40081	0x50	Channel 1 analog zero	Signed 16 bit integer (temperature 1 * 10)
40082	0x51	Channel 2 analog zero	Signed 16 bit integer (temperature 2 * 10)
40083	0x52	Channel 3 analog zero	Signed 16 bit integer (temperature 3 * 10)
40084	0x53	Channel 4 analog zero	Signed 16 bit integer (temperature 4 * 10)
40085	0x54	Channel 5 analog zero	Signed 16 bit integer (temperature 5 * 10)
40086	0x55	Channel 6 analog zero	Signed 16 bit integer (temperature 6 * 10)
40087	0x56	Channel 7 analog zero	Signed 16 bit integer (temperature 7 * 10)
40088	0x57	Channel 8 analog zero	Signed 16 bit integer (temperature 8 * 10)
40089	0x58	Channel 1 analog span	Signed 16 bit integer (temperature 1 * 10)
40090	0x59	Channel 2 analog span	Signed 16 bit integer (temperature 2 * 10)
40091	0x5A	Channel 3 analog span	Signed 16 bit integer (temperature 3 * 10)
40092	0x5B	Channel 4 analog span	Signed 16 bit integer (temperature 4 * 10)
40093	0x5C	Channel 5 analog span	Signed 16 bit integer (temperature 5 * 10)
40094	0x5D	Channel 6 analog span	Signed 16 bit integer (temperature 6 * 10)
40095	0x5E	Channel 7 analog span	Signed 16 bit integer (temperature 7 * 10)
40096	0x5F	Channel 8 analog span	Signed 16 bit integer (temperature 8 * 10)

8.4.4 Write single register, 16 bit access

Function code: 0x06 (write single register). These registers can be read and written to (see previous Section for reading instructions).

Address	Register (hex)	Name	Value
40081	0x50	Channel 1 analog zero	Signed 16 bit integer (temperature 1 * 10)
40082	0x51	Channel 2 analog zero	Signed 16 bit integer (temperature 2 * 10)
40083	0x52	Channel 3 analog zero	Signed 16 bit integer (temperature 3 * 10)
40084	0x53	Channel 4 analog zero	Signed 16 bit integer (temperature 4 * 10)
40085	0x54	Channel 5 analog zero	Signed 16 bit integer (temperature 5 * 10)
40086	0x55	Channel 6 analog zero	Signed 16 bit integer (temperature 6 * 10)
40087	0x56	Channel 7 analog zero	Signed 16 bit integer (temperature 7 * 10)
40088	0x57	Channel 8 analog zero	Signed 16 bit integer (temperature 8 * 10)
40089	0x58	Channel 1 analog span	Signed 16 bit integer (temperature 1 * 10)
40090	0x59	Channel 2 analog span	Signed 16 bit integer (temperature 2 * 10)
40091	0x5A	Channel 3 analog span	Signed 16 bit integer (temperature 3 * 10)
40092	0x5B	Channel 4 analog span	Signed 16 bit integer (temperature 4 * 10)
40093	0x5C	Channel 5 analog span	Signed 16 bit integer (temperature 5 * 10)
40094	0x5D	Channel 6 analog span	Signed 16 bit integer (temperature 6 * 10)
40095	0x5E	Channel 7 analog span	Signed 16 bit integer (temperature 7 * 10)
40096	0x5F	Channel 8 analog span	Signed 16 bit integer (temperature 8 * 10)

8.4.5 Modbus exception codes

The T/Guard Modbus implementation supports 3 exception codes.

Exception code	Description
01	Function not supported
02	Register number out of range
03	Quantity of registers out of range (0 register requested or more registers than the maximum allowed).

If a parity error or CRC error is detected in a received message, the T/Guard simply ignores this message (no response is sent).

8.5 Modbus function code and register addresses (9-16 channels)

Warnings:
- Registers can only be read in groups of up to 16 registers.
- Multiple write to more than one register is not supported.

Supported Function Code

Function code	Name	Usage
01 (01h)	Read Coils	Read device config
02 (02h)	Read Discrete Inputs	Optical signal present
03 (03h)	Read Holding Register	Read temperatures
05 (05h)	Write Single Coil	Write device config
15 (0Fh)	Write Multiple Coil	Write device config

Function code: *0x01, 0x05, 0x0F*
Type: *R/W, Bit access*

Address	Reg	Name	0 meaning	1 meaning
00001	0x00	*Reserved*	*valid*	*invalid*
00002	0x01	*Reserved*	*valid*	*invalid*
00003	0x02	*Reserved*	*valid*	*invalid*
00004	0x03	*Reserved*	*valid*	*invalid*
00005	0x04	*Reserved*	*valid*	*invalid*
00006	0x05	*Reserved*	*valid*	*invalid*
00007	0x06	*Reserved*	*valid*	*invalid*
00008	0x07	*Reserved*	*valid*	*invalid*
00009	0x08	Scan speed	Slow	Fast
00010	0x09	Calibration type	Neoptix	Nortech
00011	0x0A	Unit	C	F
00012	0x0B	*Reserved*	*valid*	*invalid*
00013	0x0C	wtune	disable	enable (optimize CCD time)
00014	0x0D	*Reserved*	*valid*	*invalid*
00015	0x0E	*Reserved*	*valid*	*invalid*
00016	0x0F	*Reserved*	*valid*	*invalid*

Function code: *0x02*
Type: *Read only, Bit access*

Address	Reg	Name	0 meaning	1 meaning
10017	0x10	Channel 1 status	No signal *	Probe detected
10018	0x11	Channel 2 status	No signal *	Probe detected
10019	0x12	Channel 3 status	No signal *	Probe detected
10020	0x13	Channel 4 status	No signal *	Probe detected
10021	0x14	Channel 5 status	No signal *	Probe detected
10022	0x15	Channel 6 status	No signal *	Probe detected
10023	0x16	Channel 7 status	No signal *	Probe detected
10024	0x17	Channel 8 status	No signal *	Probe detected
10025	0x18	Channel 9 status	No signal *	Probe detected
10026	0x19	Channel 10 status	No signal *	Probe detected
10027	0x1A	Channel 11 status	No signal *	Probe detected
10028	0x1B	Channel 12 status	No signal *	Probe detected

10029	0x1C	Channel 13 status	No signal *	Probe detected
10030	0x1D	Channel 14 status	No signal *	Probe detected
10031	0x1E	Channel 15 status	No signal *	Probe detected
10032	0x1F	Channel 16 status	No signal *	Probe detected

* No probe or broken probe.

Function code: ***0x03***
Type: ***Read only, 16 bits access***

Address	Reg	Name	Value
40033	0x20	Channel 1 temperature	Signed 16 bit integer (temperature 1 * 10)
40034	0x21	Channel 2 temperature	Signed 16 bit integer (temperature 2 * 10)
40035	0x22	Channel 3 temperature	Signed 16 bit integer (temperature 3 * 10)
40036	0x23	Channel 4 temperature	Signed 16 bit integer (temperature 4 * 10)
40037	0x24	Channel 5 temperature	Signed 16 bit integer (temperature 5 * 10)
40038	0x25	Channel 6 temperature	Signed 16 bit integer (temperature 6 * 10)
40039	0x26	Channel 7 temperature	Signed 16 bit integer (temperature 7 * 10)
40040	0x27	Channel 8 temperature	Signed 16 bit integer (temperature 8 * 10)
40041	0x28	Channel 9 temperature	Signed 16 bit integer (temperature 9 * 10)
40042	0x29	Channel 10 temperature	Signed 16 bit integer (temperature 10 * 10)
40043	0x2A	Channel 11 temperature	Signed 16 bit integer (temperature 11 * 10)
40044	0x2B	Channel 12 temperature	Signed 16 bit integer (temperature 12 * 10)
40045	0x2C	Channel 13 temperature	Signed 16 bit integer (temperature 13 * 10)
40046	0x2D	Channel 14 temperature	Signed 16 bit integer (temperature 14 * 10)
40047	0x2E	Channel 15 temperature	Signed 16 bit integer (temperature 15 * 10)
40048	0x2F	Channel 16 temperature	Signed 16 bit integer (temperature 16 * 10)

Temperature if no signal: -9996 (-999.6)
Temperature if channel disabled: -9995 (-999.5).

8.5.1 Read/Write, bit access

Function codes: 0x01 (read coils), 0x05 (write single coil) or 0x0F (write multiple coils).

8.6 Modbus and the sleep mode

The T/Guard system is fitted with a "sleep-mode" feature. See Section 6.4, command "p", for a detailed description of this mode. When monitoring temperatures in system where the temperature does not change very quickly, Neoptix recommends that this mode be used. In non-sleep mode, the T/Guard takes temperature measurements every one to two seconds (less than 1 second for a system that has 1 or 2 channels, or up to 3 seconds for a system with 8 channels), which is often too fast. To extend the life of the internal scan lamps, the T/Guard can be forced to enter a sleep-mode, during which no temperature scanning is done. For transformer applications, Neoptix suggests a scanning rate of one new reading every 15 or 30 seconds. To achieve this, follow this procedure:

    1) Force the T/Guard to enter the sleep mode (register 0x0B)
    2) Wait 15 or 30 seconds
    3) Force the T/Guard to exit the sleep mode (register 0x0B)
    4) Wait 3 seconds
    5) Read the temperatures, on all channels
    6) Return to step 1).

