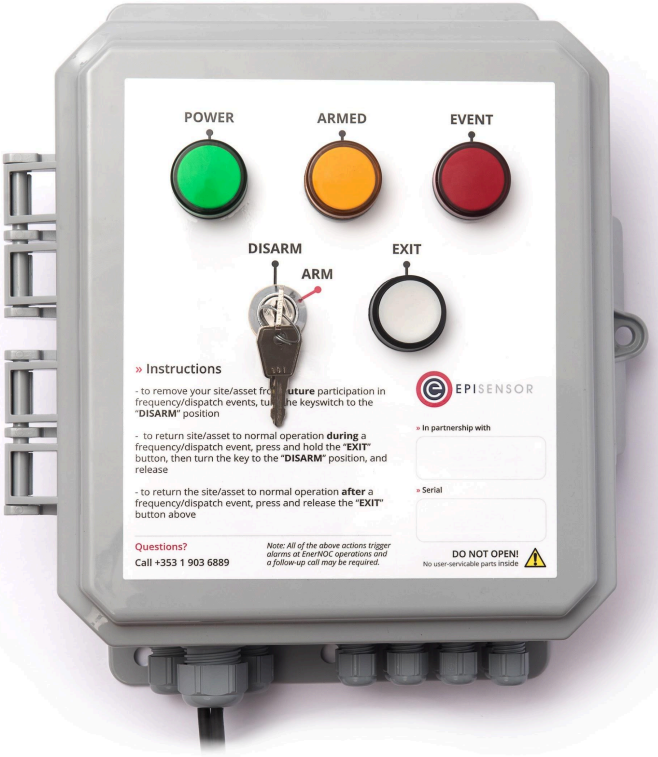

User Guide

Wireless Demand Response Controller

Applies to: ZDR-10, ZDR-15, ZDR-16, ZDR-17

EPI-078-03

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Safety Information

Please read these instructions carefully before trying to install, operate, service or maintain the ZDR. The following special notes may appear throughout the user guide (or on the equipment labels) to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure for users.

Symbol	Description
	The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.
	This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.
	This symbol notes that Electrostatic discharge (ESD) events can harm electronic components inside this product. Protect against ESD and discharge static electricity from your body before you interact with this product.

Electrical Installation

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

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

Installation, wiring, testing and service must be performed in accordance with all local and national electrical codes.

 **HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH** 

- ➔ NEVER work alone.
- ➔ Use appropriate personal protective equipment (PPE) and follow safe electrical work practices.
- ➔ Only qualified electrical workers should install this equipment. Such work should be performed only after reading the entire set of installation instructions.

- If the equipment is not used in a manner specified by EpiSensor, the protection provided by the equipment may be impaired.
- Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Turn off all power supplying the meter and the equipment in which it is installed before working on it.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Before closing all covers and doors, inspect the work area for tools and objects that may have been left inside the equipment or panel.
- When removing or installing metering or other equipment, do not allow it to extend into the energised bus.
- The successful operation of this equipment depends upon proper handling,
- Neglecting fundamental installation requirements may lead to personal injury as well as damage to electrical equipment or other property.
- Before performing Dielectric (Hi-Pot) or Megger testing on any equipment in which the energy meter is installed, disconnect all input and output wires to the energy meter.
- High voltage testing may damage electronic components contained in the meter.
- Failure to follow these instructions will result in death or serious injury.

Installation & Safety Notes

- EpiSensor equipment should be installed, operated, serviced and maintained only by qualified personnel. EpiSensor does not assume any responsibility for any consequences arising out of the use of this equipment.
- The ZDR voltage measurement inputs are rated for up to 250 V L-N or 433 V L-L. For any voltage exceeding 250 V L-N, an auxiliary power source must be used. Consult the ZDR datasheet for more information on available product variants. For voltages exceeding 433 V L-L, a voltage transformer must be used.

- ➔ Fuse for neutral terminal is required if the source neutral connection is not grounded.
- ➔ Clearly label the device's disconnect circuit mechanism and install it within easy reach of the operator.
- ➔ The fuses / circuit breakers must be rated for the installation voltage and sized for the available fault current.
- ➔ If Voltage Transformers are used, the power consumption values must be adjusted in ZDR settings accordingly.
- ➔ Each ZDR meter is individually calibrated and the current transformer cables should not be extended or interchanged.

Intended Use

Do not use this device for critical control or protection applications where human or equipment safety relies on the operation of the control circuit. Failure to follow these instructions can result in death, serious injury, or equipment damage.

Warning	
	This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Related Documents

Related installation and configuration documents are listed in the following table:

Document	Reference No.
EpiSensor ZDR Datasheet	EPI-066-00
Install Sheet for ZDR	EPI-065-00
Gateway API User Guide	EPI-009-10
Bootloading on a live Gateway	EPI-064-00
Configuring the High Speed Data Module on ZDR	EPI-131-02

Introduction

EpiSensor's ZDR enables customers to participate in multiple Demand and Frequency response programs. It includes best-in-class functionality to accurately monitor electrical load (via CT's or pulse inputs), frequency and can take action to shed load or engage backup generators based on frequency set points or commands sent from a remote network operations centre.

The system is capable of streaming data securely to a Network Operations Centre (NOC) to arm the system, detect low frequency events, override the system remotely, and switch loads both automatically and manually.

With a wide range of additional sensors available, EpiSensor's platform can also be used for energy management, environmental monitoring and many other applications.

This guide discusses features of the EpiSensor ZDR series demand response controller and provides installation and configuration instructions.

For the most up-to-date version of this document and others, please visit www.episensor.com

Benefits

- Significantly lower cost and physical size than other solutions
- Can be expanded to multiple 'apps' with additional sensors available
- Multiple ZDR's can communicate to a single Gateway

Features

- 4 relays for asset control
- 2-channel high frequency pulse inputs
- 2-channel 4-20mA analog inputs
- 100ms reaction time for under frequency events
- Live stream (1-second) data for 3-phase power consumption, current and frequency
- Modbus (RS-485) communications capability

Data Feeds & Settings

The list of parameters that are available to monitor on the ZDR are listed below. Data reporting can be enabled or disabled as required for each of the 'sensors' below.

Frequency Response Settings

Single Channel ZDR-16 [One Switch and one Event Value Affecting 4 Relays Concurrently]

The following table lists the settings on the ZDR that relate to frequency response. They define how the ZDR should respond to under-frequency events and how the current state of the hardware. These items are configured as properties on the ZDR rather than sensors.

Property ID	Setting	Description	Unit	Resolution	Reporting	Default	Read/Write
6500	**Event Sensor**	The sensor ID for which the system is monitoring to generate events. Initially this is only configurable for "none" indicating no events are generated locally, or "Line Frequency - 342" for frequency monitoring.	-	-	-	none	Read/Write
6501	**Enter Event Value**	The value at which the system will trigger the start of an event.	Raw Sensor Units	1	-	49700	Read/Write
6502	**Exit Event Value**	The value at which the system will exit the event.	Raw Sensor Units	1	-	49800	Read/Write

Four Channel ZDR [4 Relays - 2 for Frequency Response with Independent Upper and Lower Enter/Exit Event Values, 2 for Demand Response]

The following table lists the settings on the ZDR that relate to frequency response.

Property ID	Setting	Description	Unit	Resolution	Reporting	Default	Read/Write
6507	**Remotely Armed**	Is the system configured for Frequency Monitoring. If FALSE, It may still be locally armed with the key switch for Demand Response Events.	Boolean	1	-	none	Read/Write

The Enter and Exit Event Values for the 4 channel ZDR-16 are contained within the Sensor Settings for Relay 1 (Sensor ID 71) and Relay 2 (Sensor ID 72). Relay 3 and Relay 4 are reserved for Demand Response functions only and are not configurable for Frequency Response. Similarly, Relay 1 and Relay 2 are reserved for Frequency Response only and are not configurable for Demand Response.

Relays 1 and 2 use the following sensor level settings to configure the Enter and Exit Event Values.

Property ID	Setting	Description	Unit	Resolution	Reporting	Default	Read/Write
6490	**High Enter Event Value**	The value at which the system will trigger the start of an event when	Hz	0.001	-	50.300	Read/Write

		the frequency is above nominal					
6491	**High Exit Event Value**	The value at which the system will trigger the end of an event when the frequency is above nominal	Hz	0.001	-	50.200	Read/Write
6492	**Low Exit Event Value**	The value at which the system will trigger the end of an event when the frequency is below nominal	Hz	0.001	-	49.800	Read/Write
6493	**Low Enter Event Value**	The value at which the system will trigger the start of an event when the frequency is below nominal	Hz	0.001	-	49.700	Read/Write

Single Channel ZDR-17 [One Event Value Affecting Battery Output on a Stepped Basis]

The following table lists the settings on the ZDR that relate to frequency response. They define how the ZDR should respond to under-frequency events and how the current state of the hardware. These items are configured as properties on the ZDR rather than sensors.

