Telog Data Recorders

User Guide

R-3000 Series	WLS Series
LC-800 Series	WPS Series
R-2100 Series	Data Transfer Unit

Telog Instruments, Inc.
830 Canning Parkway, Victor, NY 14564-8940 USA
Phone: (716) 742-3000 • Fax: (716) 742-3006
Website: http://www.telog.com
E-mail: TelogSales@telog.com

Telog Part No.: 3000-051 Rev D

Released 4/99

Table of Contents

List of Tables

List of Figures

Assumptions

This User Guide contains information for setting up the Telog R-3000 series, R-2100 series and LC-800 series data recorders. This guide provides information on hardware features that are appropriate when using Telogers for Windows for programming and collecting data using these recorders. For information on using the support software appropriate for your type(s) of recorder(s), refer to the corresponding user guide: for S-3PC use the Telogers for Windows User Guide, for S-21PC use the R-2100 Series User's Manual and for S-8PC use the Linecorder LC-800 Series User's Manual.

Feedback to Telog

All of our products are the result of efforts by the engineering, marketing, and production staffs of Telog Instruments, Inc. We are eager to know what you think of our recorders, the software and our user guides. We are constantly seeking ways to improve our products based on your comments and experiences. Many of our ideas for improvement to existing products and ideas for new products come from you. Call, fax or write to use at the information on the front cover.

Product Registration

To register your recorder(s) and software with Telog, complete and return the registration card located in the front of this guide. We provide technical support for registered users. In addition, we notify registered users of product upgrades and may offer you the opportunity to purchase upgrades at substantial savings.

Organization of this Guide

This guide contains a section for each series of Telog's recorders and the optional Data Transfer Unit. You will find information for installation, setup, use and specifications for each type of recorder. Refer to the table of contents for the section that describes the type of recorder(s) for which you want information.

Unpacking Your System

Some suggestions for unpacking your system are provided below.

- Please unpack each package of the shipment carefully. Be sure to remove all items. Small items such as cables and batteries are easily overlooked.
- Compare the total received shipment contents with the packing list. Contact Telog if items are either missing or different from the packing list.
- Save the shipping cartons, boxes, etc. They can be reused if you need to return a recorder for service.
- Carefully inspect all items for shipping damage.
  If you received a sensor or transmitter with your recorder, inspect the sensing elements by unscrewing the black plastic tip of the sensor or transmitter and visually inspect the crystal diaphragm for cracks or other obvious physical damage, then replace the tip.
- Do not attempt to install or use any damaged item. If items were damaged in shipment, contact the shipper for assistance.

Cleaning Your System

Information for routine cleaning of Telog recorders is provided here. Additional information for cleaning and decontaminating e-series recorders if they are exposed to known or potential health hazards is described in Section 3.

Note:	Telog reserves the right to withhold service from any product until proper cleaning and decontamination have been accomplished and certified.

To perform routine cleaning, wipe the enclosure of the recorder with a water-dampened cloth. If needed, use a mild detergent, then wipe the detergent with a water-dampened cloth. Wipe excess water from around the connectors. Allow the water to evaporate thoroughly before returning the recorder to service.

Section 1. Telogers: R-3000 Series Recorders

Overview

The Telogers data acquisition system is designed to perform automatic data collection from remote locations. A minimum system configuration consists of at least one R-3000 series (Teloger) recorder, Telogers for Windows (S3-PC) support software running on a personal computer and a data transfer cable (C-21ATC). A more common system configuration consists of several (five, 50, or even 300) Telogers sharing Telogers for Windows.

There are several models of Teloger recorders in the R-3000 recorder series. The model number identifies the number of independent channels for data collection. Appendix A and Table 1-1 provide information on each model in the R-3000 series, sensors and accessories for a Telogers system.

Each Teloger consists of a circuit board packaged in a bent metal enclosure for panel mounting. The recorder's face-plate contains information on connections for power, telephone and signal inputs. Optional NEMA 4X enclosures are available to fit your specific application requirements.

Program each R-3000 using Telogers for Windows. The R-3308 recorder channels are completely software programmable. The R-3307 and R-3314 recorders have hardware switches that set the analog channels to collect either current or voltage information. The R-3303 recorder does not have analog channels. Information on setting the hardware switches is provided later in this section.

If your R-3000 Teloger has the optional M-324 modem module or an external modem, you can reprogram and collect data using remote communications. If the recorder does not contain the module or an external modem, use the data transfer cable for local (direct) connection to the computer running Telogers for Windows (S3-PC) to program and collect data.

Refer to the Telogers for Windows User Guide for information on setting up, programming and collecting and analyzing data from an R-3000 recorder.

Specifications

Table 1-1. R-3000 Series Recorder Specifications

	R-3314	R-3308	R-3307	R-3303
Recorder Channels				
Channels	14 total - 8 analog and 6 pulse/event	8 total - 4 analog, 3 pulse/event and 1 ambient temperature	7 total - 4 analog and 3 pulse/event	3 total, pulse or event
Memory	256K or 512K RAM total, dynamically allocated among active channels			
Analog inputs only	127,980 or 289260 12-bit data values	137,700 12-bit data values	70,560 or 151,200 12-bit data values	*NA*
Pulse inputs only	95,985 or 216,945 16-bit data values	103,275 16-bit data values	52,920 or 113,400 16-bit data values	52,920 or 113,400 16-bit data values
Event inputs only	31,995 or 72,315 events	34,425 events	17,640 or 37,800 events	17,640 or 37,800 events
Storage	Wrap-around (FIFO, first-in, first-out)			
Analog Inputs Type	User selectable			*NA*
Voltage	Bipolar or unipolar: 100 mV, 200 mV, 500 mV, 1, 2, 5, 10, or 20 V; or unipolar 1–5 V			
Current	Bipolar or unipolar: 1mA, 20 mA; or unipolar 4-20 mA			
Ambient temperature	*NA*	See Table 1-2 that follows	*NA*	
RTD				
Thermocouple				
Input Impedance				
Voltage input	1Mohm to ground (+ and – inputs)			
Current mode	200 ohms loop impedance	100 ohms loop impedance	200 ohms loop impedance	
Common Mode Rejection	± 4 Vdc on 1V or lower voltage ranges and 1 ma current range ± 40 Vdc on 2V or higher voltage ranges and 20 ma current range			
Excitation	*NA*	On time for 5 ms to 400 ms; voltage or current, selectable to suit transmitter used: 5 or 12 volts (20mA max.), or 1mA (1Vmax)	*NA*	
Resolution	12 bits (0.025% of FS)			
Accuracy	± 0.05% for 100 mV ranges and above; ±0.1% for ranges below 100mV; ±50ppm/°C			
Analog and Temperature Sampling				
Sample rate	Once/s to once every 8 h for each channel			
Sample interval	1 s to 8 h, synchronized to midnight, channel independent			
Values saved	Minimum, average and/or maximum per interval			
Totalizers	1 six-byte totalizer per channel			

Table 1-1. R-3000 Series Recorder Specifications (cont.)

Pulse/Event Inputs	
Type	Pulse counting or event recording, user selectable
Input	Uncommitted contact or active logic signals
Excitation	10μA contact sensing current; 5 volt pull-up
Contact bounce	3 ms, software programmable bounce filter
Pulse Sampling	
Low speed rate	100/s with bounce filter
High speed rate	20,000/s with no bounce filter
Total interval	1 s to 8 h, synchronized to the hour, channel independent
Values saved	Totals, overall and per interval
Event Sampling	
Event rate	1 event/s maximum
Values saved	Event with time stamp (mm:dd:yy:hh:mm:ss), and computed run time
Alarms	
Activation	any channel
Outputs	for R-3303 and R-3307: 1 high and 1 low; for R-3308 and R-3314: high/high, high, low and low/low
Type	Open collector transistor
Maximum voltage	30 V
Maximum current	100 mA
Resolution	0.025% of FS
Power	
Local battery type and life	Lithium battery pack with MTA connector: 10V 1.8Ah pack for R-3303, R-3307 and R-3314, 9V 3.6Ah pack for R-3308. Life of 6 months @ 23°C, with 1 sample every 5 s on all channels and one minute phone call/day. Refer to “Power Options” later in this section for additional information.
External Battery	For R-3303, R-3307, R-3314, 11.5Vdc to 15 Vdc. For R-3308, 10Vdc to 15Vdc.
External DC, unregulated	15-35 Vdc
Communications	
Type	RS-232 (opto-isolated), standard
Baud rate	300, 1200, 2400, 9600
Connector	9-pin ‘D’ connector, compatible with Telog C-21AT
Modem option	2400-baud plug-in module, FCC and CSA approved
Mechanical & Environmental	
Clock accuracy	± 0.01%
LED indicator	With external power 1 flash every second. On battery power, 1 flash every 5 seconds for R-3308 & R-3314 and 1 flash every second for R-3303 & R-3307.
Operating temperature	-20 to 60°C
Enclosure	Bent aluminum panel mount assembly
Size	for R-3303, R-3307 and R-3308, 21.6 cm x 17.2 cm x 5.7 cm / 8.5” x 6.8” x 2.3” for R-3314, 20.9 cm x 25.2 cm x 5.7 cm / 8.2” x 9.9” x 2.3”
Options	Fiberglass, IEC IP65, NEMA 4X enclosures, contact factory

Table 1-2. R-3308 Analog Inputs

	Measurement Range	Resolution (average)	Accuracy
Ambient temperature* (Telog AT-4 sensor)	0 to 70°C -20°C to 80°C	0.2°C 0.3°C	± 0.4°C ± 0.6°C
RTD** (100ohm Pt, α = 0.00385) Range 1 Range 2	 -220°C to 850°C -220°C to 260°C	 0.4°C 0.15°C	 ± 1.5°C ± 0.6°C
Thermocouple**			
Type K	-80 to 1200°C	0.7°C	± 3.5°C
Type E	-80 to 660°C	0.4°C	± 2°C
Type T	-80 to 350°C	0.3°C	± 2°C
Type J	0 to 750°C	0.5°C	± 3°C
Type R	0 to 1450°C	1°C	± 6°C

* Ambient temperature measurement accuracy does include sensor error for AT-4 sensor.

** RTD and thermocouple measurement accuracy does not include error of sensor.

Analog Channel Inputs

Input Types

The analog channels on the R-3307and the R-3314 have hardware switches you must set to measure either voltage or current, then use Telogers for Windows to select the same input.

Four of the R-3308 analog channels can be set for current loop, voltage (with pulsed excitation) or RTD input. An fifth analog channel is dedicated to ambient temperature input.

Voltage

Each voltage input terminal appears as a 1MΩ input to the recorder's ground and allows for differential measurement of voltage between the + and – terminals in the presence of common mode voltage. The maximum common mode voltage that can exist at each input without introducing measurement error is a function of the range and is described in Table 1-3 and shown in Figure 1-1.

Table 1-3. R-3000 Analog Voltage Inputs

Selected input range	Maximum common mode range
1V or less	± 4V
2V or more	± 40V

Current loop

Current measurement is performed by measuring the voltage across an internal shunt resistor between the + and – input terminals. This resistance produces a burden voltage to the current loop as described in Table 1-4.

The shunt resistance is comprised of a series precision resistor and a positive temperature coefficient (PTC) resistor. If the input current exceeds 80mA, the PTC resistor will increase resistance rapidly to protect the precision resistor. When external excitation is removed, the PTC resistor returns to its original resistance value. When in current mode, the maximum voltage that can be applied across the input terminals without causing damage to the precision shunt is 30V. Refer to Figure 1-2 for schematics.

Table 1-4. R-3000 Analog Current Inputs

Recorder type	Shunt resistance	Maximum burden voltage	
		1 mA range	20 mA range
R-3307, R-3314	200ohms	0.2V	4V
R-3308	100ohms	0.1V	2V

RTD

The R-3308 recorder supports 3-wire and 4-wire 100Ω platinum RTDs with α= 0.00385. Three-wire RTDs require the addition of a jumper between the excitation and + terminals. The recorder automatically performs pulsed excitation, lead-wire resistance correction and linearization for RTD inputs. Refer to Figure 1-3 for schematics.

Thermocouple

The R-3308 recorder supports five types of thermocouples: J, K, T, E and R. Thermocouple inputs are polarized. The recorder automatically performs cold-junction compensation and linearization for thermocouple inputs. Refer to Figure 1-4 for a schematic.

Ambient Temperature

The R-3308 recorder can measure ambient temperature (-20 to +80°C) on channels 1–5 with the Telog ambient temperature probe (AT-4). Channel 5 is dedicated to this measurement. Refer to Figure 1-5 for schematics.

Excitation

The R-3308 analog channels provide pulsed excitation to power external sensors and transmitters on all channels. Pulsed excitation permits the recorder to excite or power certain external sensors and transmitters to minimize power consumption, specifically when the sensor and recorder are powered by batteries. For example, a 4-20mA transmitter, which may consume as much as 240mW if continuously powered, may consume, on average, only 240μW (1000 times less) if the measurement can be taken once every 10sec with an excitation period of 10ms.

If external power is available to the recorder and sensor, it is not necessary to use the pulse excitation feature. (Standard connection diagrams, when excitation is not employed, are provided in Figures 1-1 and 1-2.)

The excitation is user-selectable as 5V, 12V, or 1ma with a programmable duration from 5 to 400ms. The maximum current for 5V and 12V excitation is 20mA. The maximum output voltage for 1ma excitation is 1V.

Some applications using pulsed voltage excitation are described in the list below. The recommended connections for each application are shown in illustrations in Figure 1-6.

- A 2-wire current loop transmitter. Note that a 12V excitation pulse provided to a remote current loop transmitter results in only 10V available for the transmitter since as much as 2V will be dropped across the R-3308 current shunt resistance.
- A 3-wire voltage sensor/transmitter where the signal return is also the negative supply of the sensor. You must supply a connection between the recorder terminal and the ground terminal.
- A resistance bridge network in the range of 250 to 50,000 ohms.
- A 4-wire voltage sensor/transmitter where the output signal is independent of the negative supply to the sensor.
- A 3-wire potentiometer in the resistance range of 250 to 50,000 ohms with 5V excitation. We recommend 5V excitation. The system determines the wiper position as a percent of full-scale travel.

For proper measurement when using the pulse excitation feature, select an appropriate excitation pulse duration. The R-3308 supports sensors that respond rapidly to applied external power and achieve a stable output within 400msec, the maximum excitation period. Some sensors, for example, the Druck PTX 1830 Pressure Transmitters, produce the specified accuracy in 10msec. However, some transducers require in excess of one second to achieve a stable output level, and hence, cannot be used with the R-3308.

If you are not certain the sensor you want to use can be supported by the R-3308 pulse excitation feature, use one of the following three methods:

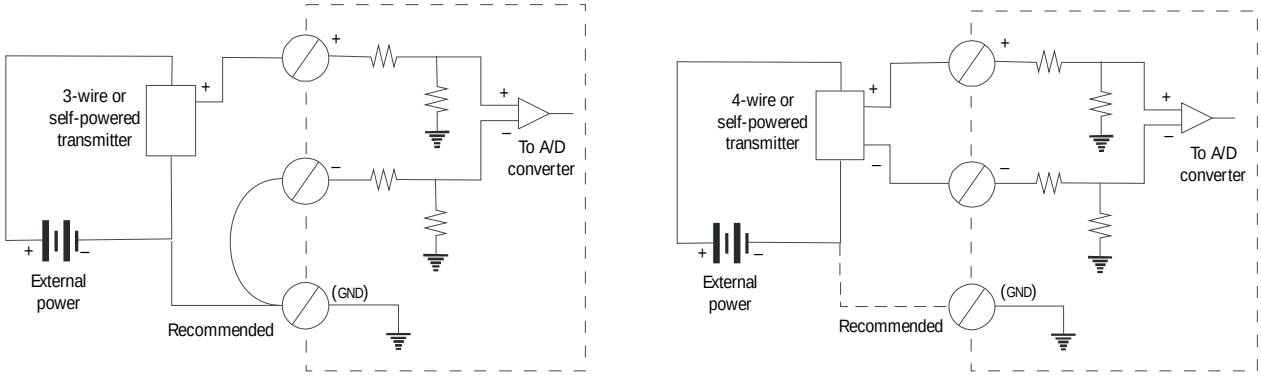
- Refer to the sensor manufacturer's information or contact the manufacturer. (The excitation period typically is not a standard sensor specification.)
- Contact Telog's Customer Service Department for information on known compatible sensors.
- Perform the simple calibration test described below.