8.7 RS-485 connector definition

8.7.1 Connector pin-out for 2W-Modbus
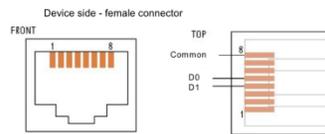
Figure 24:   2W- MODBUS on RJ45 connector (required pin-out)

Figure 25:   D-shell 9-pin connector

Screw type connectors can also be used.

If an RJ45 or a 9-pin D-shell connector is used for a standard MODBUS device, the pinouts hereafter must be respected for every implemented circuit.

2W-MODBUS RJ45 and 9-pin D-shell Pinouts

Pin on RJ45	Pin on D9-shell	Level of requirement	IDv Circuit	ITr Circuit	EIA/TIA-485 name	Description for IDv
3	3	optional	PMC	--	--	Port Mode Control
4	5	required	D1	D1	B/B'	Transceiver terminal 1, V1 Voltage (V1 > V0 for binary 1 [OFF] state)
5	9	required	D0	D0	A/A'	Transceiver terminal 0, V0 Voltage (V0 > V1 for binary 0 [ON] state)
7	2	recommended	VP	--	--	Positive 5...24 V D.C. Power Supply
8	1	required	Common	Common	C/C'	Signal and Power Supply Common

8.7.2 Connector pin-out for optional 4W-Modbus
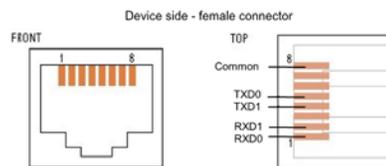
Figure 26:   4W- MODBUS on RJ45 connector (required pin-out)

Figure 27:   D-shell 9-pin connector

Screw type connectors can also be used.

If an RJ45 or a 9-pin D-shell connector is used for a 4W-MODBUS device, the pinouts hereafter must be respected for every implemented circuit.

Optional 4W-MODBUS RJ45 and 9-pin D-shell Pinouts

Pin on RJ45	Pin on D9-shell	Level of requirement	IDv Signal	ITr Signal	EIA/TIA-485 name	Description for IDv
1	8	required	RXD0	RXD0	A'	Receiver terminal 0, Va' Voltage (Va' > Vb' for binary 0 [ON] state)
2	4	required	RXD1	RXD1	B'	Receiver terminal 1, Vb' Voltage (Vb' > Va' for binary 1 [OFF] state)
3	3	optional	PMC	--	--	Port Mode Control
4	5	required	TXD1	TXD1	B	Generator terminal 1, Vb Voltage (Vb > Va for binary 1 [OFF] state)
5	9	required	TXD0	TXD0	A	Generator terminal 0, Va Voltage (Va > Vb for binary 0 [ON] state)
7	2	recommended	VP	--	--	Positive 5...24 V DC Power Supply
8	1	required	Common	Common	C/C'	Signal and Power Supply Common

Note :   When both 2 and 4-Wire configurations are implemented on the same port, the 4W notations must be used.

8.8 ModScan examples

ModScan be purchased from http://www.win-tech.com/html/modscan32.htm. ModScan is a good and simple program that can be used to exercise Modbus links. Furthermore, it can also be used to perform some simple data logging. Please note that this program must be purchased separately, it is not supplied as a standard item with the T/Guard system.

When started, the following screen will appear:
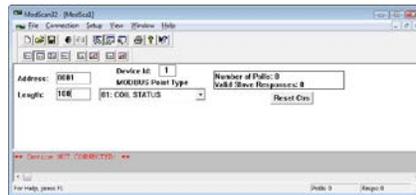
Make sure your T/Guard systems are connected to your PC computer. Usually, as a PC computer does not have a RS-485 port, you will normally need a RS-232 to RS-485 adapter or a USB to RS-485 converter (available as an option from Neoptix). You must first connect to your PC, by selecting Connection from the main menu, and then Connect. The following window will open:
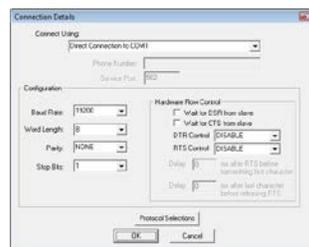
Make sure the Com port, baud rate and parity are set correctly (Word length should always be 8). Click OK. Next, make sure "Device Id:" is set to the proper Modbus address. You should now be connected and ready to monitor data. For example, the following figure shows values for all 101 input registers; you can see that temperature on channel # 1 is 23.6^{o}C, and so forth. Temperature values are multiplied by 10, and are given as integers, not floating point numbers.
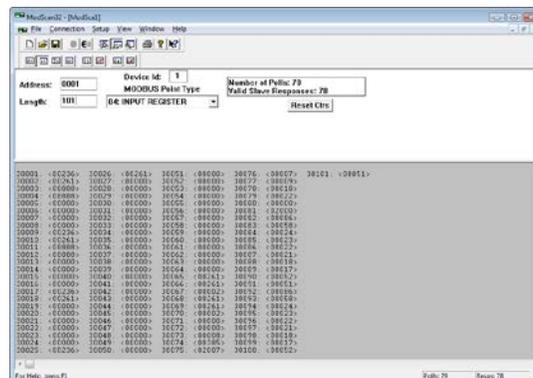
8.8.1 Monitoring multiple T/Guard

ModScan can be used to monitor either multiple T/Guard systems (as shown below), or multiple type of variables, for example, the input registers and coil status. To do this, simply open multiple windows within ModScan (from the main menu bar, select File and then New).

Warning: if you are opening many windows at once, it may be a good idea to slow down the data refresh rate. This can be done by selecting Setup from the main menu, then Data Definition, and then by entering something like 5 seconds in the Scan rate box; please remember than you will need to perform this setting for each opened window.
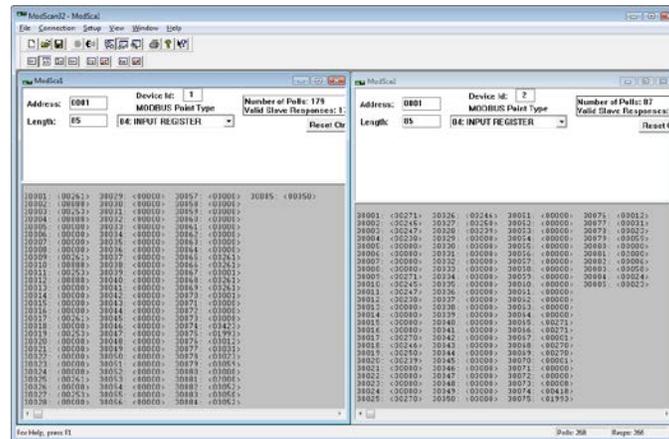
8.8.2 Writing parameters

To write data, you must select either Holding Register, or Coil Status. Then, from the main menu bar, select Setup, then Extended, then Preset Regs. Make sure the value of "Number of Points" is 1 (you cannot write to multiple registers at once). Make sure the Slave Device is corrected set (node number), and that the Address points to the register address you want to modify. For example, to change a temperature value, say from 200 to 150, you will enter (remember to multiply the temperature value by 10):
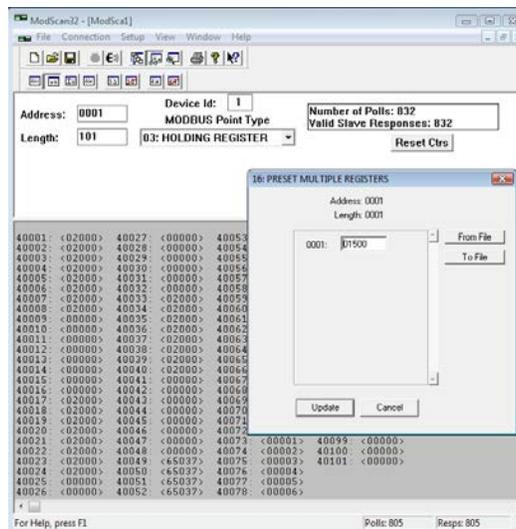
Click update to "write" your new value.

8.8.3 Data logging

ModScan allows you to log either in a text file (.txt) or a database file (.mdb, Microsoft Access format). Both are similar. Here is a quick example, saving to a text file.

Select Setup from the main menu, and then Text Capture. In the Save As box, enter a proper file name (if using Windows Vista or Windows 7, make sure your file is not saved in the Program File directory). In the next window, enter the frequency at which you want to log data:
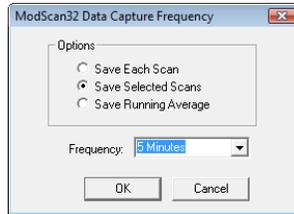
Data logging will automatically start. To end logging, select Setup and then Capture Off. The saved file can then be open using WordPad (do not use Notepad). Typically, the saved data should look like this:
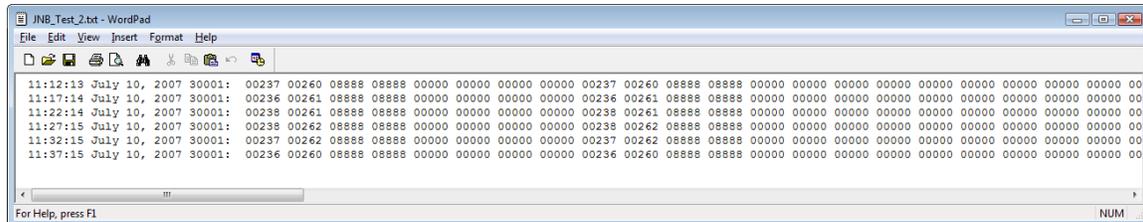
It is then easy to read this file as an Excel file.