Property ID	Setting	Description	Unit	Resolution	Reporting	Default	Read/Write
6507	**Remotely Armed**	Is the system configured for Frequency Monitoring and Battery Control.	Boolean	1	-	none	Read/Write
6501	**Enter Event Value**	The value at which the system will trigger the start of an event. Used by the High Speed Module to monitor Frequency Events	Hz	0.001	-	49.700	Read/Write
6502	**Exit Event Value**	The value at which the HSDM will determine that an event has ended.	Hz	0.001	-	49.800	Read/Write
6510	**dFFR Start Frequency**	The Frequency at which the ZDR-17 will start to request power from the Battery	Hz	0.001	-	49.900	Read/Write
6511	**dFFR Step Count**	The max number of steps in the frequency profile	-	-	-	10	Read/Write
6512	**dFFR Frequency Step Size**	The step size for each increase in energy requested from the battery	Hz	0.001	-	0.200	Read/Write
6513	**dFFR Energy Per Step**	The increase in energy per step of frequency	UOM based on Sensor 249	-	-	-	Read/Write
6514	**dFFR Maximum Event Time**	The max time the ZDR-17 will request power from the battery	seconds	1	-	120	Read/Write
6515	**dFFR Battery Enable Function**	The Modbus code sent to Sensor ID 48 to start the Battery Discharge. Battery Function minus one is the disable function to stop the discharge.	-	-	-	0	Read/Write

General Settings

6503	**Auto Exit**	Defines whether the site will exit a trip state automatically after an event, or if it should wait for a 'soft reset' from a user via the pushbutton.	TRUE /FALSE	1	-	0	Read/Write
6508	**Pre Event Log Time**	The number of seconds the HSDM should record before the event. The total event time is 30 seconds so increasing this value reduces the post event log time	seconds	1	-	5	Read/Write
6504	**Minimum Event Time**	The minimum time the event must stay active, even if the frequency, or demand response returns to a good state	seconds	1	-	0	Read/Write
6505	**Event Reset Time**	The minimum time after the event when the ZDR will not allow another event to start giving the site time to recover	seconds	1	-	0	Read/Write
6506	**Filter Sample Count**	The number of sequential "Start of Event" readings that are inside the "Enter Event Value" before an event is considered "real". Readings are taken 20ms apart	units	1	-	10	Read/Write
6552	**Frequency Analysis**	The meaning of the Frequency Analysis Sensors - 330, 331 and 332. See further explanation below	-	-	-	Power Factor	Read/Write
6553	**CT Direction**	A setting allowing the CT direction to be inverted. Useful in the case where one or more CTs have been installed in reverse	-	-	-	Fwd	Read/Write
6554	**Voltage to Current Datapath**	This allows the ZDR to redirect the Voltage from any channel into the datapath for KW and KWH of another.	-	-	-	A-B-C	Read/Write
6556	**CT Phase Angle**	An correction angle applied if the CT introduces a known error angle on the channel	seconds	1	-	0	Read/Write
6555	**VT Phase Angle**	An correction angle applied if a VT introduces a known error angle on the channel	seconds	1	-	0	Read/Write
6551	**CT Ratio**	A multiplier on the CT input channel which is applied to the calibration constants within the metering section of the ZDR System. It allows for 100:1 or 100:5 (20:1) type Ratios to be applied to the CTs	-	-	-	1	Read/Write
6550	**VT Ratio**	A multiplier on the VT input channel which is applied to the calibration constants within the metering section of the ZDR System. It allows the ZDR to be connected to MV systems with (for example) 11kV inputs using VTs that output 110V.	-	-	-	1	Read/Write

6557	**Voltage Measurement Range**	A setting allowing the ZDR to read low range voltages, or high range voltages by applying a different gain factor to the voltage channels	VAC (L-L)	-	-	120 - 600	Read/Write
6036	**Configuration**	The American ANSI C12.10 standard defines the different configurations of the meter. This defines how the active power accumulated in each watt-hour register is calculated.	-	-	-	9S/16S 4-wire Wye	Read/Write
6034	**Nominal Frequency**	The nominal frequency of the system being monitored. Only used when selecting the correct injection test for the current line frequency range.	Hz	-	-	50	Read/Write
6558	**Injection Test Profile**	A series of frequency profiles that can be used to test the ZDR Response	-	-	-	-	Read/Write
6410	**Modbus Baud Rate**	RS485 Communication Parameter for Modbus Network	-	-	-	-	Read/Write
6411	**Modbus Parity**	RS485 Communication Parameter for Modbus Network	-	-	-	-	Read/Write
6412	**Modbus Stop Bits**	RS485 Communication Parameter for Modbus Network	-	-	-	-	Read/Write

Frequency Analysis, Property 6552

Configuration	Meaning	Sensor 330	Sensor 331	Sensor 332
Power Factor	Using the Phase Angle between Voltage and Current to calculate the Power Factor for the Phase	Phase A Power Factor	Phase B Power Factor	Phase C Power Factor
Voltage to Current Phase Angle	Phase Angle between Voltage and Current	Phase Angle delay between Phase A voltage and Current	Phase Angle delay between Phase B Voltage and Current	Phase Angle delay between Phase C Voltage and Current
Voltage to Voltage Phase Angle	The Phase Angle between various Voltage Waveforms	Phase Angle Delay between Phase A Voltage and Phase C Voltage	Phase Angle Delay between Phase B Voltage and Phase C Voltage	Phase Angle Delay between Phase A Voltage and Phase B Voltage
Current to Current Phase Angle	The Phase Angle between various Current Waveforms	Phase Angle Delay between Phase A Current and Phase C Current	Phase Angle Delay between Phase B Current and Phase C Current	Phase Angle Delay between Phase A Current and Phase B Current

Voltage to Current Datapath, Property 6554

The ZDR can direct one phase voltage input to the computational datapath of another phase. For example, Phase A voltage can be introduced in the Phase B computational datapath, which means all powers computed by the ZDR in Phase B are based on Phase A voltage and Phase B current.

Configuration	Meaning	Phase A Powers	Phase B Powers	Phase C Powers
A-B-C	All channels lined up	VA and IA	VB and IB	VC and IC
A-C-B	B and C swapped	VA and IA	VC and IB	VB and IC
B-A-C	B and A swapped	VB and IA	VA and IB	VC and IC
B-C-A	Phases Rotated “left”	VB and IA	VC and IB	VA and IC
C-A-B	Phases Rotated “right”	VC and IA	VA and IB	VB and IC
C-B-A	A and C Swapped	VC and IA	VB and IB	VA and IC

Meter Configuration, Property 6036

The active power accumulated in each watt-hour sensor depends on the configuration of the Meter. Choose the appropriate value from the table below depending on how the ZDR is connected to a 3-phase system. This is based on the ANSI C12.10 standard.

Ansi Meter Form	Configuration	Phase A Watt Hours	Phase B Watt Hours	Phase C Watt Hours
9S/16S	4-wire wye	VA x IA	VB x IB	VC x IC
5S/13S	3-wire delta	VA x IA	0	VC x IC
6S/14S	4-wire wye	VA x IA	VB × IB Where VB = −VA − VC	VC x IC
8S/15S	4-wire delta	VA x IA	VB × IB Where VB = −VA	VC x IC

System State Sensors

These sensors provide data on the state of the ZDR State Variables and can be used to trigger state changes at the NOC or for audit/compliance purposes.

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
20	**Armed 1 (On 4 channel ZDR-16 only)**	Set to 1 when the Key Switch is in the Armed position AND Remotely Armed property is TRUE so Frequency Response is active on Relay 1. Set to 0 otherwise.	1/0	1	Interval and Delta	-	Read Only

21	**Armed 2 (On 4 channel ZDR-16 only)**	Set to 1 when the Key Switch is in the Armed position AND Remotely Armed property is TRUE so Frequency Response is active on Relay 2. Set to 0 otherwise.	1/0	1	Interval and Delta	-	Read Only
22	**Armed 3 (On 4 channel ZDR-16 only)**	Set to 1 when the Key Switch is in the Armed position so Demand Response is available on Relay 3. Set to 0 otherwise.	1/0	1	Interval and Delta	-	Read Only
23	**Armed 4 (On 4 channel ZDR-16 only)**	Set to 1 when the Key Switch is in the Armed position so Demand Response is available on Relay 4. Set to 0 otherwise.	1/0	1	Interval and Delta	-	Read Only
24	**Armed (On single channel ZDR-16 and ZDR-17)**	Set to 1 when the Key Switch is in the Armed position AND the ZDR system is actively monitoring an Event Sensor. Set to 0 otherwise.	1/0	1	Interval and Delta	-	Read Only
25	**Opt Out**	Set to 1 when the Gateway or API removes a device from an active event with the Opt Out command OR when a user on site has removed the site from an event by the Opt Out key sequence on the front panel - Press and hold the Exit button and turn the key switch to Disarm.	1/0	1	Interval and Delta	-	Read Only

Event Response Sensors

The following sensors produce data on the state of the ZDR showing whether an event is currently in progress, or if the ZDR has been triggered remotely by the NOC.

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
27	**Event Response**	Notifies that an event is currently in progress. Will be reset if a user takes the site out of trip with the pushbutton and keylock, or with remote override. Or if the event ends and the system is configured to Auto Exit	1/0	1	Interval and Delta	-	Read Only
26	**Demand Response**	Notifies that a demand response event is currently in progress. Will be reset either by the manual override push button, or remote override. Or if the event ends and the system is configured to Auto Exit	1/0	1	Interval and Delta	-	Read Only
359	**Switch (On single channel ZDR-16 only)**	The position of the switch. Writing 1 to the switch initiates a DR Event, while writing 0 to the switch ends a DR Event. Note that the switch could be ON, when no event is in progress if the system is waiting for a manual Exit.	1/0	1	Interval and Delta	-	Read/Write

71	**Relay 1 (On 4 channel ZDR-16 only)**	The position of the RL1 Relay. This Relay is for FR Events only so cannot be set externally. Note that the switch could be ON, when no event is in progress if the system is waiting for a manual Exit.	1/0	1	Interval and Delta	-	Read/Write
72	**Relay 2 (On 4 channel ZDR-16 only)**	The position of the RL2 Relay. This Relay is for FR Events only so cannot be set externally. Note that the switch could be ON, when no event is in progress if the system is waiting for a manual Exit.	1/0	1	Interval and Delta	-	Read/Write
73	**Relay 3 (On 4 channel ZDR-16 only)**	The position of the RL3 Relay. Writing 1 to the Relay 3 initiates a DR Event, while writing 0 to the switch ends a DR Event. Note that the switch could be ON, when no event is in progress if the system is waiting for a manual Exit.	1/0	1	Interval and Delta	-	Read/Write
74	**Relay 4 (On 4 channel ZDR-16 only)**	The position of the RL4 Relay. Writing 1 to the Relay 4 initiates a DR Event, while writing 0 to the switch ends a DR Event. Note that the switch could be ON, when no event is in progress if the system is waiting for a manual Exit.	1/0	1	Interval and Delta	-	Read/Write

User Interface Sensors

These sensors provide data on the state of the user interface and can be used to trigger state changes at the NOC or for audit/compliance purposes.