Procedure to perform a calibration test

1. Connect the sensor to an appropriate calibrator input and to the R-3308 analog input channel.
2. Provide the sensor with a continuous source of external power (5V, 12V, or 1ma).
3. Document the calibrated output signal level on the R-3308.
4. Replace the external power source with the R-3308 excitation source programmed for 400 msec pulse duration at 10 sec intervals.
5. Repeat step 4 using progressively shorter pulse duration values until you detect a departure from calibration.
6. Select the shortest pulse interval that produces reliably stable calibrated measured values.
7. Repeat this calibration test (steps 1 — 6) at multiple points over the amplitude range to ensure that the sensor responds correctly independent of input signal level.

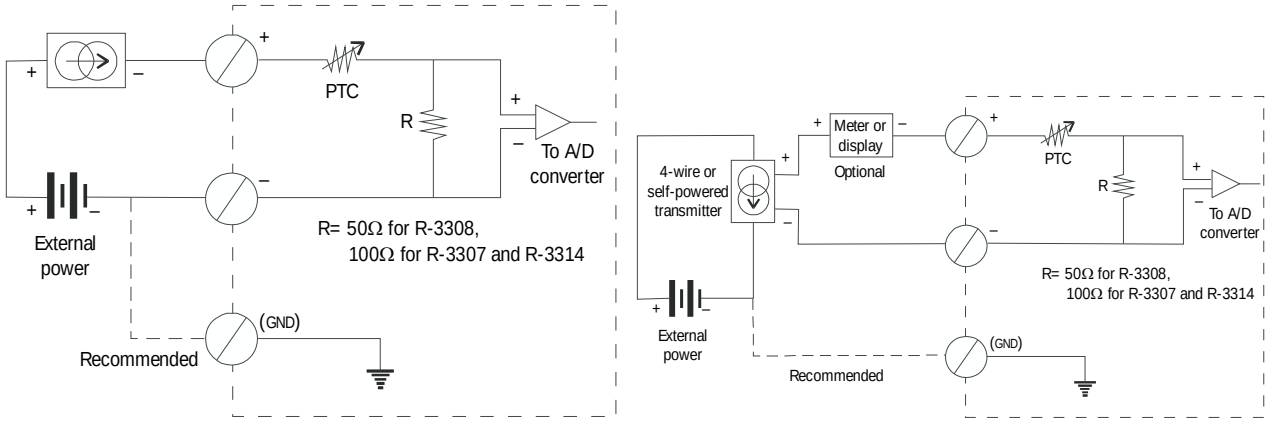
Schematics

This section contains analog channel schematics.



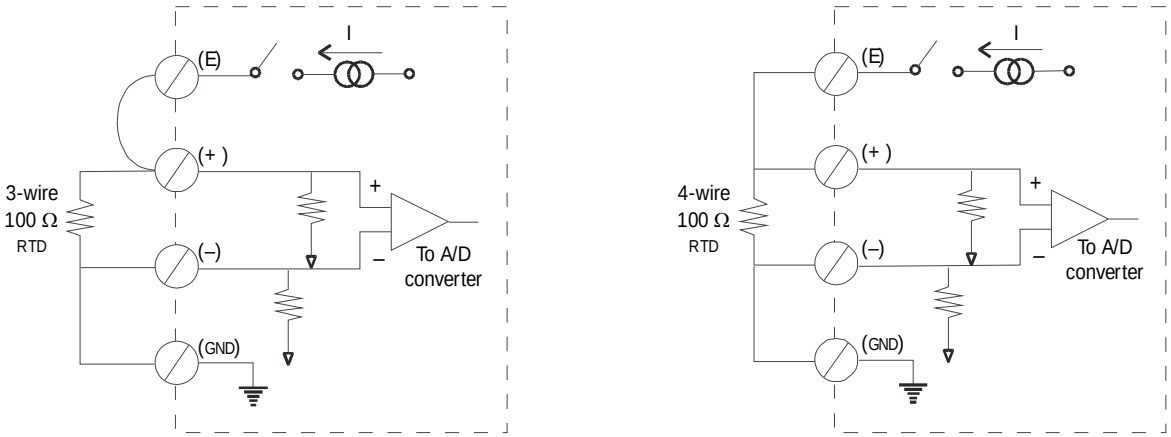
Three-wire voltage transmitter *Four-wire voltage transmitter*

Figure 1-1. R-3000 Voltage channel schematics



Two-wire current loop transmitter *Four-wire current loop transmitter*

Figure 1-2. R-3000 Current transmitter schematics



Three-wire *Four-wire*

Figure 1-3. R-3308 RTD input schematics

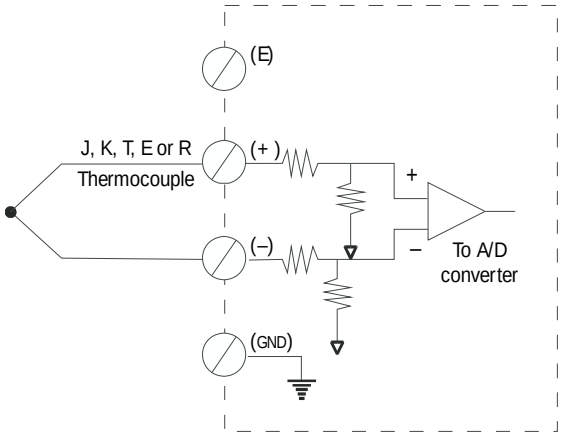
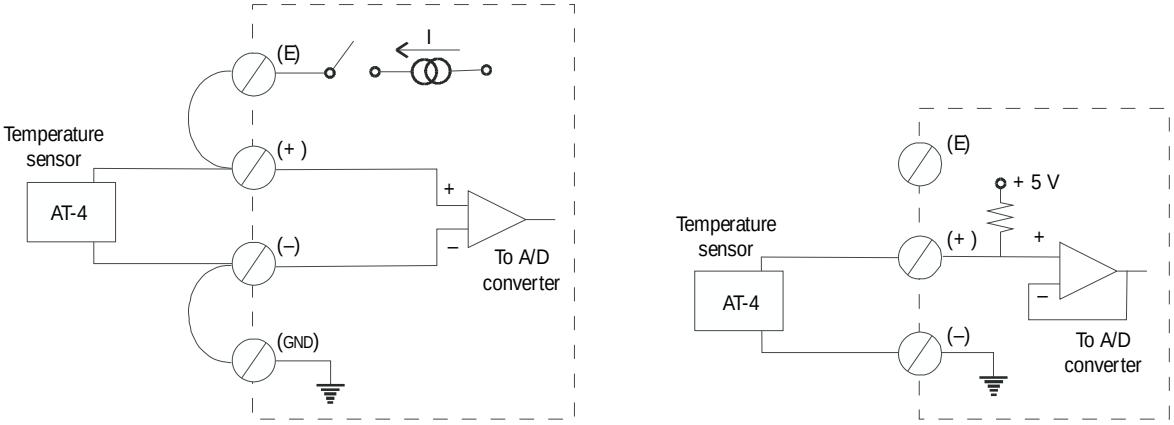
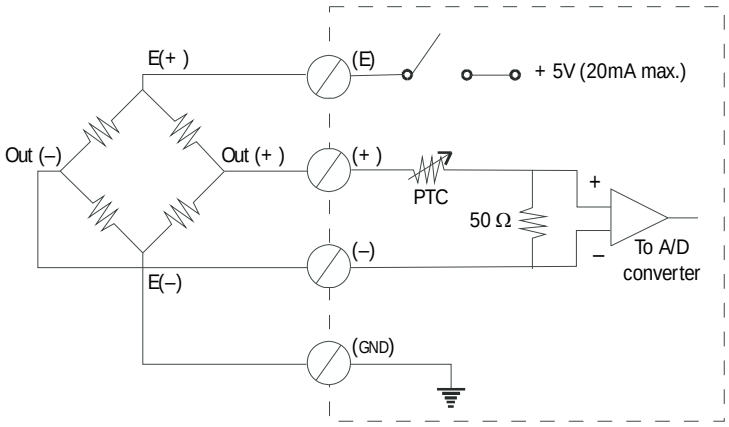


Figure 1-4. R-3308 Thermocouple input schematic

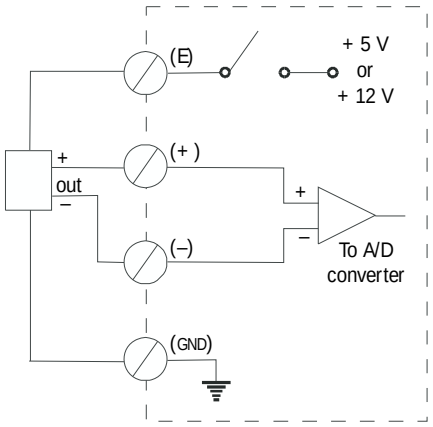


For Channels 1-4 *For Channel 5*

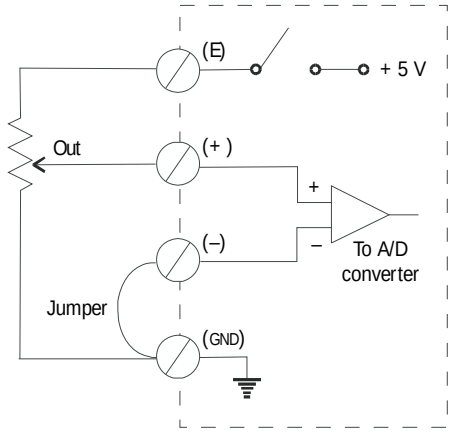
Figure 1-5. R-3308 Ambient temperature input schematics



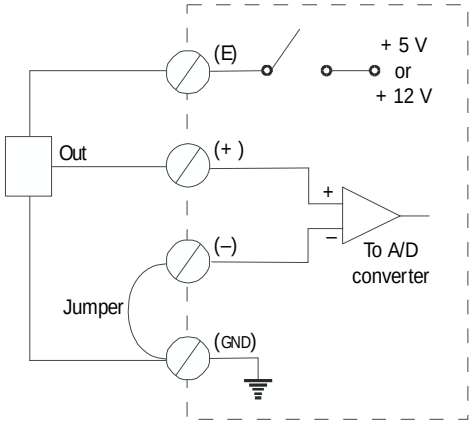
Four-wire resistance bridge



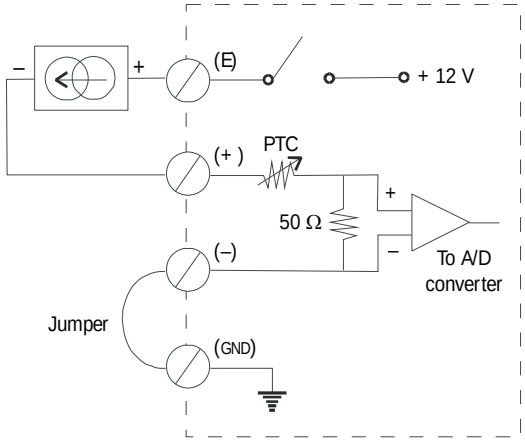
Four-wire voltage transmitter



Three-wire potentiometer



Three-wire voltage transmitter



Two-wire 4-20ma current loop transmitter

Figure 1-6. R-3308 Pulsed excitation applications

Digital Channel Inputs

Summary

The R-3303, R-3307 and R-3308 each have three digital channels and the R-3314 recorder has six digital channels for pulse or event recording. Refer to Table 1-1 for additional information.

Pulse

The pulse input mode is useful for counting the number of pulse events that occur during sequential intervals. For example, it can count the number of times a tipping bucket rain gage tips per hour or the blade rotations of a turbine meter per minute. Each pulse event can be scaled into the appropriate engineering units of measure. Hence, you can converts tips of the bucket rain gage into inches of rainfall per tip, and more appropriately, inches of rainfall per hour. The rotations per minute of a turbine meter can be converted to a flow rate, such as gallons per hour (gph).

The digital inputs may interface either uncommitted mechanical contacts such as switches or relay contacts, actively driven logic or transistor inputs, as shown in Figure 1-7. When interfacing mechanical contact inputs, select the low-speed pulse input, which employs a 3msec contact bounce filter, to eliminate false counting of contact switch bounce. The high-speed pulse selection does not employ an input filter; use it when monitoring high rate events such as turbine meters or radiation counters.

Event

The event input mode records the date and time, to one-second resolution, of a contact closure and/or opening, or the positive and/or negative transition of an analog logic signal. This is useful for recording pump and motor run-time or logging the time-stamp of critical events. For additional information refer “Installation considerations”.

Installation considerations

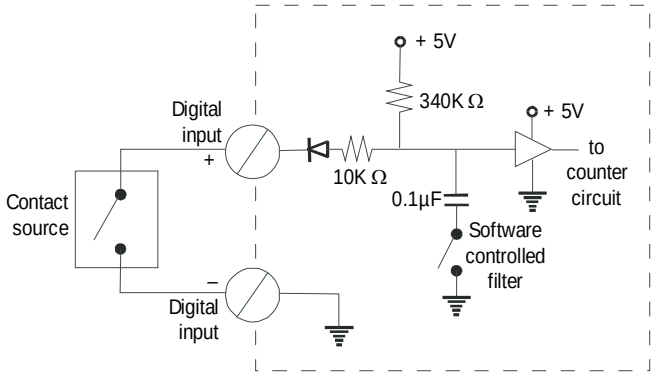
Generally, sensors or systems that produce actively-driven digital output signals have low impedance outputs and are less susceptible to electromagnetic interference than uncommitted contacts or open-collector transistor circuits which use passive pull-up resistors. As a general rule, actively-driven logic signals can be satisfactorily interfaced at cable lengths of 2000ft (600m) while uncommitted contacts (or open-collector transistor circuits) should be less than 100ft (30m).

The pulse/event input circuit employs a high impedance pull-up resistor (350K ohms) to +5VDC to detect contact closures to ground. In applications where the environment is electrically noisy or where the input cable distance exceeds 100ft (30m), add an external resistor and capacitor network with external DC excitation as illustrated in Figure 1-7 to improve the signal integrity. The external excitation may be the recorder’s external power supply input or any DC voltage greater than 5VDC up to a maximum of 30VDC.

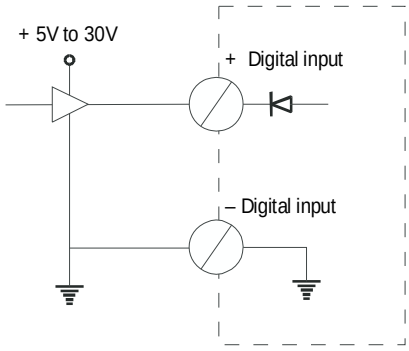
When interfacing active logic inputs (shown in Figure 1-7) select the high-speed pulse input to count pulses as short as 50μsec or frequencies as high as 20KHz. Very short pulses must have high and low periods of at least 25μsec to be detected. The recorder’s detection threshold for the pulse/event inputs is 2.5VDC ± 1VDC.

Schematics

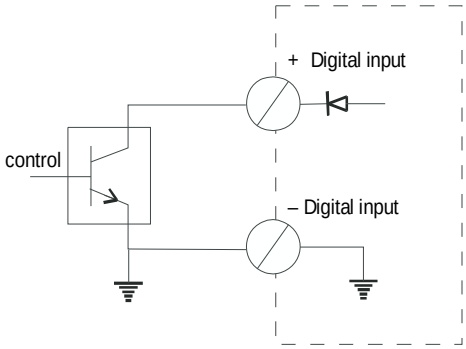
This section contains digital channel schematics.



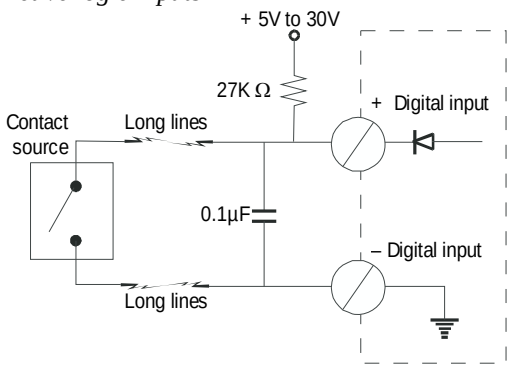
Digital input circuit with contact input



Active logic inputs



Open collector transistor input



Low impedance setup with external resistor and capacitor

Figure 1-7. R-3000 Digital input circuits

Data Collection

Since each channel has separate signal inputs, you can program parameters including channel information, recording and alarm parameters, phone settings and security options for each channel independently using Telogers for Windows. After downloading the channel parameters to the recorder, data collection begins using these parameters.