Warning: If you have multiple ModScan windows open, then you will have to start multiple logging sessions.

8.9 Excel data-logging application

A versatile but easy to use data-logging program is supplied with the Modbus application option; it is called ModbusDataLogger. As this application is based on Microsoft Excel, it does not require any installation; however, it requires that Microsoft Excel be installed on the target PC computer. Furthermore, this application uses an ActiveX program that must be purchased and licensed by the end-user, as Neoptix does not supply the OCX license; contact http://www.win-tech.com/html/mbusocx.htm for more information. You will have to buy this license first; then make sure it is properly installed as explained below.

A demo can be downloaded from the web: http://www.win-tech.com/demos/mbmv7ocx.zip; for your convenience, a copy of this ActiveX is included on the OptiLink CD. It will run for 20 to 30 minutes, after which Excel application would need to be stopped and run again.

To install this application, simply copy the following file to a suitable directory on your PC: L0021R02_ModbusDataLogger.xls. You are now ready to use it.

8.9.1 Modbus ActiveX installation

The following two files should be installed in your C:\WINDOWS\SYSTEM32 directory:
        mbMasterV7.ocx
        modbusm.dll
        mbMasterV7.rtl
        mbMasterV7.lic

Note: The last 2 files are only available with a purchased OCX license. If these files are not there, the OCX will run in demo mode, and will time out after about 20 to 30 minutes of use.

Then, click the Windows Start button, then Run…, and enter the following command, as shown here:
        Regsvr32 mbMasterV7.ocx
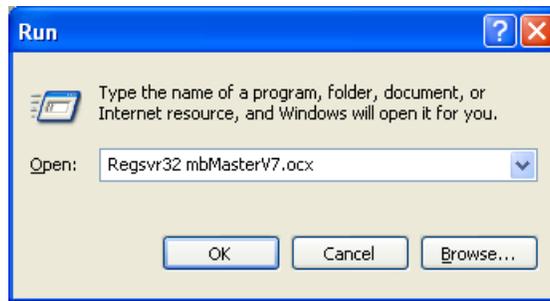
Click OK. You should get the following answer. If not, review this OCX installation procedure.

8.9.2 Using the Excel ModbusDataLogger utility

Open Windows Explorer, and double click "L0021R02_ModbusDataLogger" file name, as illustrated below; this will start Excel, and the logging utility.
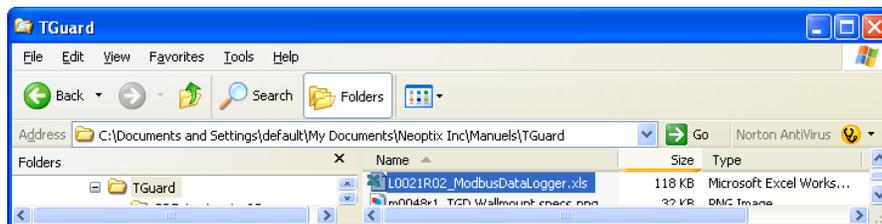
When the following message appears, it is very important to select "Enable Macros".
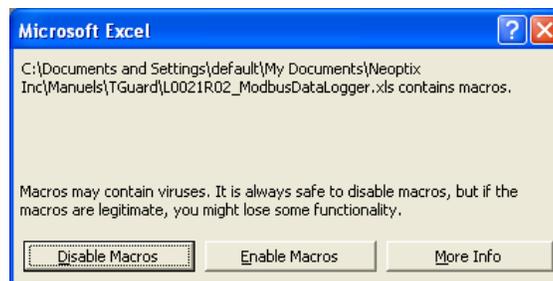
Note that some versions of Excel may return a different warning message; again, make sure you click "Yes" to enable macros.

Finally, the following Excel application window appears:
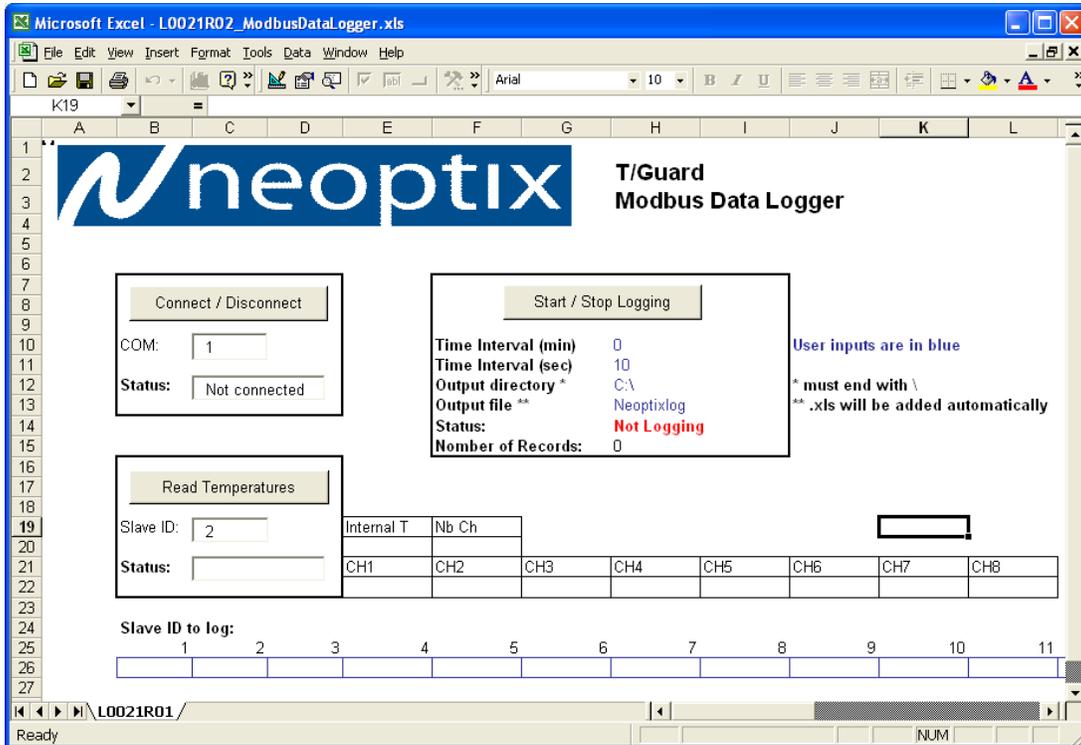
Set the "COM:" variable according to your PC configuration. This is the port number that will communicate with your Modbus network. Default value is 1.

Click the "Connect / Disconnect" button to connect the application to the Modbus network; the Status: box should change from "Not connected" to Connected". You are now ready to acquire temperatures.

The first method to read temperatures from a given thermometer is to click "Read Temperatures" button, after having set the Modbus address of that T/Guard thermometer. The following example reads temperature from a T/Guard-4 thermometer, at address # 7:
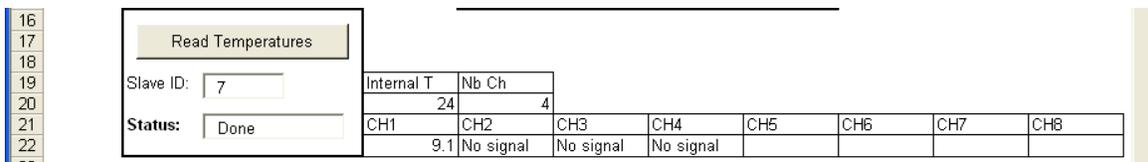
"No signal" is displayed for any channel that cannot return a valid temperature value, as shown above. If you enter a non-valid address, an error message is displayed.

8.9.2.1 Logging temperatures

First you need to set the Modbus addresses of your slave T/Guard thermometers; logging can be done with up to 32 units. The addresses need to be entered in Excel line # 26; fill the addresses starting with cell # B26, and leave unused cells blank. The present example uses addresses 2 and 7, but you must use the addresses that are present in your Modbus network configuration.

You need to set the file name where the logged temperatures will be saved. Setting the "Output directory" and "Output file" variables in the Excel sheet can do this. Set the data-sampling interval by entering the "Time Interval (min)" and "Time Interval (sec)" variables; take note that the actual sampling interval is the sum of these 2 variables.