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
41	**Key Switch**	The position of the key switch. 1 = Armed, 0 = Not Armed	-	1	Interval and Delta	-	Read Only
42	**Exit Button**	The position of the Exit Button, 1 = pressed, 0 = released	-	1	Interval and Delta	-	Read Only
250	**Enter Event Value (On single channel ZDR-16 and ZDR-17)**	An Echo of the Enter Event Value Property 6501 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only
251	**Exit Event Value (On single channel ZDR-16 and ZDR-17)**	An Echo of the Exit Event Value Property 6502 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only
252	**Relay 1 High Enter Event Value (On 4 channel ZDR-16 only)**	An Echo of the High Enter Event Value Property 6490 On Relay 1 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only
253	**Relay 1 High Exit Event Value (On 4 channel ZDR-16 only)**	An Echo of the High Exit Event Value Property 6491 On Relay 1 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only

254	**Relay 1 Low Exit Event Value (On 4 channel ZDR-16 only)**	An Echo of the Low Exit Event Value Property 6492 On Relay 1 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only
255	**Relay 1 Low Enter Event Value (On 4 channel ZDR-16 only)**	An Echo of the Low Enter Event Value Property 6493 On Relay 1 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only
256	**Relay 2 High Enter Event Value (On 4 channel ZDR-16 only)**	An Echo of the High Enter Event Value Property 6490 On Relay 2 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only
257	**Relay 2 High Exit Event Value (On 4 channel ZDR-16 only)**	An Echo of the High Exit Event Value Property 6491 On Relay 2 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only
258	**Relay 2 Low Exit Event Value (On 4 channel ZDR-16 only)**	An Echo of the Low Exit Event Value Property 6492 On Relay 2 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only
259	**Relay 2 Low Enter Event Value (On 4 channel ZDR-16 only)**	An Echo of the Low Enter Event Value Property 6493 On Relay 2 which allows this to be exported as a Sensor in the normal fashion	-	1	Snap to Clock	-	Read Only

Electricity Metering Sensors

These read-only ‘sensors’ provide data on the power consumption and frequency of the 3-phase system that the ZDR is monitoring.

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
300	**Phase A kWh**	Phase A kWh value. This is a continually increasing kWh reading.	kWh	0.01	Off	-	Read/Write
301	**Phase B kWh**	Phase B kWh value. This is a continually increasing kWh reading.	kWh	0.01	Off	-	Read/Write
302	**Phase C kWh**	Phase C kWh value. This is a continually increasing kWh reading.	kWh	0.01	Off	-	Read/Write
303	**Phase A RMS Current**	Instantaneous Phase A RMS Current.	A	0.1	Off	-	Read Only
304	**Phase B RMS Current**	Instantaneous Phase B RMS Current.	A	0.1	Off	-	Read Only
305	**Phase C RMS Current**	Instantaneous Phase C RMS Current.	A	0.1	Off	-	Read Only
306	**Phase A RMS Voltage**	Instantaneous Phase A RMS Voltage.	V	0.1	Off	-	Read Only
307	**Phase B RMS Voltage**	Instantaneous Phase B RMS Voltage.	V	0.1	Off	-	Read Only
308	**Phase C RMS Voltage**	Instantaneous Phase C RMS Voltage.	V	0.1	Off	-	Read Only

324	**Phase A Active Power**	Instantaneous Active Power on Phase A	W	1	Off	-	Read Only
325	**Phase B Active Power**	Instantaneous Active Power on Phase B	W	1	Off	-	Read Only
326	**Phase C Active Power**	Instantaneous Active Power on Phase C	W	1	Off	-	Read Only
330	**Phase A Power Factor**	Power Factor on Phase A	%	1%	Off	-	Read Only
331	**Phase B Power Factor**	Power Factor on Phase B	%	1%	Off	-	Read Only
332	**Phase C Power Factor**	Power Factor on Phase C	%	1%	Off	-	Read Only
333	**Total kWh**	The sum of Phase A, B and C kWh, sensors 300, 301 and 302	kWh	0.1	Off	-	Read/Write
335	**Total Active Power**	The instantaneous sum of Phase A, B and C Active Power, sensors 324, 325 and 326	KW	0.001	Off	-	Read Only
338	**Interval Phase A kWh**	The kWh on Phase A since the previous data point.	kWh	0.01	Off	-	Read/Write
339	**Interval Phase B kWh**	The kWh on Phase A since the previous data point.	kWh	0.01	Off	-	Read/Write
340	**Interval Phase C kWh**	The kWh on Phase A since the previous data point.	kWh	0.01	Off	-	Read/Write
341	**Interval Total kWh**	The total kWh on all phases since the previous data point.	kWh	0.1	Off	-	Read/Write
342	**Line Frequency**	The Line Frequency of the 3 Phase system. This is read from the Phase A voltage channel	Hz	0.001	Live Stream	-	Read Only

Analogue & Digital Inputs

These data feeds show the number of pulses counted by the ZDR and average 4-20mA analogue input readings.

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
394	**4-20 MilliAmps Now 1**	The Instantaneous Milli Amp value on channel 1 of the 4-20 Milliamp input.	mA	0.001	Off	-	Read Only
396	**4-20 MilliAmps MIn 1**	The number of pulses recorded on channel 2 during the previous reporting interval.	Ma	0.001	Off	-	Read Only
397	**4-20 MilliAmps Max 1**	The average 4-20mA value of channel 1.	mA	0.001	Off	-	Read Only

494	**4-20 MilliAmps Now 2**	The Instantaneous Milli Amp value on channel 1 of the 4-20 Milliamp input.	mA	0.001	Off	-	Read Only
496	**4-20 MilliAmps MIn 2**	The number of pulses recorded on channel 2 during the previous reporting interval.	Ma	0.001	Off	-	Read Only
497	**4-20 MilliAmps Max 2**	The average 4-20mA value of channel 1.	mA	0.001	Off	-	Read Only
450	**Pulse Count**	The total Pulse Count on Channel 1 of the Pulse Input	pulses	1	Off	-	Read/Write
462	**Interval Pulse Count**	The total number of Pulses on channel 1 during the previous reporting interval	pulses	1	Off	-	Read Only
444	**Pulse Rate 1**	The instantaneous Pulse Rate on Channel 1	Hz	0.001	Off	-	Read Only
463	**Pulse Count 2**	The total Pulse Count on Channel 2 of the Pulse Input	pulses	1	Off	-	Read/Write
464	**Interval Pulse Count 2**	The total number of Pulses on channel 2 during the previous reporting interval	pulses	1	Off	-	Read Only
447	**Pulse Rate 2**	The instantaneous Pulse Rate on Channel 2	Hz	0.001	Off	-	Read Only

Modbus Sensors

The following generic Modbus sensor is available in the 4 channel ZDR-16 and ZDR-17 Only

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
1100	**Modbus Register 0**	Generic Modbus Register that can be used to interface with any connected Modbus Slave	-	-	Off	-	Read/Write

The following Modbus sensors are available in the ZDR-17 only. They are designed to be used in conjunction with "Node Profiles" to reconfigure the sensors as "battery specific sensors". A Modbus Slave is connected to the ZDR-17 through the RS485 (Modbus) connection and these sensors are read to provide data on the operation of the battery. The following is the default naming and units of these sensors. They can be renamed, given different Units of Measure and given different dividers using a node profile.

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
230	**Nominal Capacity**	Battery nominal energy capacity	kWh	1	Off	-	Read Only
231	**Energy Deliverable**	Energy capacity available for up regulation	kWh	1	Off	-	Read Only
232	**Energy Receivable**	Energy capacity available for down regulation	kWh	1	Off	-	Read Only

233	**DR Mode Active**	Notify external communication that UPS is in DR mode	-	1	Off	-	Read Only
234	**UPS Power Rating**	System output power rating	kW	1	Off	-	Read Only
235	**Power Deliverable**	Maximum power capacity available for up regulation	kW	1	Off	-	Read Only
236	**Power Receivable**	Maximum power capacity available for down regulation	kW	1	Off	-	Read Only
237	**Battery Power**	Current battery power	kW	1	Off	-	Read Only
238	**Rectifier Power**	Current Input Power	kW	1	Off	-	Read Only
239	**Inverter Power**	Current Output Power	kW	1	Off	-	Read Only
240	**DR Regulation Mode**	Regulation Mode	-	1	Off	-	Read Only
241	**Discharge Time Remaining**	How long the up regulation can be supplied	seconds	1	Off	-	Read Only
242	**Charge Time Remaining**	How long the down regulation can be supplied	seconds	1	Off	-	Read Only
243	**Time Until DR Remaining**	How long it takes until DR mode is available again	hours	1	Off	-	Read Only
244	**Input Frequency**	Line Frequency - This may have an offset defined by the UPS	Hz	1	Off	-	Read Only
245	**Phase A Voltage**	Measured Input Voltage, Phase A	Volts	1	Off	-	Read Only
246	**Phase B Voltage**	Measured Input Voltage, Phase B	Volts	1	Off	-	Read Only
247	**Phase C Voltage**	Measured Input Voltage, Phase C	Volts	1	Off	-	Read Only
248	**DR Requested**	Value written to UPS to start the Regulation Mode	-	1	Off	-	Read Only
249	**DR Requested Power**	Power written to UPS to request desired Power	kW	1	Off	-	Read Only

ZDR-17 Special Handling of Sensors 248 and 249

The ZDR-17 is pre-programmed to use Sensors 248 and 249 to control the battery.

1. Sensor 248 is used to Start or Stop discharge, that is to reduce the dependency on the grid and use battery reserves instead.
2. Sensor 249 is the power value requested from the Battery.

It is important to note that these sensors are not multiplied or divided internally in the ZDR before the values are written to the UPS/Battery Controller.