After recorder installation, each active channel samples its input signal at the programmed sample rate. At the end of a sampling interval, the recorder:

- fetches a reading from each active channel.
- for each analog channel, compares the current reading with the highest and lowest readings that have occurred for that recording interval. If a new minimum or maximum value occurred, the recorder discards the old value and stores the new value in an intermediate buffer.
- adds the reading to an intermediate summation register.

If programmed, at the end of each recording interval, the recorder:

- determines the minimum and/or maximum values for each channel and stores them.
- for each analog channel, computes the average (intermediate summation register / number of samples taken during the recording interval), rounds the value, and stores it. (Inputs on pulse channels are not averaged.)
- updates the totalizer register (channel average *x* number of seconds in the interval) and stores the value.
- clears the intermediate summation register.

At midnight (standard time) the recorder stores a snapshot of the current totalizer value in memory. The recorder maintains a buffer of the most recent 40 days of totalizers for each totalizing channel. The contents of the totalizing buffer is transferred to your computer during routine data transfer.

The time stamps reported for each recorded interval correspond to the start time of a recording interval. For example for a 15 minute recording interval, data reported at 12:00 am was obtained between midnight and 12:14:59 am.

Power Options

Summary

Each Teloger recorder has three power inputs: local battery, external battery and external unregulated DC. Each input is described in Table 1-5 and represented in the schematic in Figure 1-8.

Table 1-5. R-3000 Summary of Power Inputs

Power Source / Input	**Applications**	**Notes**
Local battery	External power is not available at the monitoring site. (In typical applications local battery can power recorder and modem for six months. For the R-3308, pulse excitation can occur.) External power to recorder fails.	Lithium battery pack shipped with recorder (10V for R3303, R3307 and R-3314 and 9V for R3308). Operating temperature: -40° to 70°C. Shelf life is greater than 8 years, but replacement recommended at five years, or more frequently, if primary power source. Refer to Tables 1-6 and 1-7 for battery life calculations.
External battery	12V battery. Solar panel rechargeable battery system. Regulated DC power supply.	Battery voltage range for R-3303, R-3307, R-3314 should be 11.5 to 15VDC. If voltage drops below 11VDC, local battery becomes power source. Input voltage range for R-3308 should be 10 to 15VDC. If voltage drops below 9.5VDC, local battery becomes power source. Input voltages above 16VDC may damage this power input circuit.
Unregulated dc input (15 to 35 VDC)	24VDC power supplies. Unregulated AC to DC converters. Any DC power source with a range of 15-35VDC.	Power sources connected to this input are conditioned by a voltage regulator that consumes 5ma continuous current for R-3303, R-3307, R-3314 (2ma for R-3308). If input voltage drops below 15VDC, external battery, if provided, then local battery, will become power source. Voltages above 36VDC may damage this power input circuit.

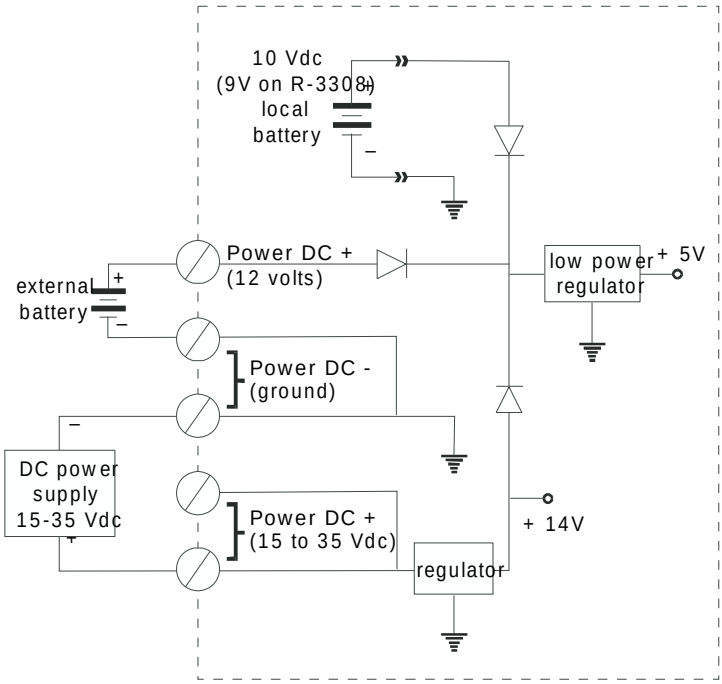


Figure 1-8. R-3000 External power inputs

Battery Life Considerations

Since user applications vary widely and each may place a different set of demands on the recorder's power requirements, it is not possible to provide a single value for the battery life expectation. However, for long-term battery-powered monitoring applications, you should determine, in advance, the battery requirement needs. In general, the factors affecting the rate of battery consumption are:

- Sampling current. The frequency of sampling and current consumed when performing measurements or computations.
- Communications current. The current consumed when the modem is communicating with the host computer by phone (land-line or cellular).
- Excitation current (R-3308 only). The current required to produce the pulsed excitation power for remote sensors and transmitters.
- Background current. The continuous current consumed by the recorder when not performing the above tasks.

The supplied local battery will power the recorder for six months when sampling occurs at 5 second intervals and calling occurs once per week for 5 minutes. A faster sampling rate, more frequent phone calls, or exciting external sensors (R-3308 only) will shorten the battery life.

Computing the battery life, or power requirements, for different applications with the R-3303, R-3307 and R-3314 recorders is described in the next topic. For additional information regarding a specific application, contact Telog Customer Service.

Computing battery life for the R-3308 is substantially more complex than that for other R-3000 series recorders because of the programmable excitation feature and, therefore, it is not provided here. At the time this User Guide went to press, Telog was developing a software utility program that will allow you enter a set of recorder parameters and obtain the battery life, or power requirements, for an operating period. This utility will be posted on Telog's web site (www.telog.com) as soon as it is available. In the meantime, please contact Telog Customer Service for specific questions related to this issue.

Procedure to compute battery life

This procedure computes the battery life for your recorder (R3303, R-3307 or R-3314) based on its current configuration. The local battery life is its power capacity divided by the power demands placed on the recorder.

$$Battery\ Life = \frac{power\ capacity}{power\ used\ (sampling + communications + background\ \ functions) / month}$$

The example used in this section calculates the battery life for an R-3307. This recorder records on two channels set for 5-second sampling intervals and store three statistics per 15-minute recording interval. The recorder is programmed to call once a week to transfer data. Table 1-6 describes each step of this computation and Table 1-7 shows the actual calculation of battery life for this example. At the end of Table 1-7, we find the recommended time for a battery check and/or change would be nine months.

Table 1-6. Computation of battery life

Step	Resulting parameter	Recorder setting / Value	Multiplier or addition	Notes
1	A power used for sampling each month (mAh/month)	# of samples/minute (value entered in Telogers for Windows)	x *sampling power/month per sample/min factor*	The more frequently data samples are collected, the higher the value of A. Factor is: For R-3303, use 2.2; For R-3307, use 3.7; For R-3314, use 12.4.)
2	B (# of data values)	# of statistical values stored	x recording interval/hr x # channels x # of days between calls	As an example, an R-3307 is using two channels set to sample at 5 second intervals and store three statistics per 15-minute recording interval. This produces 3 values/rec int x 4 rec int/ hr x 2 channels, or 24 values/hr. If the recorder is programmed to call once a week, the amount of data to be transferred is computed using 24 values/hr x 24 hr/day x 7 day/wk, or 4032 values.
3	C estimated call duration (seconds)	B	x 2.1 bytes ÷ (baud rate/10) + 45 seconds	Call duration includes time to establish a comm. session (45 seconds is the average time required for telephone switching and computer log-in) and time for data transfer. Although different types of data take up different amounts of byte space, we use a conservative estimate that each value takes up 2.10 bytes. Actual time for data transfer is obtained by dividing the baud rate (in bytes/second) by the amount of data to be transferred (in bytes). Although a baud is a bit/second or 1/8 byte/second, we use a value of 10 to allow for the start and stop bits that get added to each value transferred.
4	D total monthly call time (minutes/month)	# of calls/month (use values entered in Telogers for Windows)	x estimated call duration (in minutes)	The more frequent the recorder calls, the higher the value of D.
5	E power used for calling each month (mAh/month)	D	x *recorder communications power usage factor*	Power usage factors are: For R-3308, use 0.75: For R-3307, use 0.833; For R-3314, use 1.17.
6	F total battery power used each month (mAh/month)	A + E	+ 100 mAh/month (background power consumption)	This is the sum of the main power usage: power used for sampling each month (A), used for calling out each month and used for background tasks.
7	G calculated battery life (months)	1800 mAh	÷ F	1800Ah is the power capacity of the battery pack used in R-3303, R-3307 and R-3314.
8	Battery Life (months)	G	x 80% (safety factor)	For a conservative estimate, use the safety factor.

Table 1-7. Example computation of battery life

Step	Calculations	Calculated parameter
1	12 samples/min x 3.7 samples/min/mAh/month	= 44.5 mAh/month (A)
2	3 statistics x 4 rec interval/hr x 2 channels x 24 hours/day x 7 days	= 4032 values/call
3	[(4032 values x 2.1) ÷ (2400 baud/10)] +45 sec	= 80.28 sec or 1.34 min
4	4 calls/month x 1.34 min/call	= 5.35 min/month (C)
5	C x 0.833 mAh/min	= 4.46 mAh/month (D)
6	A + D +100 mAh/month	= 148.96 mAh/month (E)
7	1800 mAh ÷ E	= 12.08 months (F)
8	F x 80%	= 9.66 months

Alarms

Four local alarms are available on the R-3308 and R-3314 recorders and two are available on the R-3303 and R-3307 recorders. The Telogers recorder alarm connections are a simple FET switch to ground. They will short to ground only when an alarm condition occurs.

Set the alarm conditions using Telogers for Windows. Alarm connections can trip a relay, sound an alarm, or provide an input to external logic. Figures 1-9 and 1-10 show the alarm connections.

If the recorder detects an alarm condition, the corresponding alarm switch (identified in Table 1-8) closes. The alarm switch will return to its normal open state when all channels have cleared that alarm condition.

Pulse channels on R-3308 recorders can monitor pulse count alarms. If an alarm condition occurs, the alarm switch closes at the end of a recording interval, not during the interval. The alarm switch will return to its normal open state at the end of the next interval when all channels have cleared that alarm condition.

Table 1-8. R-3000 Alarm Switch Assignments

Alarm Condition	**Corresponding switch**	
	R-3303 & R-3307	**R-3308 & R-3314**
LoLo alarm	—	Alarm 1
Lo alarm	Alarm 1	Alarm 2
Hi alarm	Alarm 2	Alarm 3
HiHi alarm	—	Alarm 4

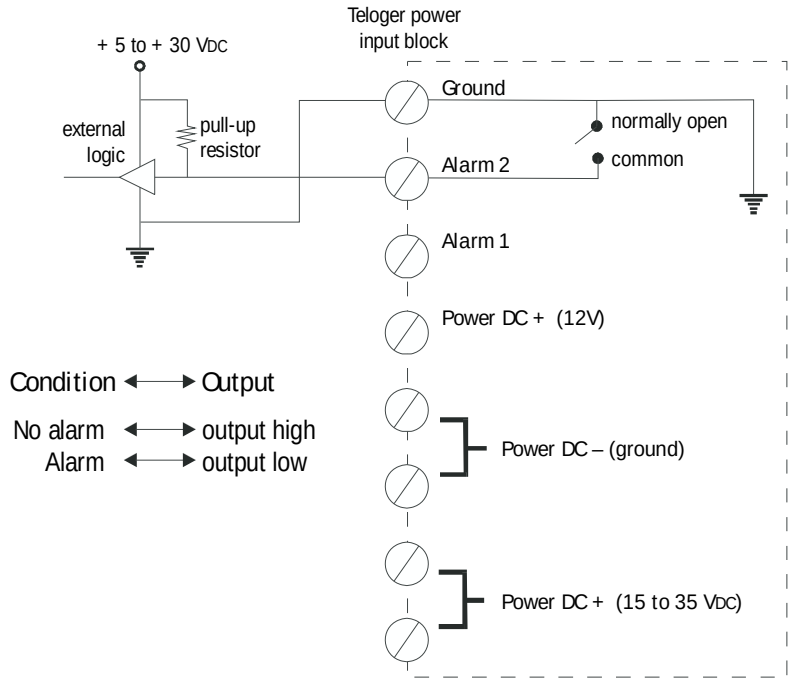


Figure 1-9. R-3000 Voltage signal alarm connection diagram

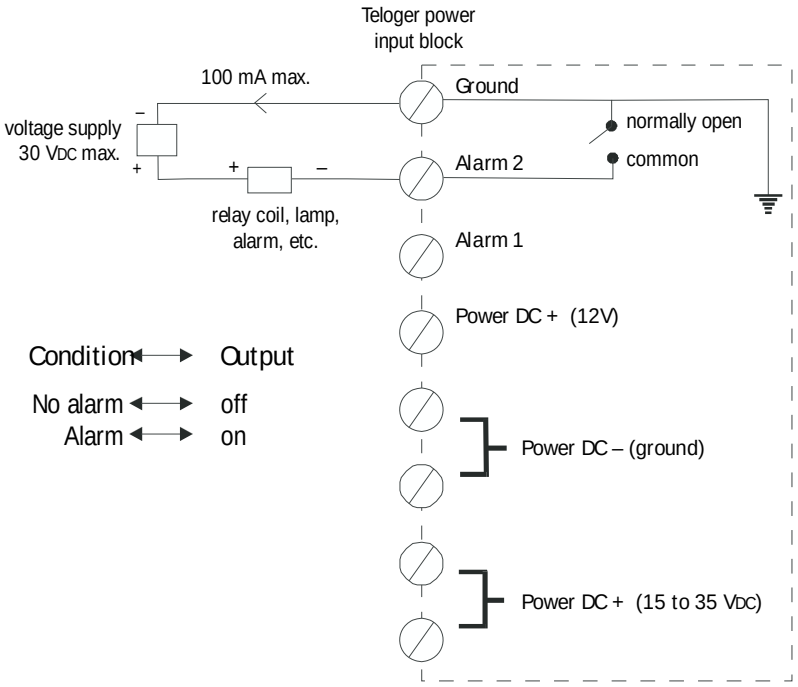


Figure 1-10. R-3000 Relay control connection diagram

Modem Module

The M-324 Teloger modem module is designed to provide remote access to Telog's R-3000 series recorders using a computer running the Telogers for Windows software. The M-324 derives all required signals, including power, from the R-3000 recorder in which it is installed.

Procedure to install the modem

1. Use Telogers for Windows to enter modem information (Setup | Options | Communications.
2. Align the M-324 Telog modem with the 14-pin connector and the raised threaded shaft in the "Auxiliary Module Connection" area on your R-3000.
3. Gently, press the M-324 onto the connector until it sits flush with the surface of your recorder. Do not force the module. It should seat with little effort. If you experience any difficulty, straighten any misaligned pins, carefully realign the module, and try again.
4. Tighten the thumb screw on the M-324 only hand-snug. Over tightening can damage the module.
5. Plug the telephone line's RJ11/CA11 connector into the recorder's phone jack.
6. Check the modem installation by pressing the Tamper button on the recorder for at least one second. If configured in Telogers for Windows, the recorder places a call to the phone number you set for tampering. Refer to the Telogers for Windows User Guide for information on triggers.

General U.S. FCC information

The M-324 Teloger modem complies with Part 68 of the Federal Communications Commission (FCC) rules. On the side of the Teloger modem is a label that contains, among other information, the FCC registration number and Ringer Equivalency Number (REN) for the modem.

The FCC of the United States restricts specific uses of modems. The FCC places the registration responsibilities described below on both the manufacturer and the individual user.

The modem may not be connected to a party line or to a coin-operated telephone. Connection to a party line service is subject to state tariffs. Please contact your state public utility commission, public service commission or corporation commission for information.