Click the "Start / Stop Logging" button to start the logging process.
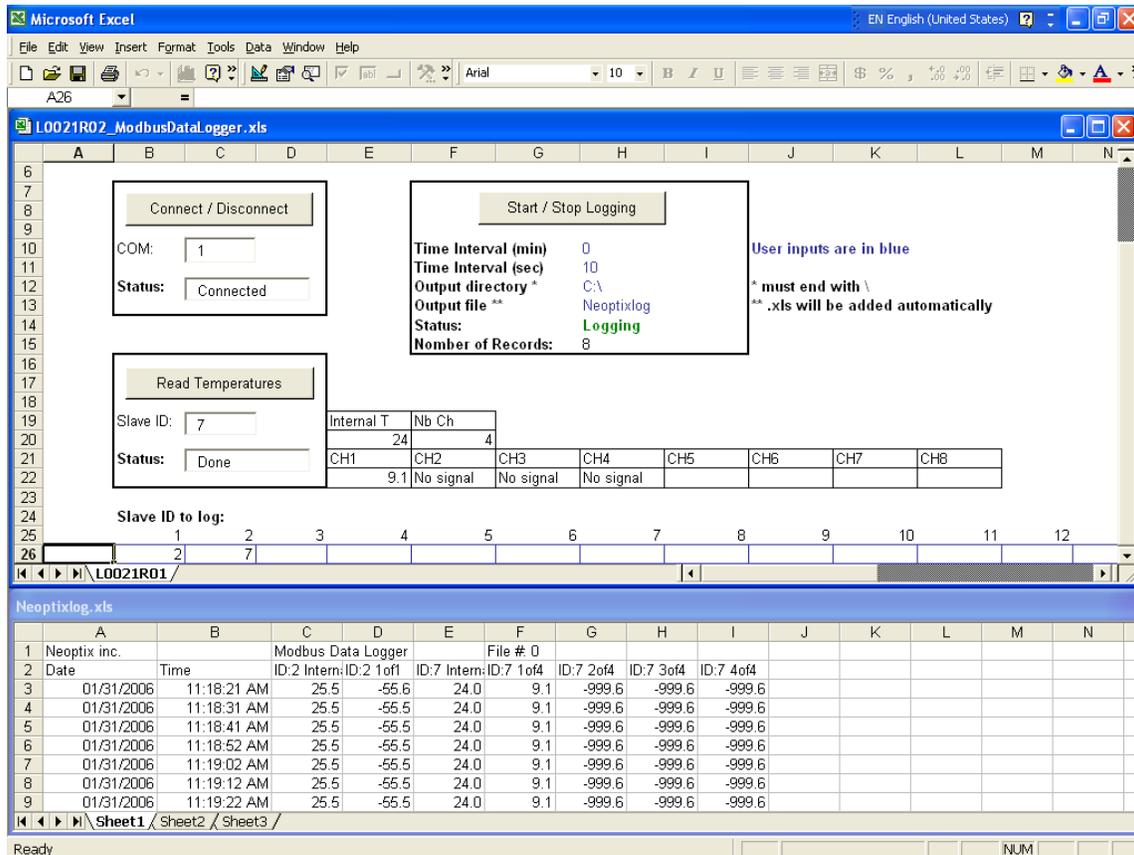
A value of –999.6 is returned if a non-valid temperature is returned from any channel.

If the Modbus OCX encounters a problem during acquisition, an error code is returned, and saved in the internal temperature cell for the T/Guard unit that has caused the error. When this happens, all temperature values for this thermometer are set to "0.0". Possible error codes include:

Code	Description
255 or less	Slave Device Exception Response
256	Invalid Connection Handle
257	Message Overrun
258	Invalid Point Address
259	Invalid Slave Node Address
260	Invalid Length
261	Unsupported Modbus Command
263	Slave Device Time-Out
264	Invalid Transmission Mode
265	Invalid CRC in Slave Response
266	Connection Not Established
267	Invalid Slave Response
271	Demo Time Expired
272	Invalid Modbus/TCP Command.

When logging temperatures for a very long time, one needs to note that a standard Excel sheet is limited to 65535 lines. If this limit is reached, the logging application will close the current data-logging file, and will open a new one, with the same name but with "_1" appended to the file name, and so on ("_2" …), until the application is stopped or your disk is full.

Note: Internal thermometer enclosure temperatures are always logged, one value for each T/Guard unit.

It is possible to create graphics, etc., using standard Excel functions.

8.10 Using opto-isolators, to deal with grounding problems

When experiencing communication problems with multiple Modbus-RS-485 systems, it is recommended to add opto-isolators to your RS-485 lines. One opto-isolator module is required per T/Guard system. Neoptix part number NXP-320 is a complete opto-isolator kit.

The installation instructions are summarized using the following two drawings. The first one is applicable when you have a 2-wire RS-485 configuration, while the second one is for 4-wire installations.

Refer to information given in Section 11 for more information regarding converters that have ground insulation.

To measuring instrument

From external RS-485

Industrial Din Rail Mounted
RS-422/485 Line Isolator/Repeater
Model: 4850PDR

Rx (+)
Rx (-)
Tx (+)
Tx (-)
24 V RTN
+24 V

OUT (-) (H)
OUT (+) (L)
IN (-) (G)
IN (+) (K)
SIG.GND.(M)
+10 to 30VDC(J)

OUT (-) (D)
OUT (+) (A)
IN (-) (E)
IN (+) (B)
SIG. GND.(F)
PROT.GND.(C)

Tx (-)
Tx (+)
Rx (-)
Rx (+)

485OPDR

	Positon 8 RX Enable	Positon 7 TX Enable
RS-485 4-Wire Module (full duplex)	OFF	ON

Baud Rate Selection

	Position 1	Position 2	Position 3	Position 4	Position 5	Position 6	R7 & R28	Time (ms)
9600	OFF	OFF	ON	OFF	OFF	OFF	Not used	1.10
19200	OFF	OFF	OFF	ON	OFF	OFF	Not used	0.62

Neoptix inc.
1415, blvd. Charest Ouest, suite 220, Québec
Qc Canada G1N 4N7

Wiring configuration using optical isolator
(Four wires setup)

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These modules are DIN rail mounted. And external DC power supply is required (+24 V on the above drawings); we recommend that you use the same power supply as for the T/Guard system (18 to 24 VDC).

The baud rate should be set to the same value (9600 or 19200) as your T/Guard Modbus setting; see Section 8.1 above.

9   TCP/IP INTERFACE OPTION – SERIAL COM MODE

T/Guard systems can be optionally fitted with an Ethernet TCP/IP interface. The TCP/IP interface is based on a module manufactured and supported by Lantronix. The module model number is Micro100, 10/100Base-T; for more information, see http://www.lantronix.com/device-networking/embedded-device-servers/micro100.html, where documentation and other information can be downloaded. The Xpress DR model is also supported, in RS232 mode; see http://www.lantronix.com/device-networking/external-device-servers/xpress-dr_dr-iap.html.

This chapter gives instructions on how to set up the Lantronix module for use with a standard serial port, such as required when interfacing with OptiLink/OptiLink. For Modus compatibility, please refer to the next chapter.

Warning: Since 2009, Neoptix will supply only the Xpress-DR model.

9.1   TCP/IP interface specifications

Category	Description
Memory	256K RAM
Serial Flash	512 K
Serial Interface	2 TTL serial interfaces (Async). 5V-level signals. Through-hole plated pins, DIL
Board Dimensions	Height: 1.575in (40.00 mm) Width: 1.935in (49.15 mm) (See Drawing)
Weight	0.7 ounces
Temperature	Operating range: 0° to +70° C (32 to 158° F) Storage range: -40° to +85° C (-40 to 185° F)
Protocols Supported	ARP, UDP, TCP, Telnet, ICMP, SNMP, DHCP, TFTP, AutoIP, and HTTP
Network Interface	RJ45 10/100Base-T
Data Rates	300 bps to 230400 bps
Serial Line Formats	Characters: 7 or 8 data bits Stop bits: 1 or 2 Parity: odd, even, none
Modem Control	DTR, DCD, CTS, RTS
Flow Control	XON/XOFF (software), XON/XOFF Pass Characters to Host CTS/RTS (hardware) None
Management	HTTP SNMP (read only) Serial login Telnet login
System Software	Operational code (ROM): downloadable from a TCP/IP host (TFTP) or over serial port
LEDs	Channel 1 (solid Green = idle, blink = active) Channel 2 (solid Yellow = idle, blink = active) Diagnostics (Red, in combination with Channel 1) Network Link (Green)
Compatibility	Ethernet: Version 2.0/IEEE 802.3
Power Requirements	5VDC (±5%) regulated @ 200mA

9.2   TCP/IP interface installation

This option requires that an Ethernet cable be used to connect to the T/Guard system; see Section below. In addition, special software is provided so a "standard" PC serial port can be assigned to a TCP/IP protocol; this is described in the Software Installation section below.

The MAC address is indicated on the side of the T/Guard instrument; however, it should not be required to know it under normal use.

9.2.1   Hardware installation

To connect the T/Guard system to your computer, simply use a proper Ethernet cable between the RJ45 port found on the T/Guard enclosure (on the right side) and connect it to your computer or network via a proper hub. Note: if you connect the cable directly to an Ethernet port on your PC computer, make sure you use a cable that is "crossed-wired"; if you use a hub, then a normal Ethernet cable should do the job.

Led arrangement:

Table 5 - DSTni-XPress DR LED Functions

LED	Meaning
R (Green)	**R**eady (Solid=ready, blinking = error message, port busy)
L (Green)	**L**ink (socket connection made) = Solid
A (Yellow)	**A**ctivity (network) = Random Flashing
TXD (Yellow)	Transmitting serially = Flashes during transmit
RXD (Yellow)	Receiving serially = Flashes during receive
F (Red)	**F**ault in XPress DR communication (read error) or XPress DR is in Configuration Mode

Simultaneously lit F (Red) and R (Green) LEDs mean something is wrong. If the F (Red) LED is lit or blinking, count the number of times the R (Green) LED blinks between its pauses. Six possible blink patterns, detailed in the following table, indicate which fault condition exists.