The value written to Sensor 248 to start UPS Control is the value contained in Property ID 6515 - dFFR Battery Enable Function. The value written to Sensor 248 to stop UPS Control is the same value minus one.

The value written to Sensor 249 to define the power required from the UPS is defined by the property 6510, 6511, 6512 and 6513 - those being the Start Frequency, Step Count, Frequency Step Size and Energy Per Step. Energy Per Step MUST the same Units of Measure as the UPS - This value is not multiplied or divided by the ZDR.

For Example; If the UOM of the UPS is 0.1KW, and the ZDR needs to request 10KW per Step, then Property 6513 should be set to 100. We require 100 * 0.1KW to get 10KW per Step.

Network and Zigbee Sensors

Sensor ID	Data Feed	Description	Unit	Resolution	Reporting	Default	Read/Write
4097	**Link Quality**	Link Quality % - measure of Zigbee signal			Off	60	Yes
4099	**RSSI**	Channel noise in dbm			Off	60	Yes
4101	**Neighbour Count**	The number of mains powered devices this device can route messages through			Delta and Interval	360	Yes
4102	**Child Count**	The number of battery power “child” devices that use this device to route messages through			Delta and Interval	360	Yes

Frequency Response Specification

This section describes the parameters of the ZDR that are particularly important for fast frequency response programs.

Reaction Time

The reaction time for frequency response programs is defined as the amount of time between an under-frequency event, and when a relay is latched / asserted.

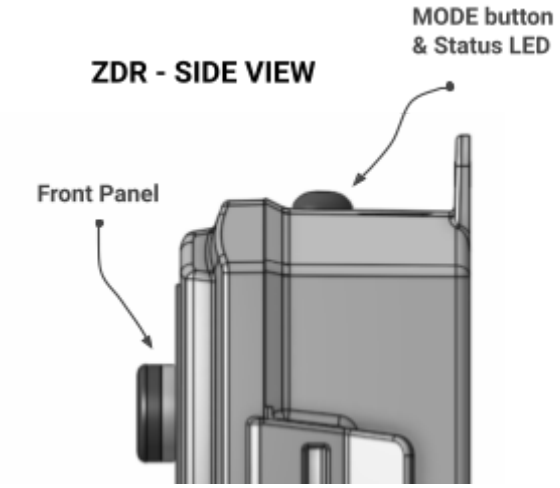
Some frequency response programs (or the certification for some programs) will require sub-second response times. The metering chip used in the ZDR samples the voltage waveform regularly to determine the frequency.

The frequency register on the metering chip is polled directly from the ZigBee SoC every 2-3 cycles, which at 50Hz would be every 40ms to 60ms. The main processor then compares the value to the frequency set point, checks the armed state, and if the ZDR is in fact armed, takes an action to latch a relay.

The overall reaction time for the ZDR is 100 milliseconds.

User Interface

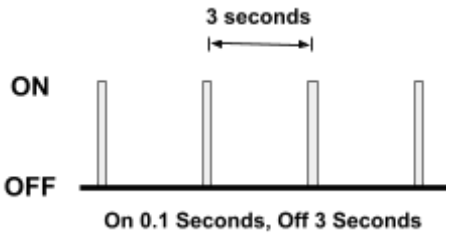
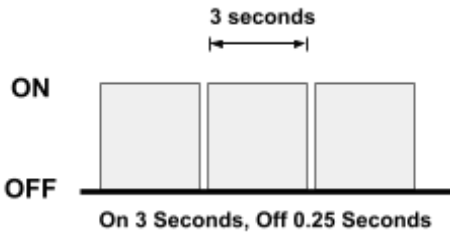
There are two user interfaces on the ZDR - the front panel, and the mode button & LED. The front panel user interface is intended to inform local users about the state of the ZDR, whether it is armed / participating in DR programs, and if an event is currently in progress. The status button and LED are located on the top of the ZDR enclosure, as shown on the diagram to the right. This section describes the user interface of the ZDR and what each state means.

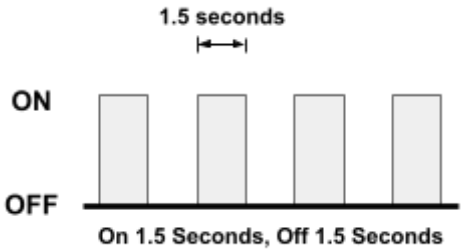


A node must be in “command mode” before users can interact with the product. To put the node in Command Mode, press and hold the “MODE” button for 2 seconds, then release. At this point the ZDR Status LED will flicker then switch the LED On Solid, then transition into showing a node’s status.

Status LED

The red status LED will flash in different sequences depending on the current state of the ZDR. This table below lists all possible LED flash sequences and their meaning.

Flash Sequence	Description	Diagram
Heartbeat	The node is operating correctly and has successfully joined a wireless network.	
Inverse Heartbeat	The node has received valid security keys, but is not connected to a Gateway.	

Square Wave	The node is operating correctly but has lost contact with the Gateway.	
On Solid, or Off	If the LED is On Solid, the node is searching for a Gateway to join. If it is Off, the node may not be powered, or there is a problem with the node. Check the power supply, and if the problem persists, contact EpiSensor support.	

Mode Button

The following options are available with Command Mode. The button should be pressed and then released to register a valid button press. If no further button presses are made, the device will terminate “command mode” 4 seconds after the last button press.

Press	Description
0	Send a PING message disable any active Install Mode or Range Test Mode. If the node is not joined, try and join a network.
1	Send a DATA message to the Gateway for any enabled sensors that are not reporting in ‘snap-to-clock’ mode.
2	Leave the current network. Mains powered Nodes will automatically try and join a new network once they have left and will periodically retry the join. Battery powered nodes will go to sleep.
4	Start “Install Mode”. Node sends a PING message every 15 seconds, with the LED pulse speed indicating the wireless signal strength of the reply. Automatically expires after 5 minutes.
6	Reboot the node. Security keys for the wireless network that the node is connected to will not be erased, and all other settings will remain the same.
8	Factory-reset the node and perform a reboot. All settings and security keys will be lost. The node will be returned to its factory default state.
12	Start “Range Test” mode. Node will send a PING message every 5 seconds. The LED pulse speed indicates the wireless signal strength of the reply. Automatically expires after 5 minutes.

Install Mode

Issuing a press sequence on the Mode button of a powered node can enable either “Install Mode” or “Site Survey Mode” on that node. In this mode, the LED will flash at a rate that indicates the wireless signal strength (Link Quality Indicator) of that node, based on the following table:

Flash Rate	Flashes per Second	Wireless Signal Strength	LQI
Very Fast	10 flashes / second (Light on 50ms, off 50ms)	Very good Signal	> 200
Fast	2 flashes / second (LED on 250 ms, off 250 ms)	Good Signal	> 150
Slow	1 flash / 2 seconds (LED on 1 sec, off 1 sec)	OK Signal	> 100
Very Slow	1 flash / 6 seconds (LED on 3 sec, off 3 sec)	Poor Signal	< 100

This mode expires after 15 minutes for Install Mode and 5 minutes for Site Survey Mode.

Front Panel

The ZDR has a simple user interface consisting of a Key Lock, an Exit button, and three LED indicators for 'Power', 'Armed' and 'Event'.

The 'POWER' light is connected to the panel's power supply, and will show that the panel is powered on.

The 'ARMED' light indicates that the system is armed for a sensor event OR demand response event. Once the Key Switch is in the ARM position, the ZDR is always available for a Demand Response Event. This 'ARMED' light will be ON solid if the key switch is set to the 'ARM' position, **and** the ZDR is monitoring a sensor. The light will PULSE once every 2 seconds when the key switch is set to the 'ARM' position, but the ZDR is **not** monitoring a sensor. When an event ends, and a Manual Reset is required to restore the ZDR, the 'ARMED' light will PULSE every 1 second while the 'EVENT' light remains on. Pressing the 'EXIT' button executes the Manual Reset, restoring the unit to a state determined by the Key Switch.

The 'EVENT' light indicates that a sensor or DR event is in progress. It will switch off when the relays switch off at the end of an event. When an event ends, and a Manual Reset is required to restore the ZDR, the armed light will PULSE every 1 second while the Event light remains on. Pressing the EXIT button executes the Manual Reset.

To "Opt Out" of any event, Press the EXIT button and switch the key to the DISARM position. This forces the relays back to the reset position. Alternatively, use the remote Opt Out function available through the gateway to achieve the same thing. Both the Armed and Event lights will FLASH every second until there are no events active on the ZDR.

Amber LED	Red LED	Description	Diagram
Off	Off	The system is disarmed with the Key Switch and is not available for either Event Or Demand Response programs	

Off	Flashing	The system is disarmed, but would trigger an Event Response if Armed. The system must have a Sensor configured for Event Monitoring for this status to arise.	
Flash every 2 seconds	Off	The system is armed but is only available for Demand Response Programs, No Sensor is configured for Event Monitoring	
On	Off	The system is fully armed and is monitoring a sensor for an Event program and is available for Demand Response.	
On	On	The system has triggered either an Event Response and/or Demand Response	
Flashing	On	All Event Response and Demand Response events have ended, but a manual Exit is required. Press the EXIT button.	
Flashing	Flashing	The system has been Opted Out of an event. The system waits for the Event to end before returning to a state specified by the key switch and other internal settings.	

Demand Response Logic

This section describes the various states the ZDR can be in, and how it moves between them taking the various inputs and outputs into account.

Rules Engine

The table below lists all the states the ZDR can be in. Having the relay in the 'ON' position means that it's in an asserted position, as would happen during a sensor or demand response event.