The modem manufacturer must make any repairs to the modem to maintain valid FCC registration. If you experience trouble with the M-324 Teloger modem, please contact Telog Customer Service Department at 716-742-3000 for repair and/or warranty information.

If the trouble is causing harm to the telephone network, the telephone company may request you remove the M-324 Teloger modem from the network until the problem is resolved. The telephone company will notify you in advance of any such needed temporary discontinuance of service. However, if advance notice is not practical, the telephone company will notify you as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

Notification to the telephone company is no longer required prior to connecting registered equipment. However, the telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the Teloger modem. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications to maintain uninterrupted service. Upon request from the telephone company, the user shall tell the telephone company to which line the M-324 Teloger modem is connected, as well as the registration number and ringer equivalence number of the M-324 Teloger modem.

Note: The REN is used to determine the number of devices which may be connected to the telephone line. Excessive RENs on the telephone line may result in the connected devices not ringing in response to an incoming call. In most, but not all areas, the sum of the RENs should not exceed five. To be certain of the number of devices that may be connected to the line, as determined by the total RENs, please contact the telephone company for the maximum REN for your calling area.

Please do not attempt to perform any repairs without authorization from Telog Customer Service Department at 716-742-3000.

Canada Department of Communications Notice

The Canadian Department of Communications label identifies certified equipment. This certification means that the labeled equipment meets certain telecommunications network protective operational and safety requirements. The Department does not guarantee the certified equipment will operate to your satisfaction.

Before installing an M-324 Teloger modem, you should make sure that your local telecommunications company will permit connection of the Teloger modem to their facilities. The Teloger modem must also be installed using an acceptable method of connection. In some cases, inside telephone wiring associated with a single-line individual service may be extended by means of a certified connector assembly (for example, telephone extension cord). However, you should be aware that even an acceptable method of connection may not prevent degradation of telecommunications service in some situations.

The load number of the Teloger modem will help determine if your telephone loop will be overloaded. Any combination of devices can be connected to a telephone loop as long as the total load number from all the connected devices does not exceed 100. The load number of a device shows the percentage of the total load of the telephone loop the device will use when it is connected.

For your safety and protection, you should make sure that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

Caution: Connections should be completed by the appropriate electric inspection authority or an electrician.

Repairs to your Teloger modem should be made by Telog or an authorized Canadian maintenance facility designated by Telog. Please call Telog's Customer Service Department at 716-742-3000 for more information. Any equipment malfunction or repairs or alterations made by the user may give the telecommunications company cause to ask you to disconnect the Teloger modem from their service.

This page is intentionally blank.

Section 2. R-2100 Series Recorders

Overview

The Telog R-2100 series of data recorders are microprocessor-based products designed to collect, process and store data from a wide range of sources in a variety of environments. Each recorder has unique analog circuitry which provides the signal conditioning for the type of measurement being performed. The R-2100s are battery-powered instruments. These recorders are designed to record data continuously; they have no on/off switch.

Program and collect data from R-2100s using one of two computer software package supplied by Telog: the R-2100 Series Support Software (S21-PC) or Telogers for Windows software (S-3PC). R-2100 recorders do not support modem communication, therefore, remote communication for programming and collecting data are not possible. Use a direct connection to program R-2100 and to collect data, use either a direct connection or Telog's Data Transfer Unit (DTU).

Note:	For information on the R-2100e recorders, refer to the Section 3 of this guide.

Specifications

Refer to the information that follows and literature in Appendix A for complete specifications for R-2100 Series Recorders.

Description and Operation

Most single and dual channel R-2100 recorders operate in the same manner as described in “Typical R-2100 Operation”. The operation of the R-2107, the R-2112 and the R-2126 recorders does not conform to the typical manner. The operation of these atypical R-2100 recorders is described below the recorder heading.

Typical R-2100 Operation

The operation of the typical single and dual channel R-2100 recorders is described here. This information does not describe the operation of the R-2107, the WLS-2109e, the R-2112 and the R-2126, which is described for each of these types.

Once each second, a built-in real-time-clock signals the microprocessor to perform a number of functions involved in sampling and processing the input signal(s). For example, the R-2105 thermocouple recorder performs thermocouple cold-junction compensation each second and linearizes the thermocouple signal. Each second, the recorder determines if a new minimum or maximum reading has occurred. The recorder also updates an internal summation register that is used to compute the average reading. At the end of a user-programmed recording interval, which can range from as short as one second to as long as eight hours, the recorder computes and stores the desired results into solid-state memory. The

recorder can store the minimum, average, and/or maximum reading for each recording interval.

Each second, after sampling the data, the recorder monitors its serial communications port for activity. If the serial interface is active (as detected by a proper sequence of characters sent from a connected computer or Data Transfer Unit), the recorder automatically selects the proper baud rate and waits to process commands received from the computer or DTU.

After receiving specific commands, the recorder performs the requested function(s) as programmed by the software package.

Using the information transferred from the recorder, the software performs the necessary computations to display graphs, store and print data. In addition, by processing user-entered prompts, the software sends the proper commands to the recorder to program appropriate parameters.

R-2100 Series recorders, except R-2107 or R-2126, are equipped with a programmable alarm switch that is activated when the input signal diverges from the programmed level and when controlled using S-21PC software, supports alarm logging. Alarm logging for R-2100 recorders is described in the S-21PC User's Manual. Use of Telogers for Windows (S-3PC) with these recorders does not support alarm logging.

R-2101 Analog Voltage Recorder

Telog's standard R-2101 analog voltage recorders measure from zero to the maximum voltage specified. Bipolar devices are also available. Refer to Telog's literature for a list of current R-2101s and their specifications.

The input connections are made at the positive (+) and negative (-) voltage terminals shown on the recorder label. The voltage is measured with respect to the negative terminal. If the voltage exceeds the specified range, the recorder will store the maximum value within its range for that entry.

R-2102 Current Loop Recorder

Unipolar and bipolar R-2102 current loop recorder are available. Refer to Telog's literature for a list of current R-2102s and their specifications.

Battery operation of the R-2102 current loop recorder means that, generally, you can place it anywhere in a current loop without adverse effects. However, to avoid erratic operation in some applications, we recommend:

For internal power operations, a ground loop can exist between the recorder and a grounded power supply when the recorder's zinc-aluminum enclosure touches ground. This is because the R-2102 Recorder circuit is grounded to its enclosure. Avoid the formation of a ground loop by isolating the recorder enclosure from ground by placing it on a block of wood or other nonconductive material.

During external power operation, when the recorder is powered from the loop power supply, the recorder input should not rise more than 3 volts above the power supply ground. Avoid reaching this limit by placing the recorder at the most negative point in the current loop (toward the negative (-)) side of the power supply with no load between the power supply and recorder as shown in Figure 2-1.

R-2103/R-2123 Ambient Temperature Recorders

The R-2103 is available in several models with different temperature ranges and different types of temperature probes (internal or external). The R-2123 is a dual channel recorder has two external sensors. Refer to Telog's literature for a list of current R-2103s and their specifications.

External sensors should be connected to the positive (+) and negative (-) terminals marked on the recorder label (red lead to positive and black to negative). External sensors are serialized and calibrated at the factory. They are not interchangeable.

R-2104 RTD Recorder

The R-2104 RTD recorders can measure over a broader temperature range than the ambient temperature probes described above. The two available R-2104 models have different temperature ranges. The R-2104-01 accepts inputs from -200°C to 400°C and the R-2104-02 supports the input range -200°C to 800°.

Either two, three, or four-wire RTD can be connected to the recorder. For three and four-wire RTDs, automatic lead-wire compensation is performed. With four-wire RTDs, the fourth wire should be left unconnected.

R-2105 Thermocouple Recorder

The R-2105 thermocouple recorders support various types of thermocouples for recording over a large range of temperatures. Telog's literature provides a list of the types of thermocouples supported and temperature ranges for all current models.

R-2107 Event/Pulse/Runtime Recorder

The R-2107 can operate as an event recorder or a pulse recorder as programmed using Telogers for Windows. Refer to Telog's literature for a list of current R-2107s and their specifications.

When operating as a pulse recorder, the R-2107 records the number of pulses appearing at its input terminal each second. Pulse rates of up to 100 pulses per second can be recorded. When recording pulses, the R-2107 can use either one byte or two byte counters to record the number of pulses occurring during the user-programmed totalizing period. In addition, you can enter a prescaler value to be applied to the total number of pulses occurring within a totalizing period to divide down the pulse totals as required.

As an event recorder, the R-2107 records changes that occur at its terminal connections, either a low to high (the opening of a switch) or high to low (the closing of a switch) transition. The R-2107 records the time the event occurs to the nearest second and stores up to 2000 events. Like other R-2100 Recorders, only the most recent data is recorded.

R-2108 Potentiometric Recorder

Potentiometers can be measured by the R-2108 without the need for additional hardware by connecting the potentiometer directly to the three terminals of the recorder. The recorder uses a ratiometric method of measurement, and can automatically handle resistance ranges from 1K ohms to 50K ohms. Since the recorder must power the potentiometer, battery life will be somewhat reduced. A potentiometer adapter kit is available from Telog to convert float and counterweight level monitors to paperless recording systems. Refer to Telog's literature for R-2108 specifications.

R-2109 Pressure Recorder

The R-2109 pressure recorder can take measurements from a differential strain gauge pressure transducer without the need for additional hardware.

Figure 2-2 provides details for connecting a pressure sensor to the R-2109. Refer to Telog's literature for R-2109 specifications.

The R-2109's internal power regulator regulates externally supplied DC voltage in the range of 10-28 volts.

Note:	The R-2109e recorder is an analog current loop recorder with transmitter excitation. Its enclosure is similar to that of the Level Trackers. The R-2109e can operate with a 0-20mA or 4-20mA transmitter that can supply a stable reading within 500msec of the voltage pulse. Refer to the next section of this guide for further information.

SVR-2112 Stray Voltage Recorder

The SVR-2112 Stray Voltage Recorder is designed specifically for monitoring stray AC voltages that may occur in remote locations. One typical application is in monitoring the stray (or "tingle") voltages that may or may not be present on dairy farms. Stray voltages have been shown to affect the health of farm animals. With a low 500 ohms input impedance, the SVR-2112 is the perfect tool for detecting and recording data about stray voltages. Higher input impedance recorders are also available. The SVR-2112 provides trend information of any neutral-to-ground AC power line with voltages of up to 20 V*rms*. Each voltage recorder comes with an input cable of your choice.

Two ranges are available. The R-2112-20 is designed to measure a voltage range of 0 to 20 Vrms; the SVR-2112-150 is designed to measure a voltage range of 0 to 150 Vrms.

Refer to Telog's literature for additional R-2112 information and specifications.

The SVR-2112 recorders are packaged in an ABS plastic enclosure that has no exposed terminals. Connect the recorder's cable with the water-tight connector to the signal to be monitored. The recorders have an LED which flashes once every 5 seconds during normal operation. If the input signal is above the programmed upper alarm level, the LED flashes once every 2 seconds.

The operation of the R-2112 Stray Voltage Recorder is similar to that of typical single channel recorders; however, the sampling method is different. SVRs have a true RMS detector which monitors the RMS voltage or current every second. After the RMS reading is taken, the rest of the processing performed by the recorder is similar to other voltage recorders, such as the R-2101.

The R-2112 Stray Voltage recorder has only a single upper alarm. There are no alarm contacts, but the upper alarm can be used to trigger the alarm logging feature if using S-21PC software. (Alarm logging is not supported in S-3PC.)

The SVR recorders use a 9-volt alkaline battery, rather than the lithium batteries used in most other R-2100 recorders. The 9-volt battery provides up to 2 months of operating life.

The input impedance of the R-2112 is 500 ohms. The R-2112 has a resolution of 0.01% and accuracy of ± 0.5% of full scale.

LCR-2112 Line Current Recorder

The LCR-2112 provides trend information on any AC current conductor. It receives inputs from a clamp-on sensor and cable (ordered separately). Several interchangeable sensors are available for monitoring currents up 1000 A*rms*. The true rms data values are continuously integrated.

LVR-2112 Line Voltage Recorder

The LVR-2112 provides trend information on any AC power line voltage of up to 300 V*rms*. The true rms data values are continuously integrated.

Each voltage recorder comes with an input cable of your choice. Additional cables are available for purchase.

There are three LVR-2112 models: LVR-2112-150, LVR-2112-250 and LVR-2112-300 with input ranges of 0–150 V, 0–250 and 0–300 V, respectively.

Table 2-1. LCR-2112, LVR-2112 and SVR-2112 Recorder Specifications

Recorder	**LCR-2112 Line Current**	**LVR-2112 Line Voltage**	**SVR-2112 Stray Voltage**
Measurements			
Input	True rms AC current, continuously integrated	True rms AC voltage, continuously integrated	True rms AC voltage, continuously integrated
Range	0 to 10, 100, 500, or 1000 A*rms*, sensor dependent	0 to 150, 250 or 300 V*rms* @ 45 to 65 Hz	0 to 20 V*rms* @ 45 to 65 Hz
Resolution	0.1% of full scale input	0.1% of full scale input	0.02 V
Accuracy	± 3% of full scale input	± 0.5% of full scale input	± 0.1 V
Input impedance		1 megohm	500 ohms (Contact Telog for units with higher impedance.)*
Recording			
Sample rate	One sample every 1, 5, 10, 15, 30, or 60 seconds, programmable		
Recording interval period	One second to 8 hours		
Interval resolution	Any period evenly divisible into 24 hours		
Clock accuracy	0.01%		
Date and time	MM/DD/YY hh:mm:ss		
Computed Data	Any combination of the minimum, average, and/or maximum per interval		
Memory size	6500 values total, dynamically allocated according to required statistics		
Indicator	Flashing LED indicates correct operation as programmed and exceedance of user programmed threshold		
Programmable Parameters			
	Sample rate, interval period, interval length, upper alarm threshold, computed data, date and time, recorder identification.		
Power			
Battery type	One 9-V alkaline, NEDA 1604A or equivalent		
Operating life	6 months minimum at 10-second sampling rate		
Battery shelf life	2 years (refer to manufacturer specifications)		
Serial Interface			
Type	RS-232C compatible, requires RTS		
Isolation	Optical, 1200 VAC maximum		
Baud rates	300, 1200, 9600; auto-selected		
Bit format	1 start, 8 data, 1 stop		
Connector	9-pin sub 'D' socket		
Environmental and Mechanical			
Operating temperature	-25° to 60°C / -18° to 140°F		
Storage temperature	-40 to 70°C / -40° to 158°F, without battery		
Humidity	0 - 95%, non-condensing		
Enclosure	Type: Polycarbonate with UL approval; watertight, meets IEC-IP65 and NEMA 1, 2, 3, 3R, 4, 4X, 5, 12, and 13 standards Size: 8 cm x 12 cm x 5.5 cm / 4.7" x 3.2" x 2.2" Weight: 469 g / 1 lb 2 oz		

*Due to the desirably low input impedance of the SVR-2112, exposure to voltage higher than the rated input must be avoided. Exceeding these values by more than 20% for even short durations (>30 s) will damage the instrument.

R-2126 Ambient Temperature and Relative Humidity Recorder

The R-2126 dual channel recorder is packaged in a different enclosure that other R-2100 recorders. There are no external connections available, except for the RS-232 cable. The R-2126 uses a 9-volt alkaline battery, rather than the lithium batteries used in most other R-2100 recorders.

The operation of the R-2126 relative humidity/ambient temperature recorder is similar to that of typical single channel recorders; however, the sampling rate is different.

The R-2126 is programmable with the typical R-2100 sample rate of once a second and lower sample rates that are as slow as once every eight hours. With any sample rate, the recorder 'wakes up' once each second and determines if it is time to take a sample. If not, the recorder checks its serial port for activity. If there is no activity, it immediately returns to its low-power mode. If it is time to take a sample, the temperature and humidity sensors are sampled, the readings are stored and the built-in LED is flashed. At the end of the user-programmed averaging period, the recorder computes and stores the desired results into solid-state memory.

Schematics

Schematics for most of the R-2100s are provided in the Telog literature in Appendix A. The figures in this section provide additional information that is not provided in that literature.