Table 6 - LED Error Indications

LED	Error
Steady F (Red) and Blinking R (Green)	1 blink = EPROM checksum error 2 blinks = RAM error 3 blinks = Token Ring error 4 blinks = EEPROM checksum error
Blinking F (Red) and blinking R (Green)	1 blink = Faulty network connection 2 blinks = No DHCP response 4 blinks = Setup Mode

You are now ready to install and configure the software that acts as a "buffer" between your COMx software (such as Windows HyperTerminal or OptiLink) and the T/Guard system. See next section.

The XPress DR model is din-rail mountable, and is located outside the T/Guard enclosure. This figure shows a typical installation. It requires an outside 24VDC (9 to 30 VDC, or 9-24 VAC) power supply.
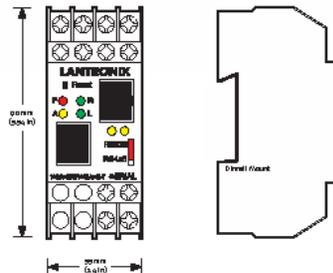
The Xpress DR model should have a serial connection as shown here (RS232 mode):

DTE, 9-Pin, MALE
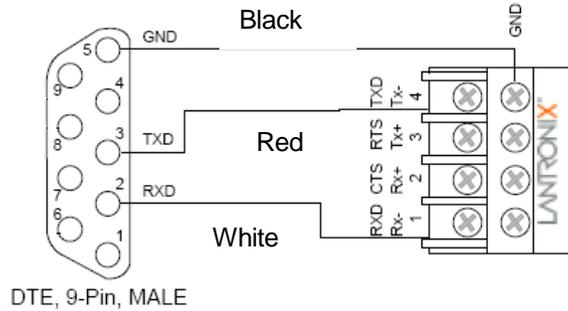
9.2.2 Software installation

To use this option, you need to load two Windows applications on your PC. These 2 applications are supplied by Lantronix.

Warning: The procedure described in this chapter assumes that

9.2.2.1 Device Installer

The first application to load is called "DeviceInstaller". You can download a fresh copy for the web at the following address http://ltxfaq.custhelp.com/app/answers/detail/a_id/644. You must use the Stand-alone DeviceInstaller Setup application for Windows; you can download it either by ftp or http. During the installation process, the following window will appear:

It is important that you install both the .NET and DeviceInstaller applications, as shown above. If you get a warning from your firewall, as shown below, you must click "Allow access".

Warning: The setup procedure that is described here assumes that your Lantronix bridge device is connected on a network where a DCHP server is present. This procedure will not directly work for an installation where your Lantronix device would be connected directly to your PC[16].

Once installed, run DeviceInstaller. Make sure the Lantronix device is on the network and powered up. You should get the following screen:

As you can see, DeviceInstaller has not found any Lantronix device. Click the Search icon. Depending on what you have on your network, here is a typical response from the search operation:

Take note of this IP address: this is the IP address of your Lantronix device.

If DeviceInstaller does not find any Lantronix devices after a few tries, check the device for proper installation on the network (power supply, wiring, etc.).

Now, we need to install the second software program, called CPR Manager (CPR = Com Port Redirector). Again, the best is to download a fresh copy from the Lantronix web site, at the following address: http://www.lantronix.com/device-networking/utilities-tools/com-port-redirector.html. Download the stand-alone CPR Setup application for Windows, either ftp or http. During installation, you will see this window, click Install.

---

[16] If you try to connect your Lantronix device directly to your PC (thus without a DHCP server), it might be useful to load a DHCP server on your PC; that way, the procedure described here will work even if you have no external DHCP server device, such as a router or hub. The following shareware (free) can be very useful for this purpose: http://ruttkamp.gmxhome.de/dhcpsrv/dhcpsrv1.9.zip; do not run it as a service, unless you want to use this configuration as a permanent installation. The readme.txt file gives instructions on how to use this very useful program (in particular how to set a range of searchable IP addresses).

Run the CPR Manager. You will get the following empty window:
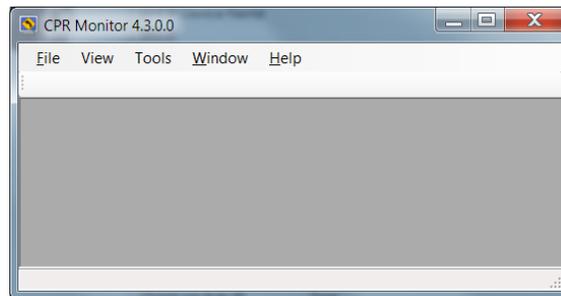
Select "Tools" from the task bar, then "Launch CPR Manager"; the following window will open:
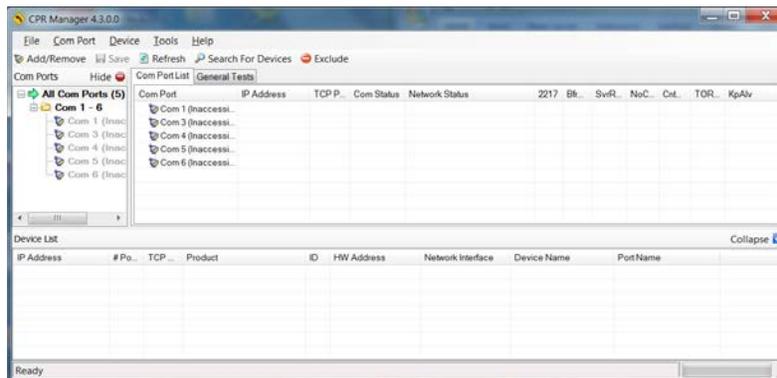
Click the "Add / Remove" button. The following sub-window opens, to allow you to select an appropriate Com port number. Neoptix suggests that you select a port number in the range or 15 to 30. In this example, we have selected port # 30[17].

---

[17] 30 could be a good default value because it will not interfere with other port addresses that are assigned automatically by other USB-to-serial adapters, and so forth.

Click OK. Then the previous window should now should the following:

Enter your IP address (see above).
TCP Port must be 10001
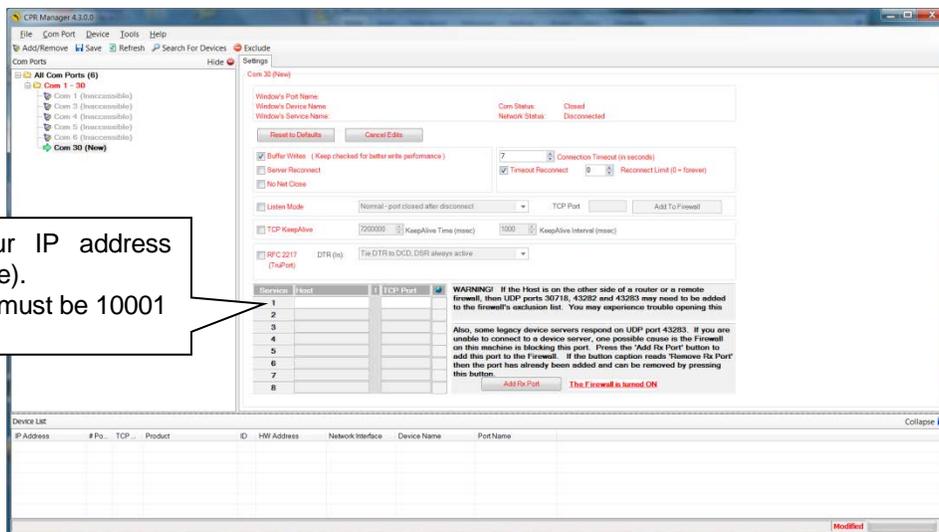
Once you have entered the IP address and TCP port number, click the "Save" button. The window content will change to this:
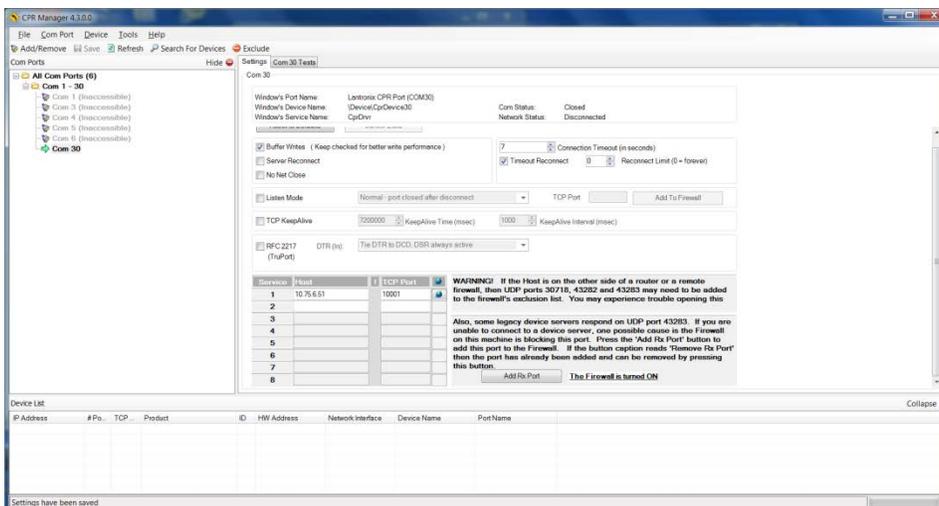
This completes the Lantronix device installation. You can use the Windows Device Manager to confirm that your Lantronix is now an active serial port element.