Key Switch	DR In Progress	Event Monitoring	Event In Progress	Event Over	Opt Out	Manual Exit	ARMED light	EVENT Light	Relay
DISARM	-	No	No	-	-	-	OFF	OFF	OFF

DISARM	-	No	Yes	-	-	-	OFF	PULSING	OFF
ARM	No	No	-	-	-	-	PULSING	OFF	OFF
ARM	Yes	No	-	-	-	-	OFF	ON	ON
ARM	Yes	No	-	-	Yes	-	PULSING	PULSING	OFF
ARM	-	Yes	No	No	-	-	ON	OFF	OFF
ARM	-	Yes	Yes	No	-	-	ON	ON	ON
ARM	-	Yes	No	Yes	-	No	ON	OFF	OFF
ARM	-	Yes	No	Yes	-	Yes	PULSING	ON	ON
ARM	-	Yes	-	-	Yes	-	PULSING	PULSING	OFF

Remote Management

It is possible to manage all aspects of the ZDR remotely from a Network Operations Centre, for initial setup, ongoing operation, maintenance and troubleshooting. The following section describes the features available for remotely managing ZDR installations.

Gateway API

EpiSensor's Gateway has a RESTful API which can be used to send commands to the ZDR node, change settings and query data.

For more detailed information on the Gateway API, and the functionality available, please refer to the Gateway API User Guide (EpiSensor Document Ref. No. EPI-009-10)

Firmware Updates

The firmware of the ZDR can be updated both locally (via a serial communications cable) and over-the-air via the ZigBee wireless network.

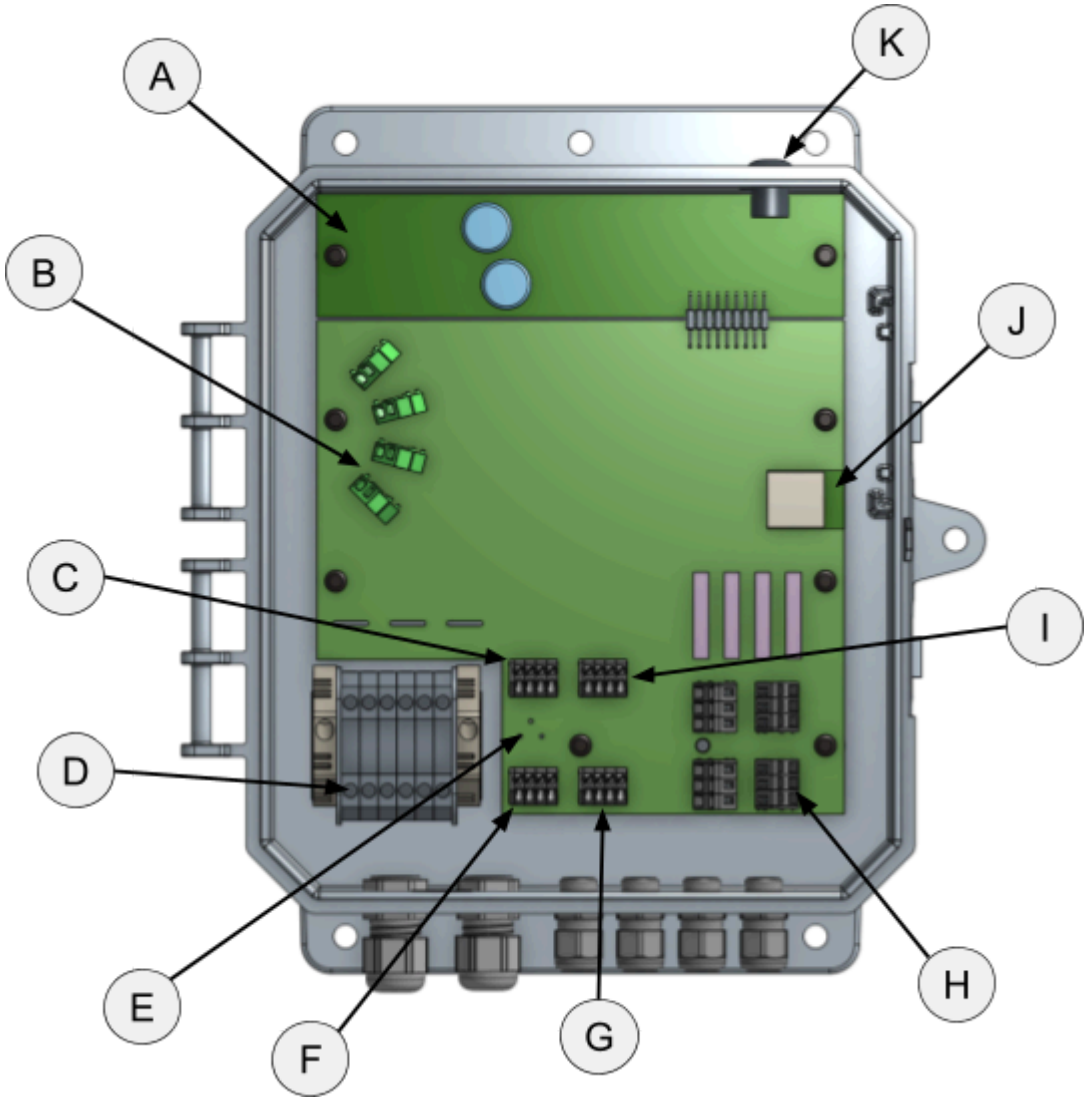
Important Note	
	All parts of the circuit within the enclosure must be considered to be at dangerously high mains voltage when the unit is connected to a mains voltage source.

For detailed instructions on updating the ZDR (and other EpiSensor nodes) over-the-air please refer to the document “How to Bootload on a Live Gateway” (EpiSensor Document Ref. EPI-064-00).

For additional advice and support, please email support@episensor.com

Hardware Features

This section has an overview of the various features / components of the ZDR. For more detailed information on any part, please email support@episensor.com



Function	Description
A	Mains power supply
B	Voltage Reference Terminals

C	Front Panel Interface (Indicator LED's)
D	Current Transformer Terminals
E	Modbus Terminals
F	Front Panel Interface (Key Switch and Push Button)
G	Dual Pulse Input Terminals
H	Relay Terminals
I	Dual 4-20mA Terminals
J	ZigBee Wireless Module
K	Mode Button & Status LED

Power Supply

There is an on-board mains power supply in the ZDR that provides 12V, 5V and 3.3V DC to various parts of the product. This section describes how to connect an AC supply to the ZDR safely, and how to protect the cable and the product.

Power Supply Wiring

The on-board mains power supply in the ZDR is designed to accept a single phase voltage from 85 VAC to 265 VAC at either 50Hz or 60Hz.

Important Safety Note

The ZDR should be connected via a switched junction box and breaker to protect the cable. Also, please ensure that the live connection is made on the same circuit as the neutral connection where residual-current devices (RCD's) are used.

Installation should only be carried out only by personnel qualified in the installation of electrical equipment. All parts of the circuit within the enclosure must be considered to be at dangerously high mains voltage when the unit is connected to a mains voltage source.

The power consumption of the ZDR at full load is less than 10 Watts. 1.5mm^2 single phase mains cable rated at 600 Volts should be used to make the connection.

Please refer to the document "Mains Power Supply, Voltage References & Current Transformers" (EpiSensor Document Ref. No. EPI-065-00) for detailed wiring instructions.

It is possible to use the same mains supply for the voltage reference and to power the ZDR by looping one phase of the 3-phase supply between the voltage reference terminals (Function “B” above) and the mains power supply terminals (Function “A”).

However, care should be taken, particularly for Demand Response applications, that the power supply is constant and won’t be interrupted during a DR event - as this would affect the operation of the ZDR.

For more information on the technical specification of the ZDR power supply, please refer to EpiSensor ZDR Datasheet.

Protection

This section will be completed in a future release of the user guide. Information to be included:

The power supply unit is built from the latest high efficiency switch mode technology which can operate over an ultra wide voltage range from 85 to 460VAC. It can also be operated from a DC supply. It does not use opto isolators, which was a weakness in older designs. It uses synchronous rectification in the secondary to achieve the highest efficiency levels, which in turn keeps the temperature low. It has multiple layers of protection including:

- Supply over-voltage protection
- Under voltage protection
- Protection from large in-rush currents
- Protection from surges
- Secondary over voltage protection
- Short circuit and overload protection
- Automatic recovery from temporary overload
- PSU over-temperature protection
- Safety isolation to CAT II 600V

Power is distributed to various functional blocks throughout the system with further protection and isolation to prevent hazardous voltages from leaving the system and from entering the system.

Communications

There are a variety of communication options on the ZDR that are used to configure settings, stream live sensor data and poll 3rd party systems for data. This section describes the communications capability of the ZDR, with information on wiring, configuration and safety considerations.

RS-485 Wiring

The leftmost 3 pins on the bottom of the ZDR are reserved for RS485 communications. From left to right, the signals are B, A and GND.

Label	Also Called	Also Called
A	RS485+	D1
B	RS485-	D0
GND	Earth	Ground

On long cable runs, a 120R terminating resistor is required at both ends across the A and B wires. Individual drops do not need terminating resistors.

The cable should be a shielded twisted pair with the shield at one end connected to Earth / Ground. If the system is earthed away from the ZDR, then the GND wire should not be connected to the ZDR.

The RS485 multidrop network is limited to 32 devices per network.

RS485 is popular for inexpensive local networks, multidrop communication links and long haul data transfer over distances of up to 4,000 feet. However, the achievable distance is a function of the cable. The longer the cable, the greater the attenuation. Because attenuation increases with frequency, cables also exhibit a lowpass filter behaviour so that achievable distance diminishes with data rate.

The communications parameters are configured using the Gateway UI or the API. Because Modbus is the only protocol implemented on the RS485 network, and Modbus always uses 8 data bits, the number of databits are not configurable. The Baud Rate, Stop Bits and Parity are all configurable through the Gateway. All Slaves connected to the ZDR must use the same communications parameters, and all slaves must use a unique Slave Address on the Network.

Modbus

The ZDR implements Modbus RTU on the RS485 network. Modbus RTU allows up to 255 Slave addresses but because of the RS485 limitation, there should be a max of 32 nodes on the multi-drop network. However, the address range of 0-255 can still be implemented, provided the are a maximum of 32 physical nodes.

The ZDR implements Modbus Master. There should only be one Modbus Master (Modbus Client) on the Modbus RTU network. Therefore all other nodes on the network are Modbus Slaves (or Modbus Servers).