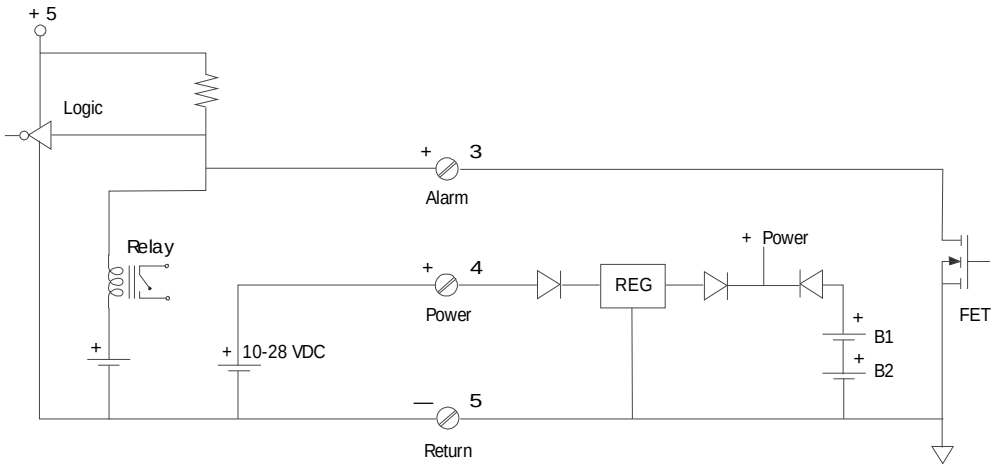


Figure 2-1. R-2102 External power connection

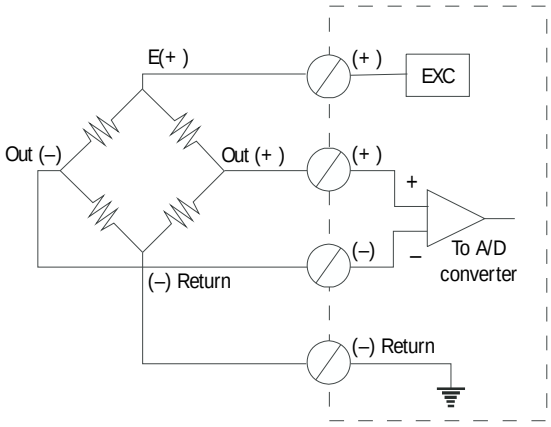


Figure 2-2. R-2109 Pressure sensor connection

s

Recorder Power

Overview

Each R-2100 series recorder has three power inputs: local battery, external battery and external DC. Each input is described in Table 2-2.

Warning: Do not connect AC power to any R-2100 recorder. Doing so will damage the recorder and void the warranty.

Table 2-2. R-2100 Summary of Power Inputs

Power Source / Input	Applications	Notes
Local battery	External power is not available at the monitoring site. External power to recorder fails.	All R-2100s, except the R-2112 and R-2126 use a 10V lithium battery pack R-2112s and R-2126s use a standard 9-volt alkaline battery Operating temperature: -40° to 70°C. In typical applications, local battery can power recorder and modem for at least a year
Unregulated dc input (10 to 28 VDC)	24VDC power supplies. Unregulated AC to DC converters. Any DC power source with a range of 10-28VDC.	Power sources connected to the terminals marked for power on the recorder label.

Battery Replacement

To retain the original data and programming (but lose a short amount of time on the internal clock), reinstall the batteries within 20 seconds of removing them.

Access the internal lithium batteries (for all R-2100s except R-2126) by removing the four Phillips screws that secure the top cover to the base of the recorder. To minimize the down time, have the new batteries ready to insert (unwrapped and close at hand) and flat-blade screwdriver handy. Pry a battery from its holders using a small flat-blade screwdriver. Insert the new battery, with the correct polarity, into the holder, using the screwdriver to pry open the battery terminal. Finally, replace the top cover and secure the screws.

Access the 9-volt alkaline battery for R-2112s and R-2126s by loosening the four enclosure screws and removing the top cover. Replace the battery, then secure the cover.

This page is intentionally blank.

Section 3. E-Series Recorders

Overview

This section describes the operation of the following e-series recorders, which are housed in a gray brick-shaped enclosure:

- WLS-2102e Level Tracker with current loop excitation and optional 4-20mA sensors
- R-2102e analog current loop recorder with transmitter excitation
- WLS-2109e Level Tracker with strain gauge excitation and an optional strain gauge sensor
- WPS-2109e water pressure recorder with strain gauge excitation and an optional strain gauge sensors.

These small sized recorders permit installation in wells with an inner diameter of 100 mm (4”) and have the following features:

- housed in a NEMA 4X/IECIP65 enclosure
- have a vented, filtered enclosure to remove the effects of atmospheric pressure changes wile preventing moisture entry into the enclosure
- contain an external data transfer port, which eliminates the need to open the enclosure
- contain a desiccant pack to protect the electronics and sensor from moisture build-up.
- record data continuously; they have no on/off switch.

A minimum system configuration consists of:

- at least one e-series recorder
- support software (either Telogers for Windows (S-3PC) support software or the R-2100 series support software (S-21PC)) running on a personal computer
- communications cable and adapter for direct connection to program and collect data from the recorders.

Telog's optional data transfer unit (DTU) provides an alternate method to collect data from a recorder. Refer to Section 5 of this guide for information on the DTU.

The e-series recorders are programmable with a sample rate of once a second and lower sample rates that are as slow as once every eight hours. With any sample rate, the recorder ‘wakes up’ once each second and determines if it is time to take a sample. If not, the recorder checks its serial port for activity. If there is no activity, it immediately returns to its low-power mode. If it is time to take a sample, the e-series recorder excites the connected sensor for the programmable period (between 2 and 500 milliseconds). After the sensor has been powered for the programmed length of time, the recorders takes a series of four samples and stores the average of the four samples. At the end of the user-programmed averaging period, the recorder computes and stores the desired results into solid-state memory.

Specifications

Refer to the information in Table 3-1 for e-series recorder specifications.

Table 3-1. E- Series Recorder Specifications

	R-2102e and WLS-2102e	**WLS-2109e and WPS-2109e**
Inputs	0-20 mA or 4-20 mA transmitter	Strain gauge pressure sensor
Sensor Excitation	~10.5Vdc	~5 Vdc
Sensor Excitation Time	2 to 500 ms, user adjustable	
Sensor Sensitivity	0 to 1 mV/V, min 0 to 100 mV/V, max	factory set
Data Resolution	5 µA	0.025% of full scale
Data Accuracy	±0.15% of sensor full scale at constant temperature ±0.01% of sensor full scale per °C change Overall system accuracy is the sum of sensor accuracy and data accuracy.	
Memory Size	2K, 4K, 8K or 21K data values, user selected	
Sample Rate	1 second to 8 hours, user selected	
Recording Interval	1 second to 8 hours, user selected	
Data Recorded	Any combination of minimum, average and maximum for each recording interval	
Power	Internal 14-volt battery pack	Internal 10.5-volt battery pack
Battery Life	18 to 36 months, typical, dependent on sample rate and sensor excitation time	
Enclosure Type	NEMA 4X / IEC IP65 fiberglass	
Enclosure Size	56 mm x 74 mm x 224 mm / 2.2" x 2.9" x 8.8"	
Weight	0.8 kg / 2 lb	
Temperature Range	Operation: -40 to 60°C / -40 to 140°F Storage: -40 to 70°C / -40 to 158°F	
Humidity Range	0 to 100% RH	
Data Communications	RS-232, opto isolated, RTS required	
Data Transfer Speed	300, 1200 or 9600 baud	
Data Bit Format	1 start, 8 data, 1 stop	
Data Connector	9-pin, sub D, environmentally sealed	

*Specifications subject to change without notification.

Sensors and Transmitters

Overview

Table 3-2 identifies the types of sensors and transmitters you can use with the e-series recorders and provides specifications for the sensors. Your choice of sensor will depend on the maximum fluctuation of the level you need to measure, the nature of the liquid being measured and the physical attributes of your site. All transmitters and sensors are connected to the recorder through watertight fittings.

Specifications

Table 3-2. Sensor and Transmitter Specifications

	Current Loop Transmitters for R-2102e and WLS-2102e		**Strain Gauge Sensors for WLS-2109e and WLS-2109e**
	PTX 1830-A140 series and PTX-1880 series	**210S series**	**PDCR 1830 series and PDCR 1880 series**
Range	PTX 1830: 1, 2.5, 5, 10, 15, 20, 30, 50, 100 PTX 1880: 5, 10, 15, 20, 30, 50, 100	1, 2.5, 5, 10, 15, 20, 30, 50, 100	PDCR 1830: 1, 2, 5, 10, 15, 20, 30, 50, 100 PDCR 1880: 5, 10, 15, 20, 30, 50, 100
Output	4 - 20 mA, 2-wire	4 - 20 mA	1-psi sensor: 2.5 mV/V 2.5 and 5 psi sensor: 5 mV/V 10-psi or higher sensor: 10 mV/V
Accuracy	±0.1% BSL	200S series: ±0.25% BSL 210S series: ±0.1% BSL	±0.1% BSL
Excitation voltage	PTX 1830: 9 - 30 Vdc PTX 1880: 9 - 32 Vdc	10 - 35 Vdc	2.5 - 10 Vdc
Cable diameter	PTX 1830: 0.74 cm / 0.29" PTX 1880: .67 cm / 0.30"	0.87 cm / 0.35"	PDCR 1830: 0.81 cm / 0.32" PDCR 1880: 0.67 cm / 0.30"
Cable material	PTX 1830: Polyurethane with Tefzel® jacket option PTX 1880: Tefzel	polyurethane, with Tefzel® jacket option	PDCR 1830: Polyurethane with Tefzel® jacket option PDCR 1880: Tefzel
Cable length, max	2286 meters / 4500 feet	2286 meters / 4500 feet	152 meters / 500 feet
Transmitter diameter	1.75 cm / 0.69"	2.54 cm / 1"	2.54 cm / 1"
Transmitter material	titanium body, titanium isolation diaphragm behind silicon oil buffer	316 stainless steel body, 316 stainless steel isolation diaphragm with silicon oil buffer	PDCR 1830: titanium body with exposed silicon diaphragm PDCR 1880: titanium body, titanium isolation diaphragm behind silicon oil buffer

Specifications subject to change without notification.

Schematics

This section contains schematics that are useful when changing various types of sensors.

2-wire battery powered transmitters

For PTX-180-A140 and 210S series 4-20 mA transmitters used with WLS-2102e or R-2102e, the connection when using a two-wire, battery pack power, is shown in Figure 3-1 and described in Table 3-3. The excitation voltage is supplied from the recorder terminal pin 1. The current completes a loop by returning to terminal pin 2 where it is measured with a 10-ohm resistor connected to the recorder's return.

Table 3-3. Two-Wire Transmitter Connections

Wire	red	black	shield
Terminal	1	2	8
Polarity	+	-	shield

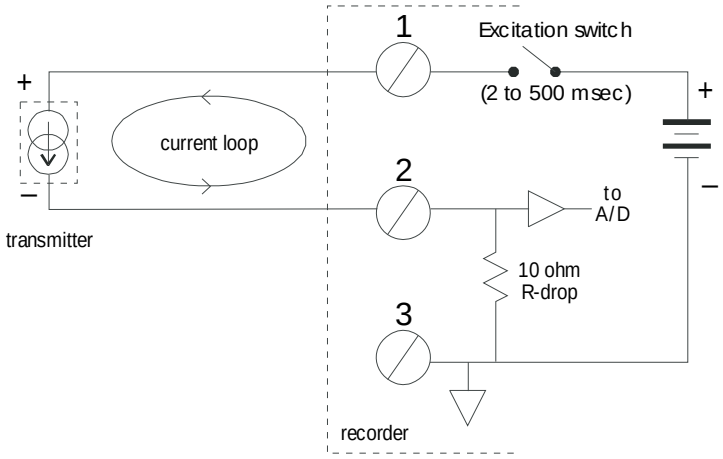


Figure 3-1. Two-wire battery pack-powered transmitter schematic

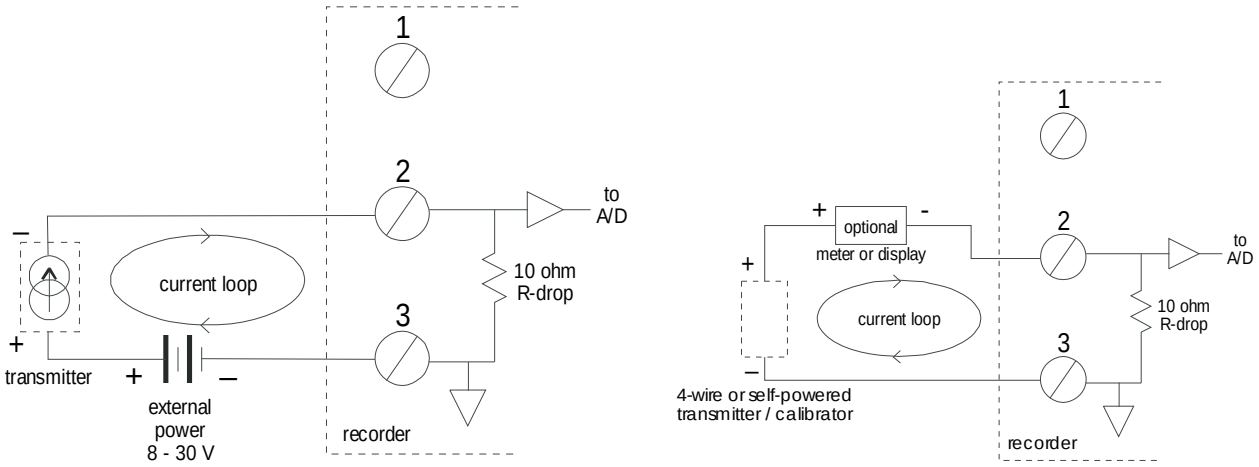
4-wire externally-powered or self-powered transmitters

Figure 3-2 shows schematics for a four-wire externally-powered and self-powered transmitter that supplies its own excitation voltage.

Note:	You must connect terminal pin 3 of the recorder to the negative output of those devices to avoid forming a ground loop.

You can connect any additional monitoring devices, such as loop display or meters, between the recorder terminal pin 2 and the transmitter.

Caution:	Do not place the external power supply directly across the recorder's inputs. It may result in damage to the recorder.



Externally powered *Self-powered*

Figure 3-2. Four-wire externally-powered or self-powered transmitter schematic

4-wire battery powered transmitter

When using a 4-wire transmitter, connect terminal pin 3 of the recorder must be connected to the negative output of those devices to avoid forming a ground loop.

Strain gauge sensors

The connection for PDCR 800 series and PDCR 900 series strain gauge sensors used with the WLS-2109e or WPS-2109e are described in Table 3-4.

Table 3-4. Strain Gauge Sensor Connections

Wire	red	yellow	blue	white	shield
Terminal	1	2	3	4	4 or 8
Polarity	excit. +	sens. +	sens. -	excit. -	shield

Procedure to add or replace a sensor

Note: Protect the sensor cable end and vent tube from moisture because moisture in the sensor can lead to performance problems. We recommend you disassemble the recorder in a low moisture environment whenever possible and that you have a fresh dehydrated desiccant pack ready to put in the enclosure during re-assembly.

Note: To perform this procedure, you will need small and medium flat blade screw drivers and slip-jaw pliers.

1. Remove the four corner screws on the cover of the recorder enclosure and carefully lift off the cover. The battery pack is attached to the bottom of the cover by velcro.
2. Disconnect an existing sensor by disconnecting all the sensor wires and loosening the water tight fitting. Then, pull the sensor cable out from the enclosure. If you cannot easily remove the cable, disassemble the water tight fitting by removing the back rubber bushing, the nylon “C” ring and the fitting cap.
3. Connect a new sensor by threading the water tight fitting parts onto the sensor cable in the following sequence: fitting cap, nylon 'C' ring and black rubber bushing, then thread the wires through the enclosure opening.

4. Connect the cable wires to the terminal block inside the enclosure by following the appropriate schematic provided earlier in this section (Figures 3-1 and 3-2). Make sure that the vent tube within the cable is not pinched, plugged or obstructed in any way.
5. Push the parts of the water tight fitting together, then tighten the fitting cap back on the enclosure. The cable should be snug in the fitting so there is no strain on the connections to the terminal strip.
6. Check the status of the desiccant pack and replace, if it is necessary. Instructions for checking and replacing the desiccant pack are provided later in this section.
7. Re-attach the battery pack to the cover and replace the cover on the enclosure. Make sure that the battery pack is seated over the terminal block of the recorder before tightening the four cover screws.