Your device should be listed here
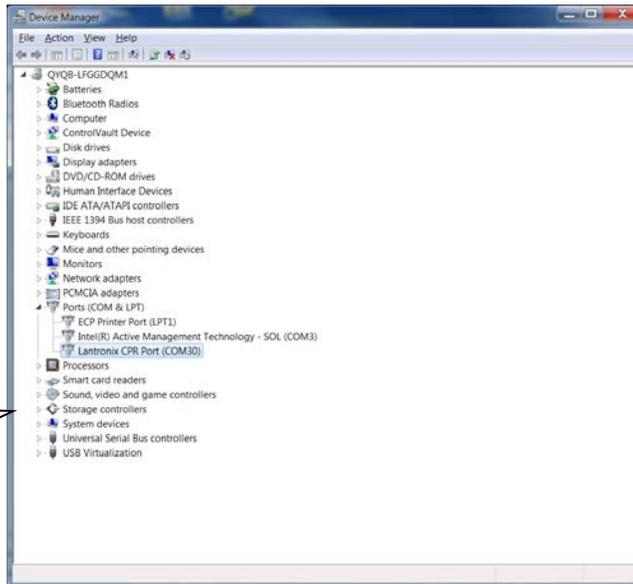
If you use, HyperTerminal, you should now be able to connect with your T/Guard system, as illustrated here (remember to set your com port to 30, and all other parameters as explained in Section 6.2 above.
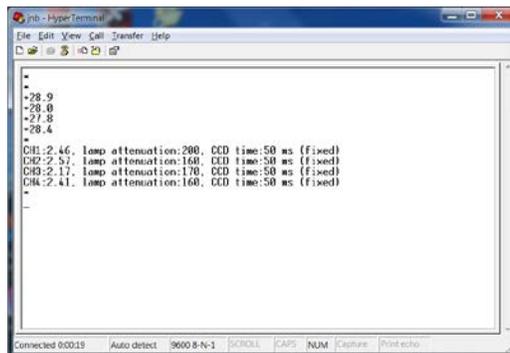
You can also use OptiLink. OptiLink should indicate that an instrument was detected at com port 30 (a Reflex in this example):
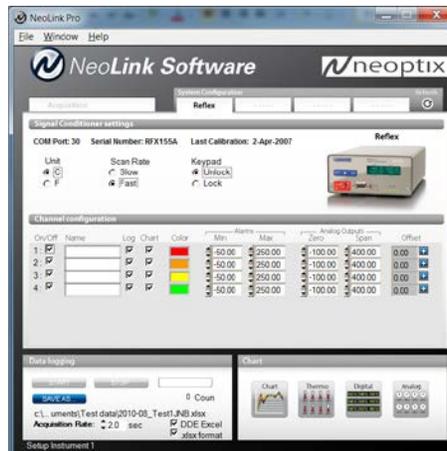
10 TCP/IP INTERFACE OPTION – MODBUS MODE

T/Guard systems can be optionally fitted with an Ethernet TCP/IP interface. The TCP/IP interface is based on a module manufactured and supported by Lantronix. The module model number is Micro100, 10/100Base-T; for more information, see http://www.lantronix.com/device-networking/embedded-device-servers/micro100.html, where documentation and other information can be downloaded. The Xpress DR model is also supported, in RS485 mode; see http://www.lantronix.com/device-networking/external-device-servers/xpress-dr_dr-iap.html.

The procedure given here is based on ModScan; this software can be purchased separately. See http://www.win-tech.com/html/modscan32.htm.

Warning: Since 2009, Neoptix will supply only the Xpress-DR model.

10.1 TCP/IP interface specifications

Category	Description
Memory	256K RAM
Serial Flash	512 K
Serial Interface	2 TTL serial interfaces (Async). 5V-level signals. Through-hole plated pins, DIL
Board Dimensions	Height: 1.575in (40.00 mm) Width: 1.935in (49.15 mm) (See Drawing)
Weight	0.7 ounces
Temperature	Operating range: 0° to +70° C (32 to 158° F) Storage range: -40° to +85° C (-40 to 185° F)
Protocols Supported	ARP, UDP, TCP, Telnet, ICMP, SNMP, DHCP, TFTP, AutoIP, and HTTP
Network Interface	RJ45 10/100Base-T
Data Rates	300 bps to 230400 bps
Serial Line Formats	Characters: 7 or 8 data bits Stop bits: 1 or 2 Parity: odd, even, none
Modem Control	DTR, DCD, CTS, RTS
Flow Control	XON/XOFF (software), XON/XOFF Pass Characters to Host CTS/RTS (hardware) None
Management	HTTP SNMP (read only) Serial login Telnet login
System Software	Operational code (ROM): downloadable from a TCP/IP host (TFTP) or over serial port
LEDs	Channel 1 (solid Green = idle, blink = active) Channel 2 (solid Yellow = idle, blink = active) Diagnostics (Red, in combination with Channel 1) Network Link (Green)
Compatibility	Ethernet: Version 2.0/IEEE 802.3
Power Requirements	5VDC (±5%) regulated @ 200mA

10.2 TCP/IP interface installation

This option requires that an Ethernet cable be used to connect to the T/Guard system; see Section below. In addition, special software is provided so a "standard" PC serial port can be assigned to a TCP/IP protocol; this is described in the Software Installation section below.

The MAC address is indicated on the side of the T/Guard instrument; however, it should not be required to know it under normal use.

10.2.1 Hardware installation

To connect the T/Guard system to your computer, simply use a proper Ethernet cable between the RJ45 port found on the T/Guard enclosure (on the right side) and connect it to your computer or network via a proper hub. Note: if you connect the cable directly to an Ethernet port on your PC computer, make sure you use a cable that is "crossed-wired"; if you use a hub, then a normal Ethernet cable should do the job.

Led arrangement:

Table 5 - DSTni-XPress DR LED Functions

LED	Meaning
R (Green)	**R**eady (Solid=ready, blinking = error message, port busy)
L (Green)	**L**ink (socket connection made) = Solid
A (Yellow)	**A**ctivity (network) = Random Flashing
TXD (Yellow)	Transmitting serially = Flashes during transmit
RXD (Yellow)	Receiving serially = Flashes during receive
F (Red)	**F**ault in XPress DR communication (read error) or XPress DR is in Configuration Mode

Simultaneously lit F (Red) and R (Green) LEDs mean something is wrong. If the F (Red) LED is lit or blinking, count the number of times the R (Green) LED blinks between its pauses. Six possible blink patterns, detailed in the following table, indicate which fault condition exists.

Table 6 - LED Error Indications

LED	Error
Steady F (Red) and Blinking R (Green)	1 blink = EPROM checksum error 2 blinks = RAM error 3 blinks = Token Ring error 4 blinks = EEPROM checksum error
Blinking F (Red) and blinking R (Green)	1 blink = Faulty network connection 2 blinks = No DHCP response 4 blinks = Setup Mode

You are now ready to install and configure the software that acts as a "buffer" between your COMx software (such as ModScan) and the T/Guard system. See next section.

The XPress DR model is din-rail mountable, and is located outside the T/Guard enclosure. This figure shows a typical installation. It requires an outside 24VDC (9 to 30 VDC, or 9-24 VAC) power supply.
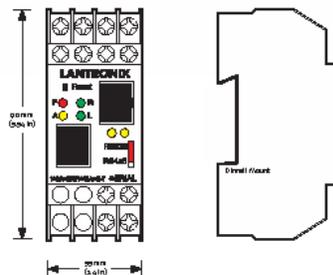
The Xpress DR model should have a serial connection as shown here (RS485, 2W and 4W). Make sure also that the little red switch RS232-RS485 is in the RS485 position.
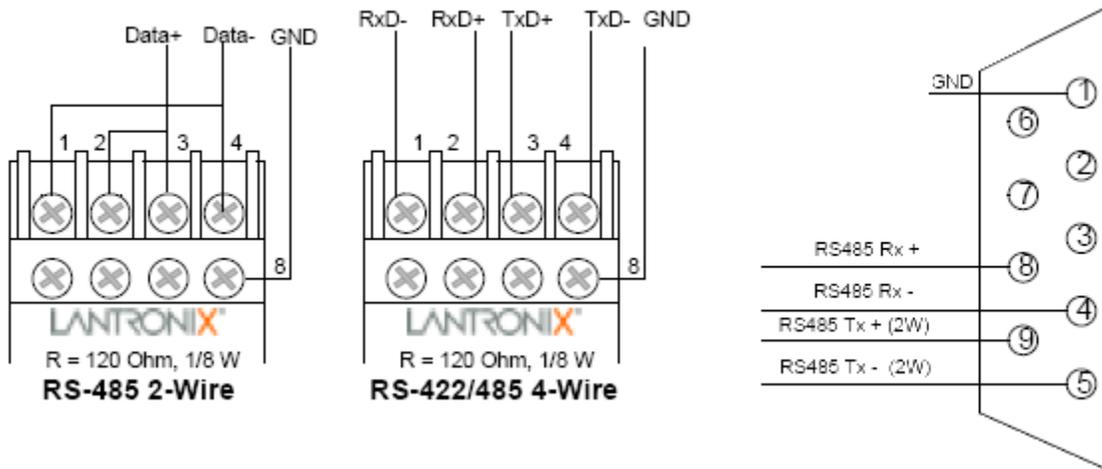
10.2.2 Software installation

To use this option, you need to load two Windows applications on your PC. These 2 applications are supplied by Lantronix.