The simplest method to configure a Modbus Slave that is connected to the ZDR is to use a “Node Profile”. Once a specific set of slave addresses, register addresses, register types, lengths etc have all been configured and are reporting correctly, the configuration from that node can be saved as a Node Profile. This Node Profile can then be uploaded to any Gateway and applied to other ZDR nodes.

The ZDR supports a number of Modbus functions;

- Read Coil 0x01
- Read Discrete Input 0x02
- Read Holding Register 0x03
- Read Input Register 0x04
- Write Coil 0x05
- Write Single Register 0x06

- Write Multiple Coils 0x0F
- Write Multiple Registers 0x10

For each of these functions, the corresponding Properties must be configured allowing the ZDR to interpret and report the data in a meaningful format. The complete list of Modbus Properties are;

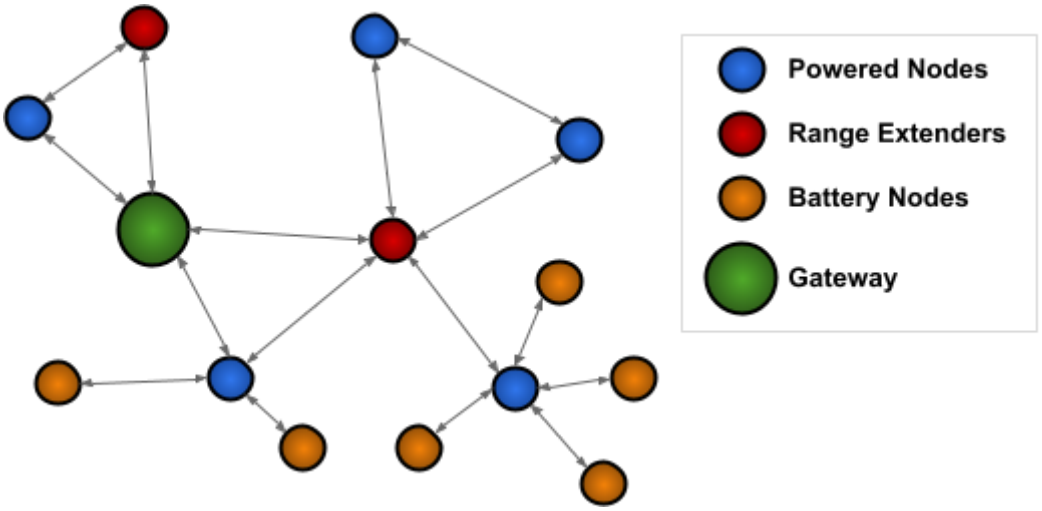
Property ID	Setting	Description	Unit	Resolution	Reporting	Default	Read/Write
6400	**Modbus Address**	The Slave Address of the unit on the RS485 Network	-	-	-	0	Read/Write
6401	**Register Address**	The Register Address on the Slave. This is zero based so may be 1 less than the Register address listed in any Slave device documentation	-	-	-	0000	Read/Write
6408	**Read Function**	The Modbus Read Fucntion for this Sensor ID. There may be none!	-	-	-	0x00	Read/Write
6409	**Write Function**	The Modbus Write Function for this Sensor ID. There may be none!	-	-	-	0x00	Read/Write
6404	**Register Count**	1 or 2. 1 Register is 16bits, 2 Registers are 32 bits	-	-	-	1	Read/Write
6407	**Register Signed Type**	Is the value returned a signed or unsigned value	-	-	-	False	Read/Write
6403	**Register Float Type**	Is the value returned a 32 bit Floating point number as defined by IEEE 754	-	-	-	False	Read/Write
6402	**Bit Position**	The position in the returned register for “Coil” type reads/writes	-	-	-	0	Read/Write
6405	**Register Byte Swap**	Swap the Byte order in a 16 or 32 bit value	-	-	-	False	Read/Write
6406	**Register Word Swap**	Swap the Word order in a 32 bit value	-	-	-	False	Read/Write

Error codes from Modbus are detected by the ZDR but are currently not reported to the Gateway.

Wireless Communications

All EpiSensor products use IEEE 802.15.4 ZigBee Pro for wireless communications operating at 2.4GHz. This is a secure, scalable mesh networking communications protocol designed for transmitting small amounts of data reliably, and at low power levels.

There are two types of nodes in the EpiSensor wireless mesh network: powered nodes and battery nodes. Powered nodes on the wireless sensor network are capable of routing data from any other type of wireless nodes.



Range extenders are powered nodes where the main function is to route data. Any node with a mains power supply will act as a routing node in the network. Battery nodes do not route data – they spend most of the time in a low power mode.

Each powered node can have up to 32 ‘neighbours’ which are nodes with a mains power supply and can Route data back to the Gateway. They can also have up to 32 ‘children’ which are nodes that are battery powered and cannot participate in any routing in the network.

The range that can be achieved with ZigBee will depend mainly on two factors: the power level of the ZigBee radio module and the environment that the device is installed in. There are two types of ZigBee radio module used across the EpiSensor product range, a power amplified version, and non-power amplified version.

The power output of nodes with a power-amplified module can be configured with an output power level of +20 dBm depending on the region they are deployed in. Non-power amplified nodes have a maximum output power of +8 dBm.

Module Type	Tx Power	Rx Sensitivity	LoS Range	Region(s)
Normal	+8 dBm	-101 dBm	up to 300m (985ft)	Worldwide
Power-amplified	+20 dBm	-106 dBm	up to 1600m (5250ft)	North America (FCC / IC)

All communications over the ZigBee wireless network is AES 128-bit encrypted. For more detailed information on ZigBee security features, contact EpiSensor support.

Electricity Metering

The ZDR has an accurate, on-board three phase metering functionality. This section describes the capability of the metering subsystem, with information on how to connect voltage references and current transformers.

Electricity Metering

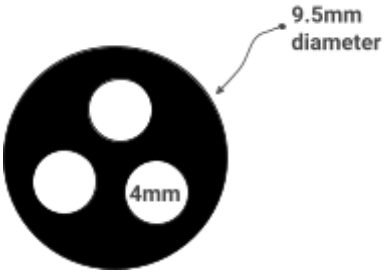
This section will be completed in a future release of the user guide. Information to be included:

- Additional information regarding the on-board 3-phase metering capability on the ZDR
- How frequency, power consumption and other parameters are measured
- Accuracy and other meter specifications

Current Transformers

The ZDR supports current transformers with a standard 5A or 1A output. Versions of the ZDR that support CT's with this output will be fitted with 'shorting' terminals suitable for conductor diameters of up to 4mm^2.

There is a single M25 gland on the ZDR enclosure with a rubber bushing to support three individual (round) cables of up to 4mm diameter.



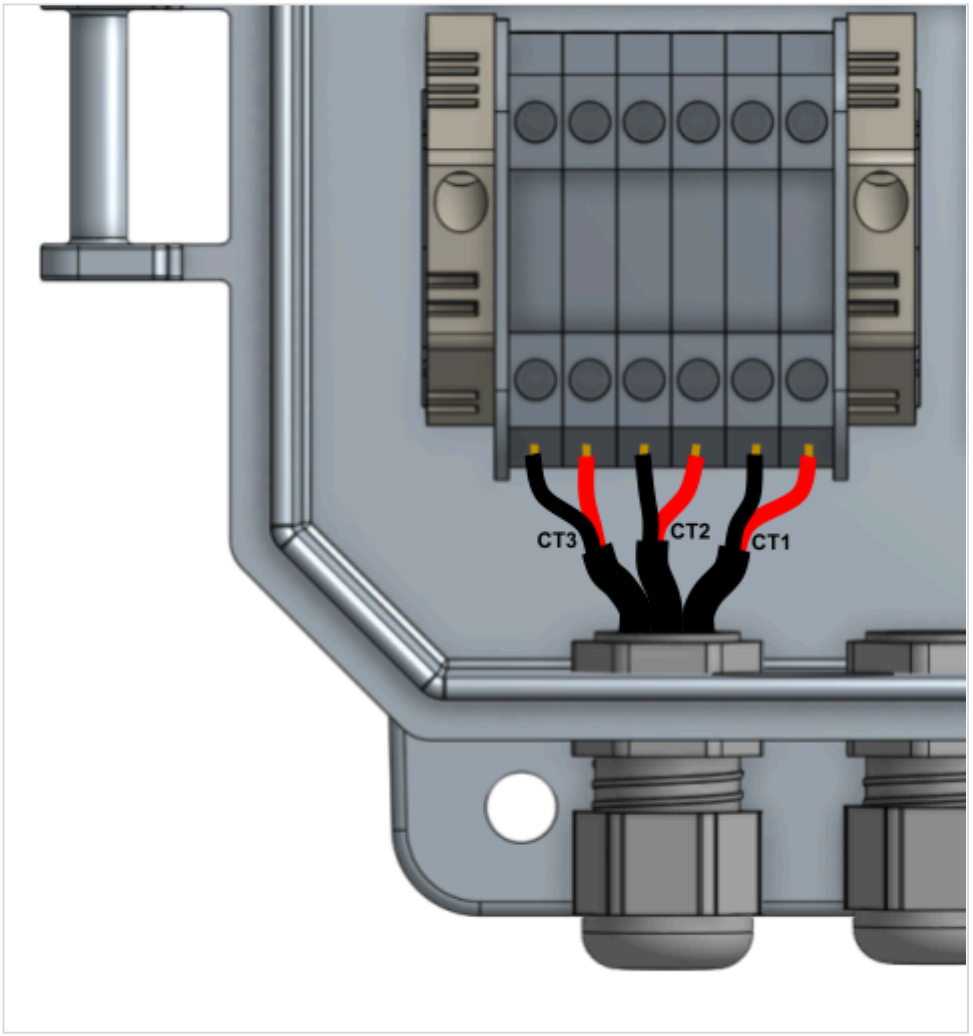
Important Safety Note

The secondary of a current transformer should never be left open-circuit. Doing so can generate dangerously high voltages and cause serious personal injury or death.