Power Options

Summary

The e-series recorders are designed to be powered by Telog's battery pack, but can be powered by externally supplied DC voltage. The internal micro-power regulator in these recorders regulates externally supplied DC voltage in the range of 10-14 volts.

The battery pack maintains the recorder’s programming, real-time clock and data in its memory and supplies power for sensor excitation.

The battery pack is a package of lithium batteries available from Telog. The WLS-2102e and R-2102e use a 14-VDC battery pack and the WLS-2109e and WPS-2109e use a 10-VDC battery pack.

The life of the battery pack is affected by the sample rate and duration of the sensor excitation time. The shorter the excitation time, the longer the battery life as described in Table 3-5. For WLS-2109e and WPS-2109e systems using PDCR 800 and 900 series sensors, an excitation time of 10 millisecond is adequate. For the PTX160 and 200S series transmitters, the recommended excitation time is 15 milliseconds.

Replace the battery pack on a regular schedule to prevent data loss when the battery falls below the recommended voltage level:

- For the WLS-2102e and R-2102e 14 VDC battery pack, the open circuit voltage should be at least 13.5 Vdc.
- For the WLS-2109e and WPS-2109e 10 VDC battery back, the open circuit voltage should be at least 9.5 Vdc at room temperature.

Table 3-5. Battery Life

Sample	**Excitation Time (milliseconds)**					
Interval	**4 msec**	**10 msec**	**25 msec**	**100 msec**	**250 msec**	**500 msec**
1 sec	320 days	260 days	175 days	65 days	30 days	15 days
5 sec	2 yrs	1.8 years	1.5 years	275 days	135 days	75 days
15 sec	2.6 years	2.5 years	2.3 years	1.5 years	330 days	200 days
1 min	2.9 years	2.9 years	2.8 years	2.4 years	1.9 years	1.4 years
5 min	3 years	3 years	3 years	2.9 years	2.7 years	2.5 years
15 min	3.1 years	3.1 years	3 years	3 years	3 years	2.8 years

Procedure to change the battery pack

1. Collect the recorder data by transferring it to a computer or DTU. Although the recorders have circuitry to protect the memory and clock for a short time period (about 20 seconds), we suggest you transfer the data prior to assure no loss of data.
2. Remove the four corner screws on the cover of the recorder enclosure and lift off the cover. The battery pack is attached to the cover with a velcro strip and connected to the circuit board by two wires and a connector.
3. Pull the battery connector off the main circuit board and remove the old battery pack from the cover, then replace it with a fresh one.
4. Push the connector from the new battery pack onto the mating connector on the main circuit board. The connectors are keyed to assure proper polarity.
5. Replace the cover on the enclosure, making sure the battery pack is situated toward the end of the enclosure where the sensor cable entrance is located.

Scaling Data

Overview

Telog configures each e-series recorder to record data as a percent of the input sensor's full scale. You can convert the signal inputs (for example, volts and amps) recorded by the recorders into more meaningful units (for example, feet of water or psi,) using direct engineering unit scaling. You can set up the system to scale the signal inputs to engineering units when you collect data or convert the signal inputs during data analysis. Refer to your support software guide for additional information on scaling data.

The following examples relate to the WLS-2102e and WLS-2109e recorders.

The default unit of measure is percent of the sensor full-scale psi measurement range. The psi ranges of the standard sensor models used with Telog's recorders and their equivalent engineering units are listed in Table 3-6.

Note: The conversions from psi in Table 3-6 are based on measurements of pure water at 4°C or mercury at 25°C. If you are measuring other liquids, such as seawater or oil, take the specific densities of the liquids into account. For accurate measurements, use the formula:
(psi *x* new unit per psi) / specific gravity of liquid measured.

In these recorders, level is measured as a function of pressure at the point of measurement, that is, at the sensing element (diaphragm) inside the pressure sensor. For the PDCR 1830 and PDCR 1880 sensor, the point of measurement is at the holes of the sensor nose cone; for the 210S series sensor, it is 2.05 cm (0.8 inch) from the tip of the nose cone.

Table 3-6. Conversion Values

Psi	feet H_2O	cm H_2O	mBar	inches Hg	mm Hg
1.0	2.307	70.308	68.947	2.036	51.715
2.5	5.767	175.770	172.368	5.090	129.288
5.0	11.533	351.540	344.735	10.180	258.575
10.0	23.067	703.080	689.470	20.360	517.150
20.0	46.133	1406.160	1378.940	40.720	1034.300
30.0	69.200	2109.240	2068.410	61.080	1551.450
50.0	115.333	3515.400	3447.350	101.800	2585.750

The Telog support software (S-3PC and S-21PC) assumes a linear relationship between the recorder units (percentage of full scale sensor input range) and the engineering units you need. The software will use two points that you supply to determine the unit conversion graph or linear equation of y = mx + b, where m is the slope and b is the offset. Those values are used to convert the data values into values in the engineering unit of your choice.

After you supply the two points that correspond to any two values within the full scale sensor range (0 to 100%), the software calculates the converted values to 1.8% beyond the full scale range. This over-range is displayed in the support software.

The values you use for determining the slope and offset will depend on your application. The values you enter may be any positive or negative numbers; however, the resultant slope must be positive. For example, you can enter point #1 = 10% and point #2 = 50%, as long as point #1 is less than point #2 to result in a positive slope. In the simplest case, point #1 will be the position of the sensor and point #2 will be the full scale value relative to the sensor position.

Note: If you exceed the full scale measurement range of the sensor, your measurements will not be accurate over the sensor's specified full scale range.

Sample Applications

For the sake of simplicity, we assume that water level is being measured. If you are measuring levels of other liquids, be sure to take into account the specific gravities of the liquids in your calculations as described earlier.

Example 1. Direct scaling

This is the most common of the scaling methods. The sensor is assumed to be at sea level (zero psi). For a 5-psi sensor, the recorder scale will be in meters and the range will be 0 to 3.515 meters.

Enter pt #1: 0% of max = 0 meters

Enter pt #2: 100% of max = 3.515 meters

Applications for this type of scaling may be the measurement of water level in a stream with the water level referenced to meters of water above the sensor diaphragm and recording water level in a deep well or tank. The zero reading would be where the sensor diaphragm would be located, near the bottom of the stream.

The highest water level that can be recorded would be determined by the full scale range of the sensor. If the stream level can get as high as 2 meters, you would need a sensor with a 5-psi range. The maximum level that could be recorded is then 3.515 meters. For a tank level fluctuating up to 6 meters, you would need a 10-psi sensor.

Example 2. Surface (grade)-to-depth scaling

This method is used for measuring levels that are recorded as units below a reference point, that is, meters below sea level. Applications for this type of scaling may be the determination of the water level from a well casing. For a 50-psi sensor, the recorder range, in meters of water, will be 0 to -35.154 meters.

Enter pt#1: 0% of max = -100.00 meters

Enter pt#2: 100% of max = -64.85 meters

Example 3. Elevation above sea level

This method of scaling is suitable when the position of the sensor is known, such as elevation of a well, or the height above sea level. The value for the first point will be the position of the sensor and the value for the second point will be the range of the sensor plus the first value.

This particular method is useful for incorporating height above sea level. Take for example, a Telog WLS-2109e system with a 5-psi sensor measuring well water level. The system can measure fluctuation from 0 to 3.515 meters, full scale. If the top of the well casing is 60 meters above sea level and the sensor is located 40 meters from the top of the well, the sensor is, in effect, 20 meters above sea level.

Enter pt#1: 0% of max = 40 meters

Enter pt#2: 100% of max = 43.515 meters (3.515 + 40.000)

Site Selection and Mounting

Summary

The e-series recorders meet NEMA 4X/ IEC IP65 standards so you can mount them indoor and outdoors. Weather, incidental wetness and dirt will not harm the recorder; however, avoid exposing the recorder to excessive and extensive moisture, dirt and grime. Telog recommends using the supplied cover shield over the communications port connector at all times, except when using the data transfer cable.

When you ordered the sensor, you specified the cable length. The cable length will affect the distance you can place the recorder from the point of measurement.

Place these recorders on any convenient surface at the recording site in any orientation, although you should not restrict clear access to the communications connector. Secure the recorder in place by mounting it directly on a firm surface or by using a Telog A-102 mounting bracket kit.

Caution: Do not hang the recorder by an attached data transfer cable. Do not support sensor and cable assemblies directly by the water tight fitting in the recorder enclosure.

Directly mounting the recorder

Fasten the e-series recorder to a flat surface by inserting screws or bolts through the enclosure's four corner holes. These holes are accessible by removing the top cover of the enclosure and detaching the battery pack from the cover. The holes are in a rectangular pattern (45 mm x 178 mm / 1.77" x 7.01") with clearance for #8/M6 screws.

Using the A-102 mounting bracket kit

Use of the A-102 mounting bracket kit lets you mount the recorder to the mounting bracket, then bolt the recorder directly on a solid surface or hang it in the well that is being monitored. You can mount the recorder in any orientation, although you should not restrict clear access to the communications connector.

Figure 3-3 provides a diagram of the mounting bracket assembly.

The A-102 kit contains the following parts:

- aluminum bracket with bent ends
- 2 stainless steel chain links
- 4 stainless steel metric Allen head screws (M4 x 12mm)
- 4 stainless steel split lock washers
- 3 mm hex wrench
- cable grip woven with stainless steel cables/threads, with a loop for linking with the mounting bracket.

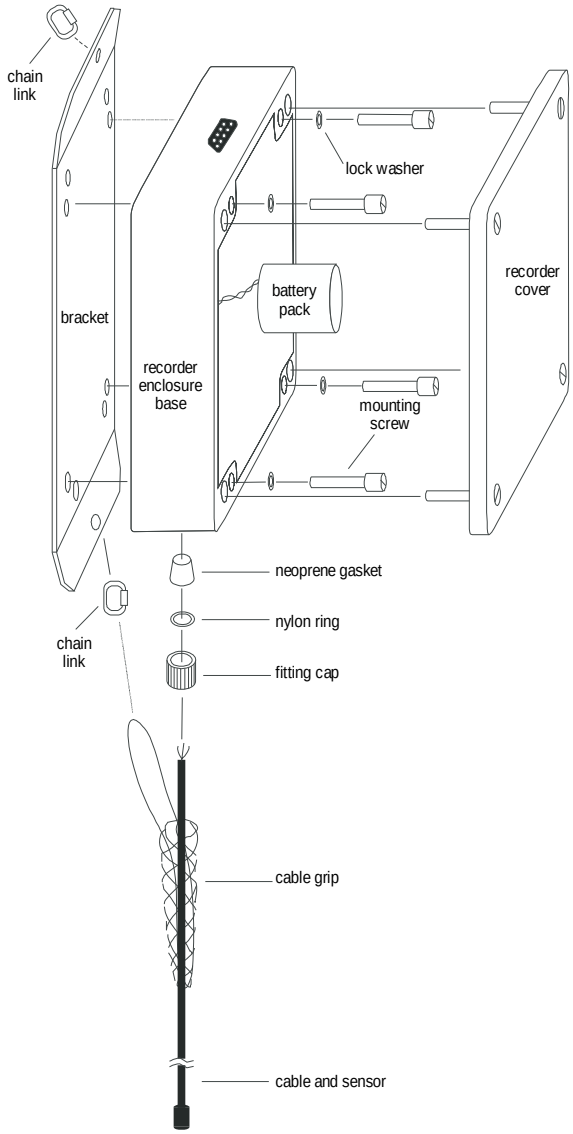


Figure 3-3. Recorder-mounting bracket assembly

Procedure to mount the recorder with the mounting bracket kit

Note: Protect the sensor cable end and vent tube from moisture: Moisture in the sensor can cause performance problems. We recommend you disassemble the recorder in a low moisture environment and insert a fresh dehydrated desiccant pack in the enclosure during re-assembly.

To perform this procedure, you will need small and medium flat blade screw drivers and slip-jaw pliers.

1. Remove the recorder's enclosure by loosening the four corner screws with the flat blade screw driver. The battery pack is attached to the cover by velcro, so carefully lift the cover.
2. Center the enclosure on the mounting bracket, with the bent ends of the bracket pointing toward the enclosure as shown in Figure 3-3.
3. Insert a lock washer and an Allen head screw into each of the four mounting holes of the enclosure. Start each screw into the threaded hole on the mounting bracket plate using the hex wrench. Tighten each screw only after all four screws have been started.
4. Disconnect all the sensor wires, remove the water tight fitting, then pull the sensor cable out of the recorder enclosure. If you cannot easily remove the cable, disassemble the water tight fitting by removing the back rubber bushing, the nylon 'C' ring and the fitting cap.
5. Thread the cable through the A-102 kit cable grip so that the loop of the cable grip is toward the wire end of the cable. The cable grip is woven with stainless steel mesh threads and can be compressed by hand to enlarge its opening to allow easier passage of the sensor cable.
6. Install the water tight fitting in the following sequence: fitting cap, nylon 'C' ring, then the neoprene gasket as shown in Figure 3-3.
7. Reconnect the cable wires to the recorder terminal strip inside the enclosure according to the wiring scheme described in Table 3-3 or 3-4. Make sure that the vent tube within the cable is not pinched, plugged or obstructed.
8. Push the parts of the water tight fitting together, then tighten the fitting cap back on the enclosure. The cable should be snug in the fitting so there is no strain on the connections to the terminal strip.
9. Connect the loop of the A-102 kit cable grip to the end of the bracket using one of the chain links. Adjust the sensor cable through the cable grip so that there is some slack (a slight loop) in the sensor cable between the water tight fitting and the cable grip. The weight of the sensor cable should be borne by the cable grip, not the water tight fitting.
10. Check the status of the desiccant pack and replace it, if necessary, Instructions for checking and replacing the desiccant pack are provided later in this section.
11. Re-attach the battery pack to the cover, then replace the cover on the enclosure. Make sure that the battery pack is seated over the terminal block of the recorder before tightening the four cover screws.
12. Attach the second chain link, your own chain or a support to the top of the bracket. Telog recommends you attach a second tether or support if you are hanging the hardware in a well to avoid dropping the recorder in the well.

Recorder Cleaning

Description

Information for routine cleaning and for cleaning if an e-series recorder has been exposed to known or potential health hazards is provided.

Brief complete submersion of these recorders in water is acceptable when followed by a thorough drying of the connectors afterward.

If during use, a recorder is exposed to known or potential health hazards (biological, organic, inorganic or radioactive), you must take special precautions. When service is required, either at your facility or at Telog, clean and disinfect the recorder to insure the safety of the service personnel.

Note:	Telog reserves the right to withhold service from any product until proper cleaning and decontamination have been accomplished and certified.

Procedure to perform routine cleaning

1. Clean the enclosure of the recorders with a water-dampened cloth.
2. If needed, use a mild detergent, then thoroughly wipe the detergent from the recorder with water-dampened clothes.
3. Wipe excess water from around the connectors.
4. Allow the water to evaporate thoroughly before returning the recorder to service.

Procedure to perform decontamination

1. Remove the recorder from the contaminated materials and thoroughly clean all contaminants from the recorder, sensor and cable.
2. Disinfect or decontaminate all exposed surfaces with an effective solvent or disinfectant for the particular contaminants. Since you are familiar with the nature of the contamination, you are expected to use the appropriate materials and procedures for decontamination. Allow the product to air dry.
3. Take normal precautions to prevent radioactive contamination and use appropriate decontamination procedures should exposure occur.
4. If exposure has occurred, you must certify that decontamination has been accomplished and that no higher than twice background level of radioactivity is detectable by survey equipment.
5. Make a copy of the cleaning certificate that follows, complete and return it with the product. If the product is to be serviced at your facility, keep the certificate with the product.

Cleaning Certificate

RMA number:_____

Cleaning must be completed and certified on any product before its return to the Telog Instruments Service Department (Fax:716-742-3006) or before field service. This cleaning certificate or a photocopy of this form must be completed and returned with the product.