Warning: The procedure described in this chapter assumes that

10.2.2.1 Device Installer

The first application to load is called "DeviceInstaller". You can download a fresh copy for the web at the following address http://ltxfaq.custhelp.com/app/answers/detail/a_id/644. You must use the Stand-alone DeviceInstaller Setup application for Windows; you can download it either by ftp or http. During the installation process, the following window will appear:

It is important that you install both the .NET and DeviceInstaller applications, as shown above. If you get a warning from your firewall, as shown below, you must click "Allow access".

Warning: The setup procedure that is described here assumes that your Lantronix bridge device is connected on a network where a DCHP server is present. This procedure will not directly work for an installation where your Lantronix device would be connected directly to your PC[18].

Once installed, run DeviceInstaller. Make sure the Lantronix device is on the network and powered up. You should get the following screen:

As you can see, DeviceInstaller has not found any Lantronix device. Click the Search icon. Depending on what you have on your network, here is a typical response from the search operation:

Take note of this IP address: this is the IP address of your Lantronix device.

---

[18] If you try to connect your Lantronix device directly to your PC (thus without a DHCP server), it might be useful to load a DHCP server on your PC; that way, the procedure described here will work even if you have no external DHCP server device, such as a router or hub. The following shareware (free) can be very useful for this purpose: http://ruttkamp.gmxhome.de/dhcpsrv/dhcpsrv1.9.zip; do not run it as a service, unless you want to use this configuration as a permanent installation. The readme.txt file gives instructions on how to use this very useful program (in particular how to set a range of searchable IP addresses).

If DeviceInstaller does not find any Lantronix devices after a few tries, check the device for proper installation on the network (power supply, wiring, etc.).

Now, we need to install the second software program, called CPR Manager (CPR = Com Port Redirector). Again, the best is to download a fresh copy from the Lantronix web site, at the following address: http://www.lantronix.com/device-networking/utilities-tools/com-port-redirector.html. Download the stand-alone CPR Setup application for Windows, either ftp or http. During installation, you will see this window, click Install.

Run the CPR Manager. You will get the following empty window:
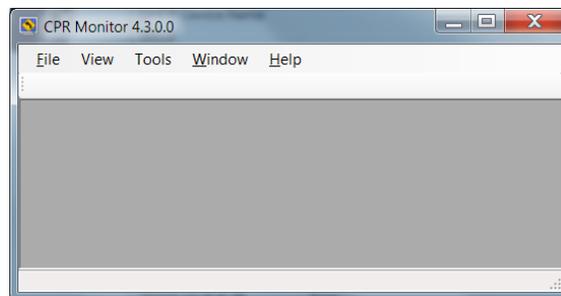
Select "Tools" from the task bar, then "Launch CPR Manager"; the following window will open:
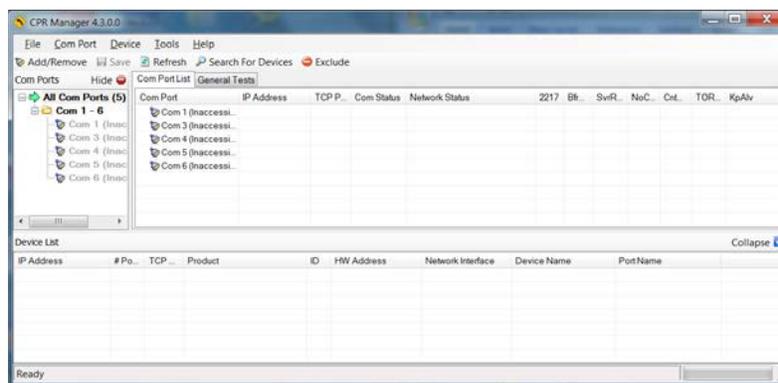
Click the "Add / Remove" button. The following sub-window opens, to allow you to select an appropriate Com port number. Neoptix suggests that you select a port number in the range or 15 to 30. In this example, we have selected port # 30[19].

---

[19] 30 could be a good default value because it will not interfere with other port addresses that are assigned automatically by other USB-to-serial adapters, and so forth.

Click OK. Then the previous window should now should the following:

Enter your IP address (see above).
TCP Port must be 10001

Once you have entered the IP address and TCP port number, click the "Save" button. The window content will change to this:

This completes the Lantronix device installation. You can use the Windows Device Manager to confirm that your Lantronix is now an active serial port element.

Your device should be listed here
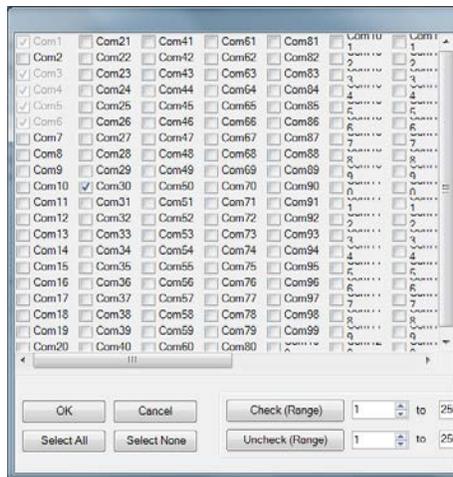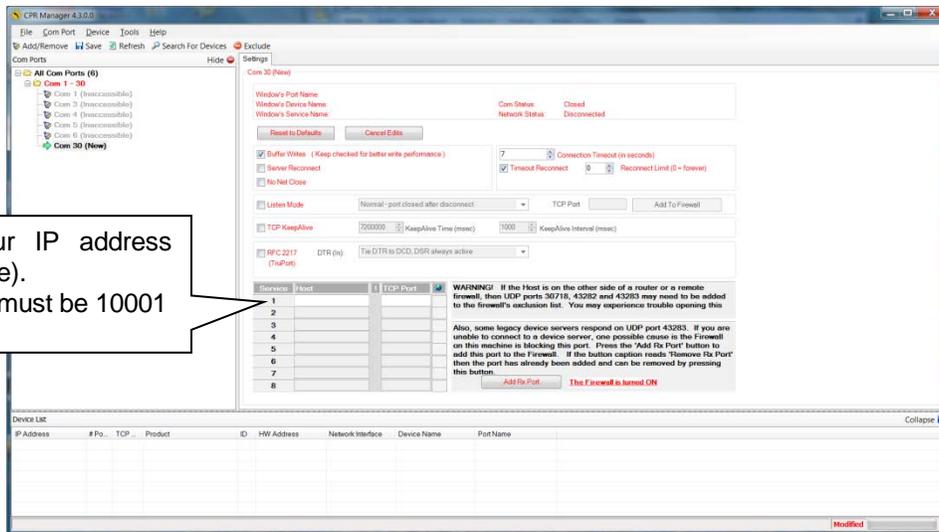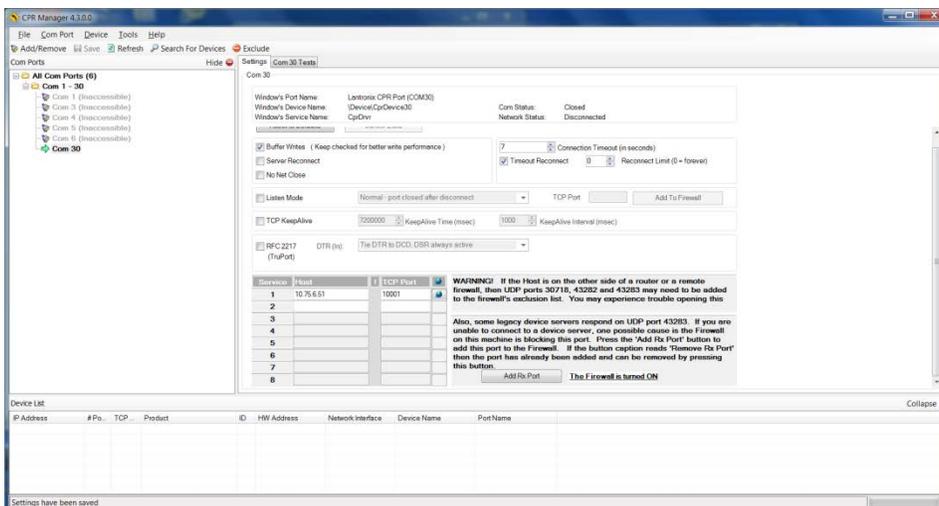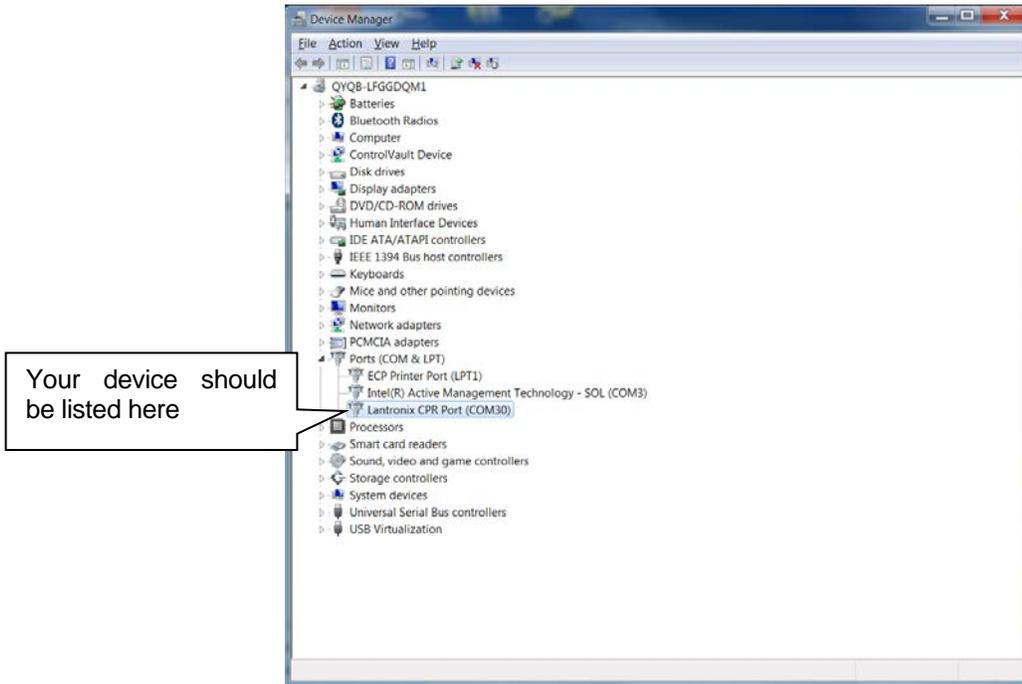
If you use ModScan, you should now be able to connect with your T/Guard system, as illustrated here (remember to set your com port to 502, as illustrated below. Open the ModScan Connection Details, as follows:

Enter your IP address (see above).
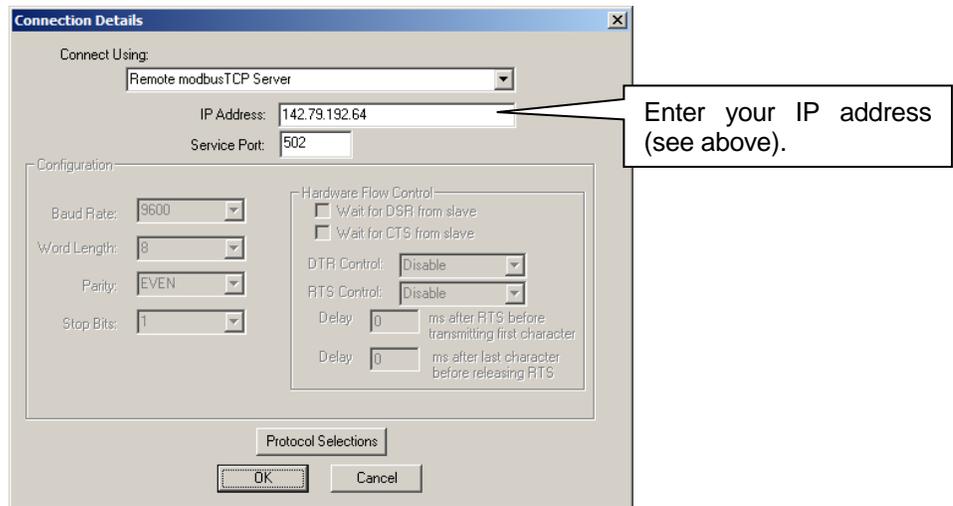
Open the ModScan communication port, and insure that everything works correctly (next figure). Refer to Chapter 8 for a description of the Modbus registers. For the T/Guard2, please refer to the appropriate user guide for the description of its Modbus registers. Note: in the figure given below, we had only 4 probes connected to channels to 5 to 8.
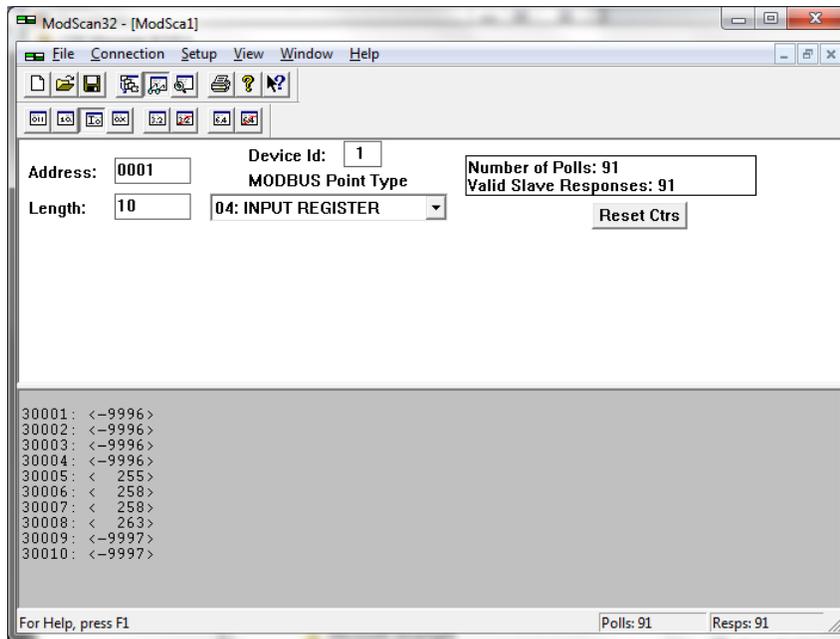
10.2.3 Lantronix Troubleshooting

Port telnet debug = 3000

Error Code, debug mode
        65520: Bad CRC
        65521: No response
        65522: Bad Form
        65524: Overflow
        65525: Incomplete data
        65526: TCP/IP err.

11 RS-485 CONVERTERS

11.1 RS-485 to USB converter

As most PC computers today don't have serial ports, Neoptix recommends using a RS-485 to USB converter (also called adapter). It works great with all T/Guard, T/Guard2 and T/Guard+ systems. This converter works for both 2W and 4W RS-485 installations; no external power supply is required. It also offers 2000V RMS optical isolation, which is great for electrically noisy applications or when grounding may be a problem. The following figure shows this adapter (when purchased form Neoptix, the adapter will be fitted with a DB9 connector suitable for use for both 2W and 4W applications):

Note that this converter requires a special software driver that needs to be installed before you use the device; you will find all details on the CD that comes with the unit.

Furthermore, the converter has 4 dip switches that need to be configured depending on your exact installation: there are 2 possibilities, as follows:

a) If you have a 2W (2-wire, also called "half-duplex") installation, then the four dip switches must be set as follows:
   a. Switch 1 must be on (RS-485 mode)
   b. Switch 2 must be on (Echo Off)
   c. Switch 3 must be on (2 Wire mode)
   d. Switch 4 must be on (2 Wire mode).

b) If you have a 4W (4-wire, also called "full-duplex") installation, then the four dip switches must be set as follows:
   a. Switch 1 must be on (RS-485 mode)
   b. Switch 2 must be off (Echo On)
   c. Switch 3 must be off (4 Wire mode)
   d. Switch 4 must be off (4 Wire mode).

Warning: When dealing with very long cables (e.g., more than 300 meters), your RS-485 network might need a termination resistor (typically 120Ω). Consult Neoptix for more details.

11.2 RS-485 to USB converter for T/Guard/Link

As explained in Section 4, the T/Guard/Link (TGL) is in Modbus mode by default. To configure a TGL or to exercise it with OptiLink or with HyperTerminal, it may be useful to disable the Modbus mode. This can be done by shorting pins 6 and 7 together when powering up the TGL (for a few seconds).

Neoptix offers a convenient assembly that combines a special cable fitted with a switch and a RS-485 to USB converter, as described in the previous section. Press the switch for a few seconds while the TGL link power is turned on, to disable Modbus[20]. The following picture shows this assembly.

This assembly works for both 2W and 4W installations.

Switch (Press during power up to disable Modbus mode)

11.3 RS-485 to RS-232 converter

Note: This converter is not recommended anymore. The USB version, described above, is recommended.

As an alternative solution, Neoptix offers (as an option) a convenient converter that can be used to link a T/Guard (or a T/Guard+) fitted with a RS-485 interface to a PC computer that has only a RS-232C interface port. This converter works with both 2W and 4W RS-485 installations. This converter does not need any software driver to be installed in your PC.

The following figure shows this adapter.

To PC ←   →To T/Guard

To use the converter, you will need a standard RS-232 cable that will attach your converter to your PC. Please note that PC's that do not have an RS-232 interface built-in will need an additional RS-232 to USB adapter that you can buy at any local computer shop[21].

This converter has 4 dip switches that need to be configured depending on your specific installation. The setting details is the same as for the USB converter, see above section.

The converter does not require any outside power supply; it is self-powered from the RS-232 signal lines. However, if termination resistors are used, an external power supply is required.

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[20] The cable part number E0105 can also be used to disable the Modbus mode and enable the Neoptix native communication mode. Use the cable to enable the Neoptix mode; otherwise, do not use it.
[21] We have found that some RS-232 to USB adapters do not appropriately power up this RS-232 to RS-485 converter; for these, the converter may require an external 12VDC power module to operate properly.

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