The Current inputs to the electricity metering section can have scaling factors applied. This is most useful in situations where there's a 1A or 5A CT already in place for monitoring current.

The scaling factor is input to the ZDR-10 using the "CT Ratio" property on the Node Settings page on the Gateway. All ratios are X:1. For example, when the CT Ratio is 100A → 5A, then set the CT Ratio on the Node Settings page to 20:1.

The Ratio that is applied to the current channels, is also applied to the Power and kWh calculators in the energy metering system. Setting the Ratio then effectively adjusts all calibration factors within the energy metering system

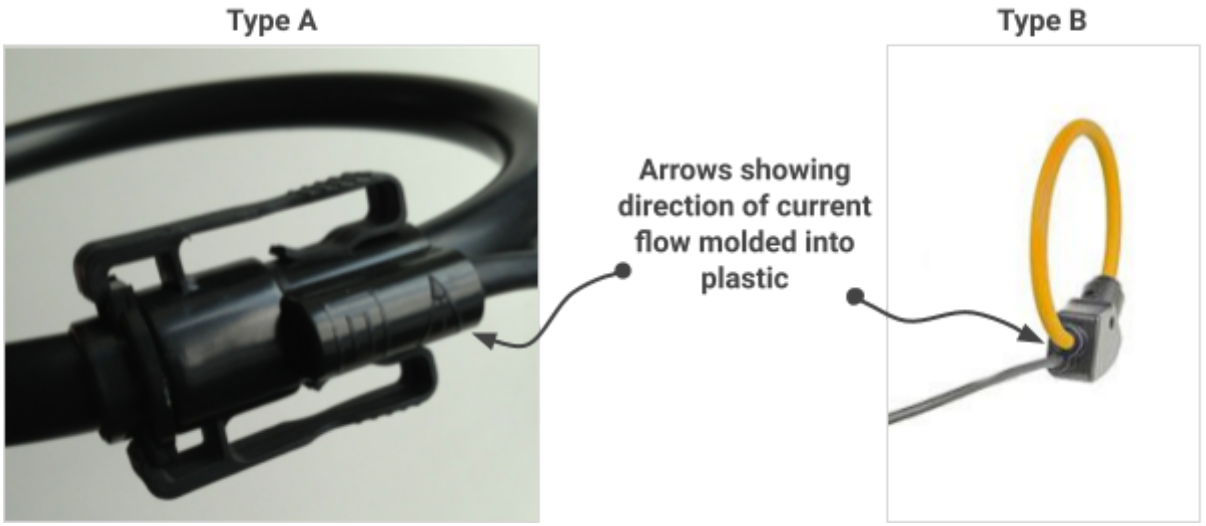


Wiring Diagram for Current Transformer Inputs (showing terminal block for 1A / 5A CT's)

Rogowski Coils

Rogowski coils (sometimes referred to as flexible CT's) are supported natively on the ZDR. They are easy to install, particularly in situations where there are multiple conductors per phase, or when the conductor size is not known in advance of starting the installation.

Arrows indicating the direction of current flow should be moulded into the plastic of the Rogowski coils as shown below, in slightly different locations depending on the coil type.



Type	Inner Diameter	Minimum Current	Maximum Current	Working Voltage
A	120mm	10A	1000A	CAT III-1000V or CAT IV-600V
B	80mm	10A	1000A	CAT III-1000V or CAT IV-600V

Important Note

Milliamp CT's & Rogowski Coils supplied with the ZDR are factory calibrated and are not interchangeable – reading accuracy may be compromised if they are mixed up or replaced on site.

Supported 3-phase configurations

The 3-phase configurations supported by the ZDR are as follows:

Ansi Meter Form	Configuration
9S/16S	4-wire wye
5S/13S	3-wire delta
6S/14S	4-wire wye
8S/15S	4-wire delta

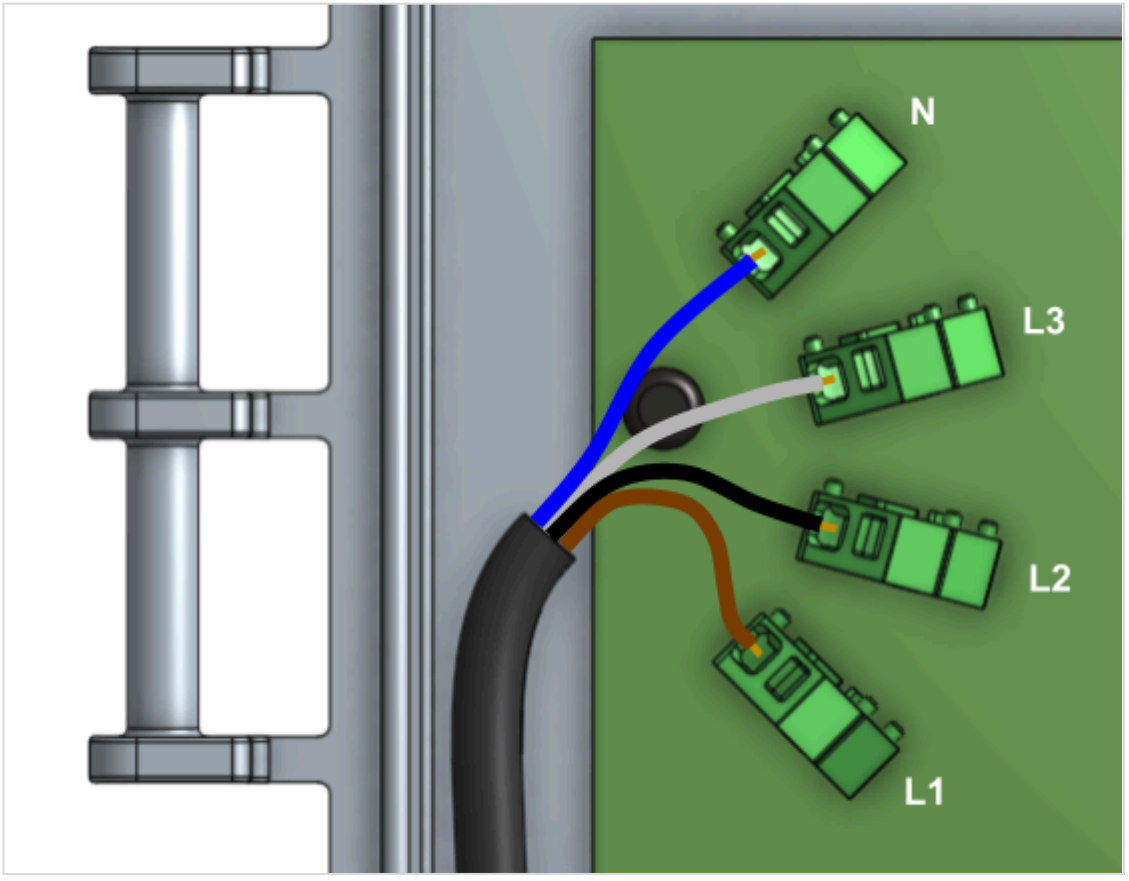
For more information on how to connect Current Transformers and the voltage references for each configuration, please consult the install sheet for the ZDR.

Voltage Reference

The Voltage inputs to the electricity metering section can have a scaling factor applied. This is most useful in situations where the voltage being monitored is stepped down with a VT such as when an MV system is stepped from 11,000V to 110V with a 100 to 1 ratio.

The scaling factors are input to the ZDR-10 using the “VT Ratio” property on the Node Settings page on the Gateway. All ratios are X:1.

The Ratio that is applied to the voltage channels, are also applied to the Power and kWh calculators in the energy metering system. Setting these Ratios then effectively adjusts all calibration factors within the energy metering system



Wiring Diagram for Mains Voltage References

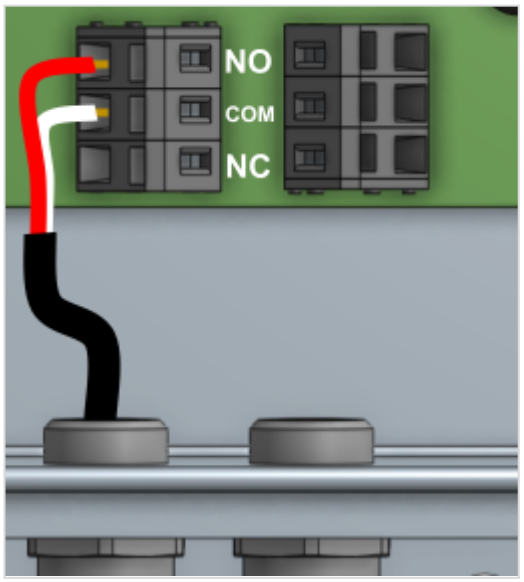
Important Note
The kilowatt hour registers on the ZDR will roll over at a value of 21,474,836 kWh. Software packages should be configured to compensate for this threshold being crossed.

Switch Output

This section of the document has information on the switching capability of the ZDR. The ZDR's relays can be controlled either remotely with a command / API request, or based on demand response logic (like line frequency crossing a set point).

Relays

There are 4 separate relay channels available on the ZDR, each one having a 'normally open' and 'normally closed' connection option. For additional technical information on the relays, like rated voltages, currents, and type - please check the ZDR datasheet.