Institution: _____

Department: _____

Address:_____

City: _____

State: _____ Zip: _____

Country:_____

Name and model of device: _____

Serial number: _____

Contaminants (if known) _____

Cleaning agent(s) used: _____

For radioactive contamination, is decontamination certified? Yes_____ No_____

Cleaning certified by:_____ Date: _____

Form completed by:_____ Date: _____

Signature:_____ Date: _____

Desiccant

Description

When shipped from the factory, the e-series recorder enclosure contains a desiccant pack that protects the electronics and the sensor from moisture build-up. If the desiccant pack is not able to maintain a dry atmosphere inside the recorder enclosure, water may be trapped in the pressure sensor's vent tube, which can damage the pressure sensor and void its warranty. Even though you can regenerate and reuse the desiccant packs, we recommend you have an extra desiccant pack available. Regenerating a moisture-saturated pack time may take up to three hours and you cannot operate a recorder without a desiccant pack.

When fresh, the material in the desiccant pack is dark blue. The color of the pack becomes lighter when it has absorbed moisture. When the pack’s color is light pink, regenerate or replace the desiccant pack.

Periodically inspect the desiccant pack’s color to be sure that it is still able to dry out the recorder’s enclosure.

Procedure to check the color of the desiccant pack

1. Remove the four corner screws on the cover of the recorder enclosure and lift off the cover.
2. View the color of the desiccant pack’s internal material through the inspection window.

Procedure to remove and install a desiccant pack

1. Firmly pull the pack from the inside of the cover (the plastic ties around the pack prevent damage during removal).
2. Place a fresh pack in place in the cover and replace the cover on the enclosure, making sure the cover is oriented with the battery pack at the end near the sensor cable entrance.
3. Tighten the enclosure screws. Loose screws will lead to water seepage and consequently, recorder malfunction.

Procedure to regenerate a desiccant pack

1. Remove the desiccant pack from the enclosure cover and remove the two plastic ties from around the pack by slipping them off the metal enclosure.
2. Bake the desiccant pack in a vented conventional oven at 300°F (150°C) for about three hours, or until pack color becomes blue.
3. Cool the pack and replace the two plastic ties.
4. Install the desiccant pack in the recorder or store it in a sealed plastic bag to keep it fresh until use.

Vent Filter

Description

A DF-5 vent filter located on the side of the e-series recorder enclosure vents the enclosure interior to atmosphere, thus eliminating effects of atmospheric pressure changes on level readings. After installing the recorder, make sure this filter is not blocked or obscured by any external object.

If a visual inspection of the filter reveals dirt or grime, clean the filter. Replace the filter if it becomes clogged and cannot be cleaned.

Procedure to remove, clean and insert a filter

1. Remove the four corner screws on the cover of the recorder enclosure and lift off the cover.
2. Remove the nut located inside the enclosure from the filter and pull the filter out through the hole in the enclosure side wall.
3. Thoroughly clean around the filter mounting hole with a small brush and dry the enclosure completely.
4. Clean the filter with a small brush to remove dirt and grime.
5. Insert the cleaned filter or a new filter through the mounting hole and secure it with the nut.
6. Replace the cover on the enclosure, making sure the cover is oriented with the battery pack at the end near the sensor cable entrance.
7. Tighten the enclosure screws. Loose screws will lead to water seepage and consequently, recorder malfunction.

Calibration

Overview

To maintain specified accuracy, Telog recommends you verify the calibration of the e-series recorders at least annually.

Note:	To perform this procedure, you will need: your recorder, a precision pressure source with an accuracy of 0.05% of the sensor full scale value, personal computer running Telog support software (S-3PC or S-21PC) and Telog C-21ATC cable.

Figures 3-4 and 3-5 show simplified board layouts for the two types of e-series recorders

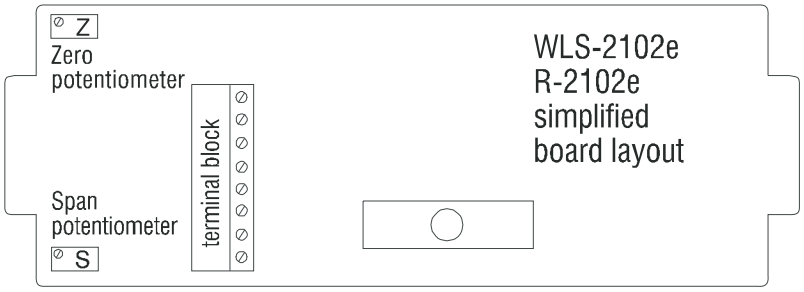


Figure 3-4. WLS-2102e and R-2102e board layout

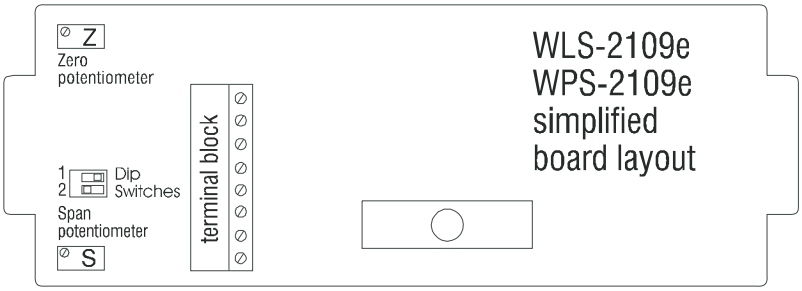


Figure 3-5. WLS-2109e and WPS-2109e board layout

Procedure to calibrate WLS-2102e and R-2102e

1. Remove the cover from the enclosure, leaving the battery wires attached to the recorder electronics. On the circuit board inside the enclosure, note the Zero (Z) and Span (S) potentiometers located on either side of the sensor cable entrance as shown in Figure 3-4.
2. Connect the C-21ATC cable between the computer serial port and the recorder serial communication port.
3. Follow the instructions in the software guide to obtain a screen display of the real-time readings from the recorder.
4. Connect the precision pressure source to the sensor and adjust the pressure to 0.5% of full scale value.
5. Adjust the zero (Z) potentiometer until the current reading is 0.5% of full scale. This is the zero adjustment. It is good practice to conduct the zero calibration at a point slightly higher than zero.
6. Adjust the precision pressure source to 100.0% of full scale.
7. Adjust the span (S) potentiometer clockwise, cw, (up to 10 full turns) until the current reading is 100.00% of full sensor scale. You will hear an audible clicking noise when you reach full cw.
8. Re-check the zero (Z) and span (S) potentiometer settings and repeat steps 5-7, if necessary, to obtain proper calibration. The recorder is now calibrated. You can seal the potentiometers with a drop of glyptol or nail polish.
9. Disconnect the pressure source from the sensor, then replace the cover on the recorder enclosure and tighten the screws.

Procedure to calibrate WLS-2109e and WPS-2109e

1. Remove the cover from the enclosure, leaving the battery wires attached to the recorder electronics. On the circuit board inside the enclosure, note the Zero (Z) and Span (S) potentiometers located on either side of the sensor cable entrance, and the Range DIP switch located near the Span potentiometer as shown in Figure 3-5. The DIP switch has two switches labeled “1” and “2”.
2. Connect the C-21ATC cable between the computer serial port and the recorder serial port.
3. Set both switches on the DIP switch to OFF.
4. Follow the instructions in the software guide to obtain screen display of the real-time readings from the recorder.
5. Connect the precision pressure source to the sensor and adjust the pressure to 0.2% of full scale value.
6. Adjust the zero potentiometer until the current reading is 0.2% of full scale. This is the zero adjustment. It is good practice to conduct the zero calibration at a point slightly higher than zero.
7. Adjust the precision pressure source to 100.0% of full scale.
8. Adjust the span potentiometer to full clockwise, CW, (up to 10 full turns). You will hear an audible clicking noise when you reach full CW.

9. Adjust both switches on the DIP switch as follows:
    a. With both switches OFF, observe the current reading as displayed on your computer monitor screen. If the current reading is greater than the input pressure, continue with step 10. If the current reading is less than the input pressure, perform step 9b.
    b. Set switch 1 ON and 2 OFF. If the current reading is greater than the input pressure, continue with step 10 below. If the current reading is less than the input pressure, perform step 9c.
    c. Set switch 1 OFF and 2 ON. If the current reading is greater than the input pressure, continue with step 10. If the current reading is less than the input pressure, perform step 9d.
    d. Set switch 1 ON and 2 ON and continue with step 10.
10. Adjust the Span potentiometer until the current reading is 100.0%
11. Re-check the zero and span adjustment settings and repeat steps 6-11, if necessary, to obtain proper calibration. The recorder is now calibrated. You can seal the potentiometers with a drop of glyptol or nail polish.
12. Disconnect the pressure source from the sensor, then replace the cover on the recorder enclosure and tighten the screws.

This page is intentionally blank.

Section 4. LC-800 Series Recorders

Overview

The Linecorder recorders are designed to monitor AC power line quality. The LC-811, LC-812 and LC-813 units are designed to monitor single-phase systems. LC-834i and LC-836i units are designed to monitor three-phase systems.

A minimum system configuration consists of at least one LC-800 series recorder, Telogers for Windows (S3-PC) support software running on a personal computer and a voltage input cable. Sensors, cables and a DTU are available to add to your system. Refer to Table 4-1 for specifications and Appendix A for Telog literature.

If your LC-800 has an external modem, reprogram and collect data using remote communications. If the recorder does have access to an external modem, use the data transfer cable for local (direct) connection to the computer running Telogers for Windows (S3-PC) to reprogram and collect data.

Refer to the Telogers for Windows User Guide for information on setting up, programming and collecting and analyzing data from an LC-800 recorder.

Specifications

Table 4-1. LC-800 Series Recorder Specifications

	LC-811	LC-812	LC-813	LC-834i	LC-836i
Trend Recording-Voltage					
Number of voltage channels	1	1	3	4 (3 isolated)	3 isolated
Input	true rms AC voltage, continuously integrated				
Range (Vrms is maximum)	50±3 or 60±3 Hz, 300V rms max		50±3 or 60±3 Hz, 2 ch: 300 Vrms 1 ch: 600 Vrms	50±3 or 60±3 Hz, 3 ch: 600 Vrms 1 ch: 100 Vrms	50±3 or 60±3 Hz, 600 Vrms
Resolution	0.1% f.s. (0.3 VAC), ½ cycle			0.1% f.s. (0.6 VAC), ½ cycle	
Accuracy	0.4% (±1.0 VAC)			0.4% (±2.4 VAC)	
Trend Recording-Current					
Number of isolated current channels	*NA*	1	*NA*	*NA*	3
Input	*NA*	true rms AC current, cont. integrated	*NA*	*NA*	true rms AC current, cont. integrated
Range (Depends on Telog IP series clamp-on sensor selected)	*NA*	0-10, 100, 500, 1000 A	*NA*	*NA*	0-10, 100, 500, 1000 A
Resolution	*NA*	0.1% f.s. input range	*NA*	*NA*	0.1% f.s. input range
Accuracy	*NA*	±3% f.s. input range	*NA*	*NA*	±3% f.s. input range
Event (rms) Recording					
Voltage sags & swells	½ cycle to 2.5 sec duration				
Over & under voltages	> 2.5 sec duration				
Current sags & swells	*NA*	½ cycle to 2.5 sec duration	*NA*	*NA*	½ cycle to 2.5 sec duration
Over & under currents	*NA*	> 2.5 sec duration	*NA*	*NA*	> 2.5 sec duration
Impulse recording on channel(s)	Channel 1	Channel 1	Channels 1 and 2	Channels 1, 2 and 3	Channels 1, 2 and 3
Impulses	Range: 200 to 4000 V, Duration 4 to 500 µsec, Resolution 0.1% (4 Vac), 1 µsec, Accuracy 10% of readings & ±2% f.s. for ½ sine wave impulses, Absolute max. input 4000 V for 4 µsec.				
Impulse data recorded	Start time (half-cycle resolution); duration (1µsec. res.); peak value (±4 v res.)				
Recording					
Sample rate	16 times per ½ cycle				
Recording interval	1 min. min., 8 hours max.				
Trend data recorded	Any combination of min., ave. and/or max. for each recording interval & channel				
Trend	6500 most recent values per recording channel				
Event data recorded	Type, start time, duration (½ cycle res.); min. or max. rms value during each event				
Event threshold	High or low limit for each event type selected				
Event (rms)	200 most recent data (except impulses) per recording channel or 150 impulse events				
Memory size	Separate memory for trend and event (rms) event (When the one type of data begins to overwrite itself, it does not affect the other type of data.)				
Date & time	MM/DD/YY & hh:mm:ss				
Internal clock accuracy	±0.01%				
Recorder identification	8 digit alphanumeric label				

Table 4-1. LC-800 Specifications (cont.)

Power		
AC Power	80 - 600Vrms, 50 ± 3Hz or 60 ± 3Hz	
Power consumption	3 watts, typical, @ 120VAC	
Internal battery	9VDC, 1604A alkaline	
Battery life	1 year, typical	
Serial Interface		
Type	RS-232C compatible, requires RTS	
Isolation	optical, 1200 VAC max.	
Baud rates	300, 1200, 2400, 4800 or 9600, user-selectable	
Bit format	1 start, 8 data, 1 stop	
Connector	9-pin sub “D”socket	
Programmable Parameters	Trend data recorded, event data recorded, event thresholds, recording interval, recorder identification, data and time.	
Environmental and Mechanical		
Operating temperature	-25 to 60°C (-18 to 140°F)	
Storage temperature	-40 to 70°C (-40 to 158°F) without batteries)	
Humidity	0 to 95%RH, non-condensing	
Enclosure	Fiberglass, NEMA 4X /IEC IP65	
Size	8.7" x 4.7" x 3.6" (22 x 12 x 9 cm)	10.2" x 6.3" x 3.5" (25 x 16 x 9 cm)
Weight	3.5 lb (1.6 kg)	5.5 lb (2.5 kg)

Table 4-2. LC-800 Voltage Input Cables

Model	Cable No.	Termination & Application
LC-811	C-81A	alligator clips, direct connection
	C-81P	EIA 320 NEMA 5-15P pass through plug, std US 120V duplex outlet
	C-81PAN	AS 3112 plug, std Australia/New Zealand outlet
	C-81PE	CEE 7/7 plug, std continental European outlet
	C-81W	wire leads, direct connection
LC-812	C-82A	alligator clips, direct connection
	C-82P	EIA 320 NEMA 5-15P, std US 120V duplex outlet
	C-82W	wire leads, direct connection
LC-813	C-83A	alligator clips, direct connection
	C-83P	EIA 320 NEMA 5-15P, std US 120V duplex outlet
	C-83W	wire leads, direct connection
LC-834i	C-82A	alligator clips, direct connection
	C-82P	EIA 320 NEMA 5-15P, std US 120V duplex outlet
	C-82W	wire leads, direct connection
	C-84A	G-N channel: alligator clips, direct connection*
	C-84W	G-N channel: wire leads, direct connection*
LC-836i	C-82A	alligator clips, direct connection
	C-82P	EIA 320 NEMA 5-15P, std US 120V duplex outlet
	C-82W	wire leads, direct connection

*These channels require cables that are smaller than cables used with other LC-834i channels.

Table 4-3. LC-800 Clamp-on Current Sensors

Input range	Max. Rating	Part No.
0 - 10 A	650 V	IP-10A
0 - 100 A	650 V	IP-100A
0 - 500 A	2.5 kV	IP-500A
0 - 1000 A	2.5 kV	IP-1000A

Site Selection and Mounting

The fiberglass case and environmentally sealed electrical connectors of the Linecorder allows mounting inside or outside. Weather, incidental wetness and dirt will not harm the unit, but avoid excessive moisture, dirt and grime as well as submersion under water.

Place the Linecorder in any orientation and provide access to both the voltage input connector and the communications connector. DO NOT support the Linecorder by hanging it from the cables.

Procedure to mount the Linecorder

1. Disconnect the voltage input cable from the Linecorder, if connected.
2. Loosen the cover's four corner screws. You cannot remove these screws from the cover, only loosen them.
3. Place the Linecorder on the mounting surface and position it so that the four holes on the bottom of the unit align with the four holes of your mounting surface.
4. Insert and tighten the four #10 or #12 (M5) screws or bolts through the four large recessed holes inside the unit.
5. Replace the cover and tighten the four corner screws.
6. Make the voltage connections and/or current connections as appropriate for your Linecorder as described later in this section.

Voltage Channel Inputs

Overview

LC-811s and LC-812s have a single voltage channel which can monitor a single leg of a three-phase system. LC-813s have three voltage inputs; two voltage inputs of up to 300 Vrms and an additional input of 100 Vrms. All three LC-813 voltage inputs are non-isolated, that is they are referenced to a common line (typically neutral for a split neutral system) and each can monitor three-phase systems using either phase-to-neutral (wye) or phase-to-phase (wye or delta) connections.

LC-834i and LC-836i units are designed to monitor three-phase systems using either phase-to-neutral (wye) or phase-to-phase (wye or delta) connections. These units can also monitor any single phase systems using either line-to-line, line-to-neutral or split neutral connections.

The voltage input cables for one Linecorder model are not interchangeable with those for other Linecorder models. The C-82A and C-83A alligator clip cables are color coded using standard US conventions to identify the input channels. The LC-813's three channels are referenced to the neutral channel (white cable) as described in Table 4-4.

Table 4-4. LC-813 Voltage Input Cable Color Coding

Line	Use clip	Data displayed as channel
L1/L2	black	1
L1/L2	red	2
Ground-to-neutral	green	3
Neutral	white	-

Excessive Voltages

When the input voltage exceeds the standard voltage, use a step-down transformer to reduce the input voltage. With a step-down transformer, the secondary voltage is the input to the Linecorder, as shown in Figure 4-1. Your Linecorder will record data using the actual engineering units when scaled with the turns ratio of the step-down transformer. For example, with the LC-811 monitoring the phase-to-phase voltage of a three-phase 480-V power system, a common 480/240-V transformer reduces the input voltage by one half. If you set the scale value to 2, the recorder scales the recorded data by a factor of two to yield statistical values in actual power system values. Refer to "engineering scaling" in the Telogers for Windows User Guide for additional information. Table 4-5 lists the standard and excessive voltages for each model and channel.

Table 4-5. LC-800 Excessive Voltages

Model	Channel(s)	Standard voltage	Excessive voltage
LC-811	1	≤ 300 VRMS	> 300 VRMS
LC-812	1	≤ 300 VRMS	> 300 VRMS
LC-813	1, 2	≤ 300 VRMS	> 300 VRMS
	3	≤ 100 VRMS	> 100 VRMS
LC-834i	1, 2, 3	≤ 600 VRMS	> 600 VRMS
	4	≤ 100 VRMS	> 100 VRMS
LC-836i	1V, 2V, 3V	≤ 600 VRMS	> 600 VRMS

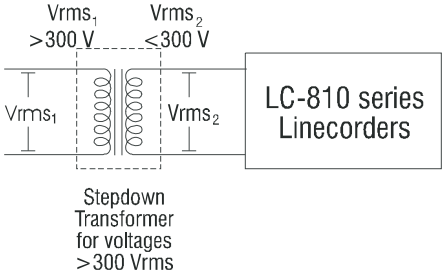
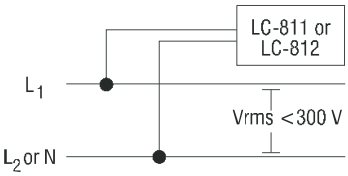


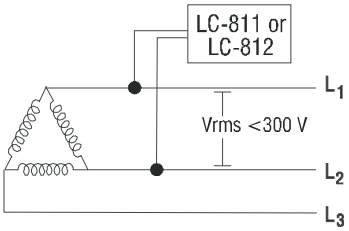
Figure 4-1. LC-811, LC-812, LC813 Sample step-down transformer connection

Schematics

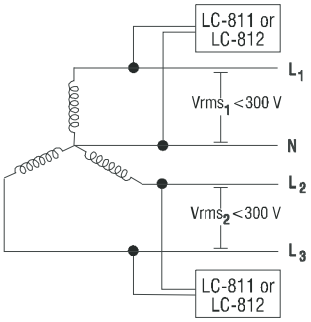
This section contains voltage channel schematics.



Single-Phase System Monitoring

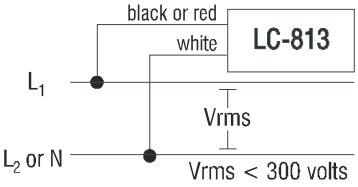


Three-Phase Delta System Monitoring

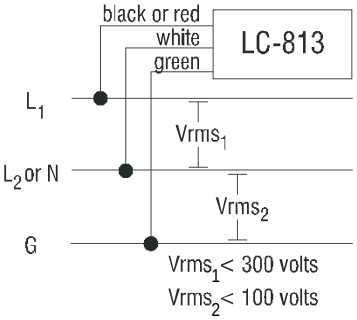


Three-Phase Wye System Monitoring

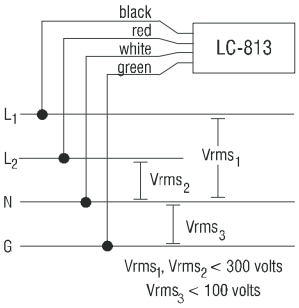
Figure 4-2. LC-811 and LC-812 Connections



Single-Phase System Monitoring

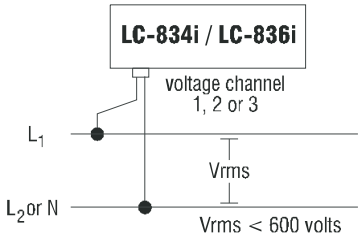


Three-Phase Delta System Monitoring

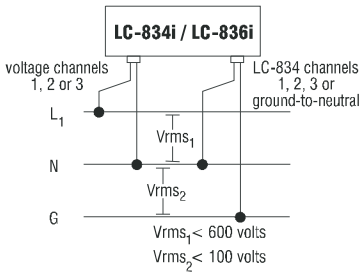


Three-Phase Wye System Monitoring

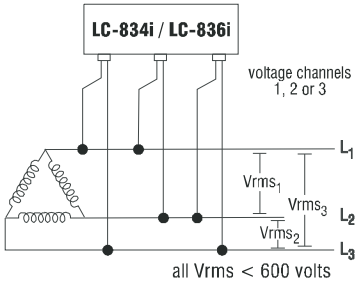
Figure 4-3. LC-813 Connections



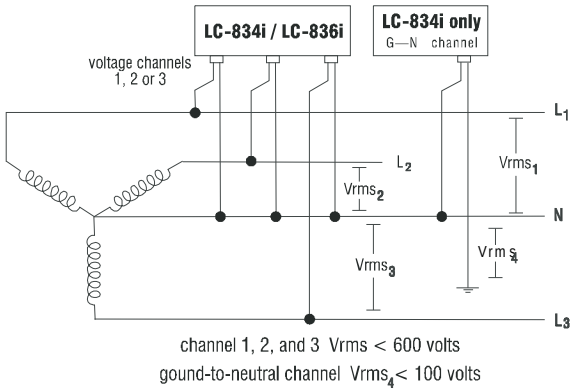
Single-Phase System Monitoring for LC-834i



Single-Phase System Monitoring for LC-836i



Three-Phase Delta System Monitoring



Three-Phase Wye System Monitoring

Figure 4-4. LC-834i and LC-836i Connections

Current Channel Inputs

Overview

The LC-812 and LC-836i Linecorders can monitor current as noted in Table 3-1. Since Linecorders derive power from the system they monitor, you cannot use them as stand-alone current monitors. You must connect these Linecorders to a voltage input.

Use a clamp-on current sensor with an integral 2-meter cable to monitor the current conductor. The current sensors are inter-changeable between Linecorder models. Table 3-3 describes the current sensors. Each sensor has integral secondary open-circuit protection. The unit's default is 100 Amps. You do not need to scale the data if you use the 0-100 A sensor. If you use other sensors, rescale the units to yield statistics in actual power system values using Telogers for Windows (see “engineering scaling”).

Data Collection

Trend Data

Trend data, also referred to as time history data, are voltage or current amplitudes detected on the power line for a particular period of time. When recording an AC trend, a Linecorder divides time into recording intervals of equal duration (from a user-programmable one minute to eight hours long). The Linecorder measures the voltage 16 times each half cycle and then computes the true RMS value. The true RMS value is stored temporarily until the end of an interval. At the end of an interval the temporarily stored true RMS values are used to calculate the statistics you set the unit to store for that interval. The Linecorder sampling technique is termed "RMS detecting, RMS indicating." As it uses the true rms value for all subsequent calculations. The original RMS sample data is not stored in memory.

You must store at least one trend statistic and can store two or three. The statistics are:

- Minimum, the lowest true RMS value measured during the recording interval.
- Average, the average true RMS value over the entire recording interval.
- Maximum, the highest true RMS value measured during the recording interval.

After the statistical values are calculated, they are stored in a first-in-first-out (FIFO) or wrap-around format. Each unit has memory capacity to store the most recent 6500 trend values for each channel. When the unit's memory reaches capacity, the newest trend data overwrites the oldest trend data. The total recording time before overwriting begins depends on the interval length and the number of statistics stored for each interval. After setting up your recorder using Telogers for Windows to display the storage capacity (see "recording capacity").

Event Data

The Linecorder's disturbance analyzer capabilities allows you to store various types of events as described in Table 4-1. You can record all, a combination of or no events.

Sags, Under-voltages and Under-currents

A voltage sag occurs when the voltage drops to or below, for at least a half-cycle, the threshold you set. An under-voltage is defined as a voltage sag with a duration of 2.5 seconds or greater.

A current sag occurs when the current drops to or below, for at least a half-cycle, the threshold you set. An under-current is defined as a current sag with a duration of 2.5 seconds or greater.

When a sag occurs, the Linecorder counts the number of half cycles that the voltage (or current) remains below the threshold, storing the duration of that sag event. (The relative half-cycle count is useful to determine the duration of events that occurred during the same second.) The unit stores the lowest level that occurs while the event is in progress. A sag event ends when either the voltage (or current) remains higher than the preset threshold level for at least one complete cycle or if the voltage (or current) exceeds the preset voltage (or current) swell threshold. The event duration does not include the one cycle of hysteresis, but if there is a single half-cycle that exceeds the sag threshold followed by one that does not, both of these half cycles are counted in the event duration.

If the input voltage level drops below 80 VAC for a period longer than 10 seconds, the Linecorder switches to a low-power pulse mode sleep mode), and the under-voltage duration is updated, at most, once a second rather than every half cycle.

Swells, Over-voltages and Over-currents

A voltage swell occurs when the voltage rises to or above, for at least a half-cycle, the threshold you set. An over-voltage is defined as a voltage swell with a duration of 2.5 seconds or greater.

A current swell occurs when the current rises to or above, for at least a half cycle, the threshold you set. An over-current is defined as a current swell with a duration of 2.5 seconds or greater.

When a swell occurs, the Linecorder counts the number of half-cycles that the voltage (or current) remains above the threshold, storing the duration of the swell event. (The relative half-cycle count is useful to determine the duration of events that occurred during the same second.) The unit stores the highest level that occurs while the event is in progress. A swell event ends when either the voltage (or current) remains lower than the threshold level for at least one complete cycle or if the voltage (or current) drops below the preset voltage (or current) sag threshold. The event duration does not include the one cycle of hysteresis, but if there is a single half cycle that exceeds the swell threshold followed by one that does not, both of these half cycles are counted in the event duration.

Voltage Impulses

The LC-811, LC-812 and LC-813 Linecorders have an impulse detection circuit as described in Table4-1. This circuit operates in conjunction with the normal sampling current to capture impulses in the range of 200- 4000 VAC. The impulse voltage is measured as a deviation from the normal sine wave voltage. The unit can record impulse durations in the range of 4 - 500 μs. It is possible for the unit to capture voltage impulses outside the specified range. If it does, these events are denoted with a ‘<’ or ‘>’ symbol. The unit can capture a minimum of one impulse per cycle.

Power Options

If Linecorders are monitoring power lines with a minimum of 80 VAC the input signal provides the necessary operating power for the Linecorder. (The LC-812 and LC-836i cannot be used as stand-alone current monitors since they derive power from the voltage power source that they are monitoring.) When a Linecorder is not monitoring a power line or is monitoring a line with less than 80 VAC, it operates using the internal 9-volt alkaline battery. If the monitored voltage drops below 80 Vrms, the unit switches to internal battery operation. If the voltage remains below 80 Vrms for longer than 10 seconds, the unit enters a sleep mode by slowing its sample rate to once per second. The unit’s internal battery protects all the stored data as well as maintains the internal time clock. While in sleep mode, all voltages below 80 Vrms are recorded as zero, even if the actual value is non-zero. Full operation resumes when the input voltage returns to 80 Vrms or higher.

This page is intentionally blank.

Section 5. Data Transfer Unit (DTU)

Overview

You can use a data transfer unit (DTU) to collect data from R-2100, e-series and LC-800 recorders and transfer the data to Telogers for Windows for storage in the Telogers database. You can also clear data in a DTU using Telogers for Windows.

When you transfer data, it is copied not erased from the recorder. Transferring data from a recorder to a DTU does not interrupt data collection. The amount of information a DTU can store depends on the amount of data in the data sets it is collecting. Prior to beginning a transfer, verify the DTU battery has sufficient voltage (2.9 volts) for the transfer and that the DTU memory is not full.

For information on transferring data in a DTU to a computer, refer to Communicate | With DTU in the Telogers for Windows User Guide.

Specifications

Table 5-1 provides specifications for the AT-203 DTU.

Table 5-1. DTU (AT-203) Specifications

Spec	**Value**
Memory size	512 KB
Storage capacity	Determined by the recorder's memory size. R-2100 series recorders - At least 60 data sets e series recorders – Up to 16 data sets from units with 21K data value memory; at least 60 data sets from all other units. LC-800 and LC-810 series recorders - At least 40 data sets
Internal batteries	2 3-volt lithium; 5 year or 2000 data transfers; 5 year shelf life 3000-5000 data transfers
Connector	9-pin sub "D" socket and plug
Enclosure	Annodized aluminum extrusion
Environmental	Operating temperature –25° to 60°C Storage temperature –40° to 70°C Humidity 0 to 95% non-condensing
Size	6.6 x 3.0 x 9.0 inches (16.8 x 7.6 x 2.3 mm)
Weight	0.5 lbs (0.22 kg)

Batteries

You can change the DTU batteries quickly without losing any data. Access the batteries by unscrewing the DTU's end cap and carefully slide the printed circuit board toward the cable-end. Pry both old batteries out of their holders using a small flat-blade screwdriver. Insert new batteries, with the correct polarity, into the holder, using the screwdriver to pry open the battery holder as necessary. The DTU will normally go through its mode 3 operation when new batteries are inserted. Finally, slide the circuit board back into the enclosure and secure the end cap.

Memory Status

To check the DTU's memory status, disconnect the DTU cable from any recorder or computer. Press the DTU button. The LED will display green for approximately six seconds, flash green, then flash red. The amount of memory occupied by recorder data is represented by the amount of red relative to the amount of green. The DTU will then turn off. If, the DTU does not respond, hold the button down for 15 seconds, then release it to reset the DTU. If there DTU is still unresponsive, check the orientation of the batteries and try again.

Data Transfer

To transfer data from a recorder to the DTU, physically connect the DTU's 9-pin communications connector on the long cable to the recorder's connector. Press and release the DTU's button. The LED rapidly flashes green to indicate a successful transfer is in progress. If the transfer is successful, the LED remains green for three seconds and when transfer is complete, the LED flashes green. If a data error occurred during the transfer or the DTU memory is full, the LED flashes red for three seconds. Check the connections and try the transfer again. When finished, disconnect the DTU connector.

WARNING! Never connect the DTU to a computer and a recorder at the same time.

To transfer data from a DTU to a computer, physically connect the data transfer cable to the computer's communications port. Start the Telogers for Windows or the S-21P support software and proceed with the data transfer as described in the guide for the software. Connect the DTU's short cable to the data transfer cable. Follow the instructions displayed on the computer screen for further information.

DTU Cleaning

Clean the DTU enclosure with a water-dampened cloth. If needed, use a mild detergent and rinse the DTU thoroughly afterwards. After cleaning always wipe excess water from around the connectors and allow the water to evaporate thoroughly before returning the unit to service.

Appendix A. Telog Literature

This appendix contains the following Telog products' sales and marketing literature:

- R-2100 Series Data Recorders

This page is intentionally blank.

Index

T

U

V

W