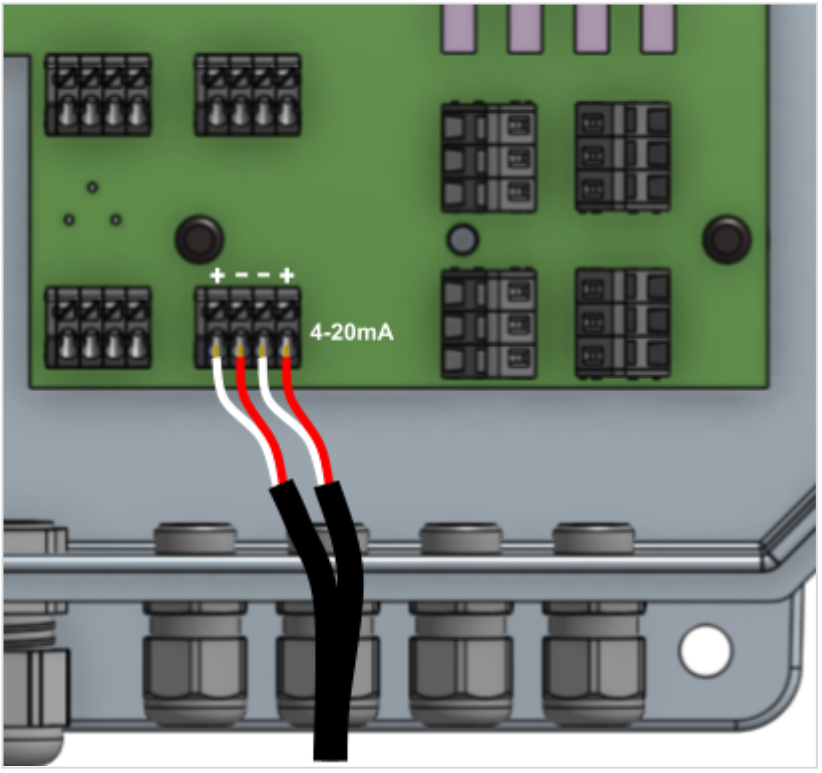
Wiring Diagram for Relay Outputs

Analogue Inputs

ZDR has two separate analogue inputs available, suitable for monitoring 0-20mA current loop signals. This section has information on the specification of these inputs, and instructions for connecting them to external systems and sensors.

4-20mA current loop inputs

The diagram below shows two 4-20mA current inputs connected to terminals on the ZDR's main circuit board. For additional technical information on rated voltages, resolution, etc. please consult the ZDR datasheet.



Wiring Diagram for 4-20mA Inputs

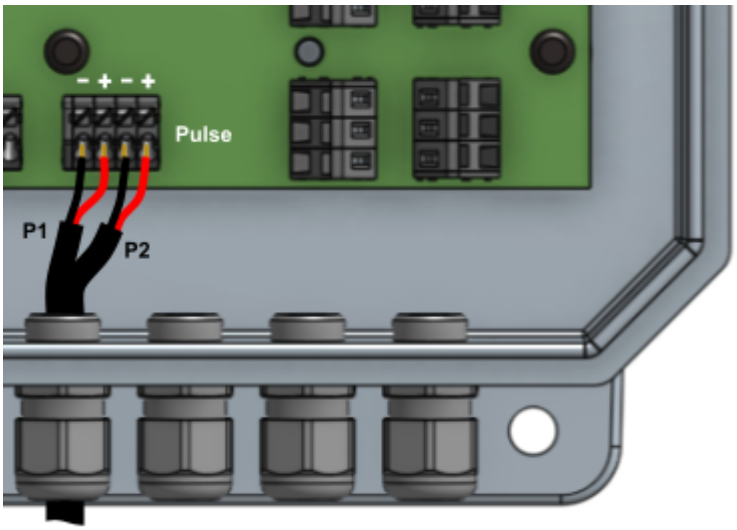
Digital Inputs

There are two digital (pulse) inputs available on the ZDR. This section has information on the types of pulse inputs that the ZDR can accept and their operating limits.

Pulse Info

For additional technical information on the pulse inputs of the ZDR, please consult the product datasheet. This section will be completed in a future release of the user guide. Information to be included:

- Max voltage
- Max frequency
- How debounce is handled
- Supported pulse types: Active vs. dry vs. open collector
- Types of wires that should be used (e.g. no figure 8)



Wiring Diagram for Pulse Inputs

Pulse Operation

This section describes the operation of the 3 different pulse types.

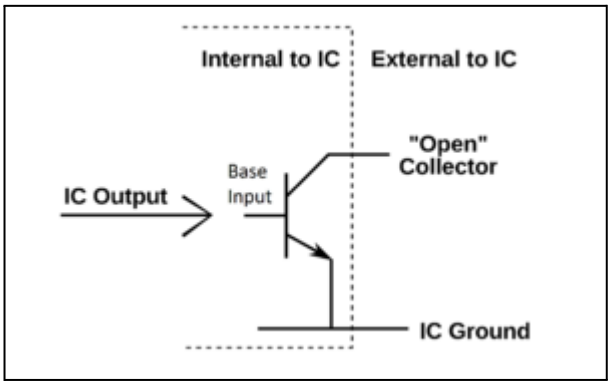
Dry Pulse

A dry pulse can be thought of as a simple switch. Window alarm contacts or reed switches would be examples of such a connection. In this configuration, a small voltage is applied to the + terminal of the IN connector. A pulse is detected when this signal is connected to the negative (–) terminal of the IN connector.

The selector grid for Dry Pulse should be on the “DP” setting.

Open Collector Pulse

An Open Collector pulse is generally used by electronic meters. The diagram below is an example of such a Pulse.



Schematic diagram of an open collector pulse output

When the Integrated Circuit (IC) Output is pulsed, the signal on the “Open Collector” gets connected to the IC’s Ground. This system is polarity sensitive. The Open Collector connection must be connected to the positive (+) terminal of the IN connector and IC Ground must be connected to the negative (–) terminal of the IN connector.

As the Open Collector is simply an electronic switch, the selector grid for the Open Collector Pulse should be on the “DP” setting.

Active Pulse

An active pulse occurs when the system generating the pulse applies a positive DC voltage for a short period of time. This system is polarity sensitive. The Pulse Generator and ZDR units share a common Ground on the negative (–) terminal of the IN connector. The positive DC voltage representing the pulse must be connected to the positive (+) terminal of the IN connector.

Important Note
The Active Pulse Voltage on the ZDR should not exceed 40 Volts!

Mechanical

This section describes how to wall-mount the ZDR enclosure, the enclosure materials and important safety considerations when connecting the ZDR to external systems.

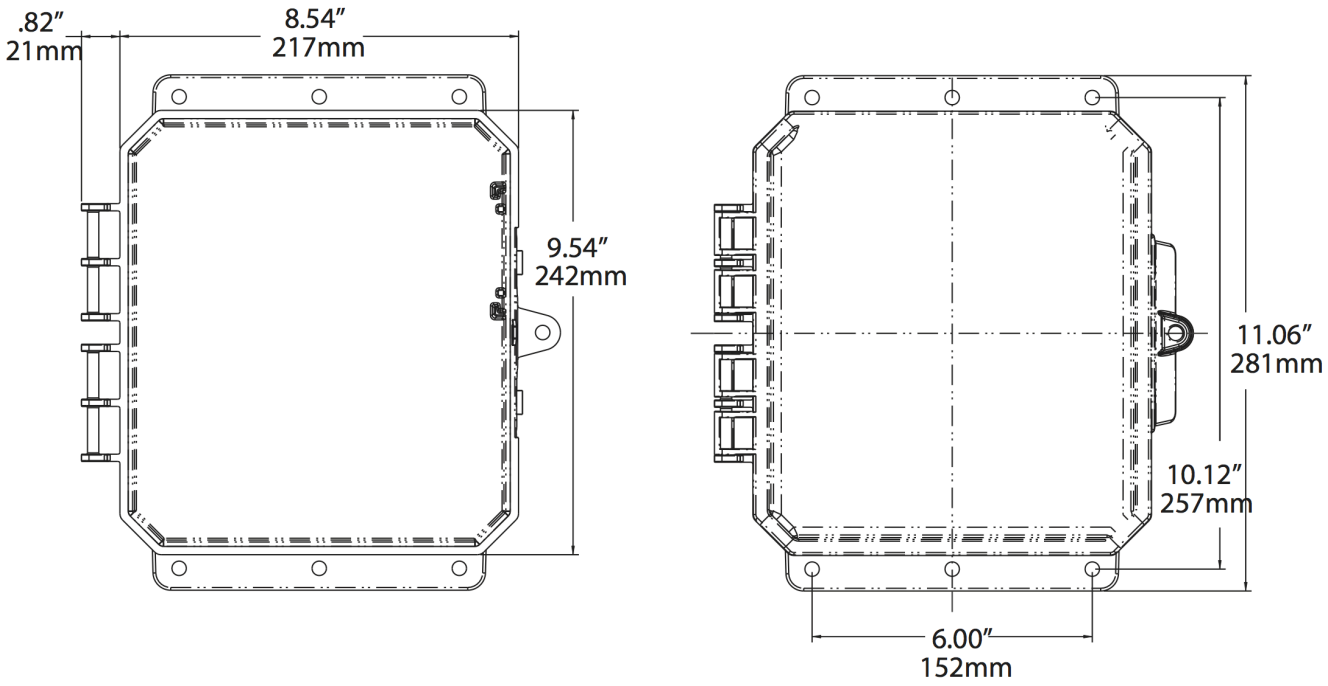
Enclosure & Label Material

The ZDR is housed in an IP67 water and dust proof enclosure to provide maximum safety, flexibility and reliability. The enclosure material is polycarbonate plastic, which is resistant to a variety of chemicals, oils and detergents.

The front label (which may vary depending on the model of the ZDR and the partner) is made from PVC. The serial number label is made from polyethylene film.

Mounting Instructions

The ZDR has 6 holes for mounting shown on the diagram below. These screws can be preinstalled on a vertical surface spaced 257 mm apart. The head of the screw should be greater than 8 mm in diameter and the screw thickness should be less than 6 mm.



Important Safety Note

The enclosure of the ZDR must not be drilled, cut or modified in any way for mounting or connecting to external systems.

All parts of the circuit within the enclosure must be considered to be at dangerously high mains voltage when the unit is connected to a mains voltage source. Modifying the enclosure could expose parts of the system to users, or cause an internal fault or short circuit.

There are no user-serviceable parts inside the ZDR enclosure, and it should always be isolated from mains voltages before opening the enclosure lid.

Opening the Enclosure

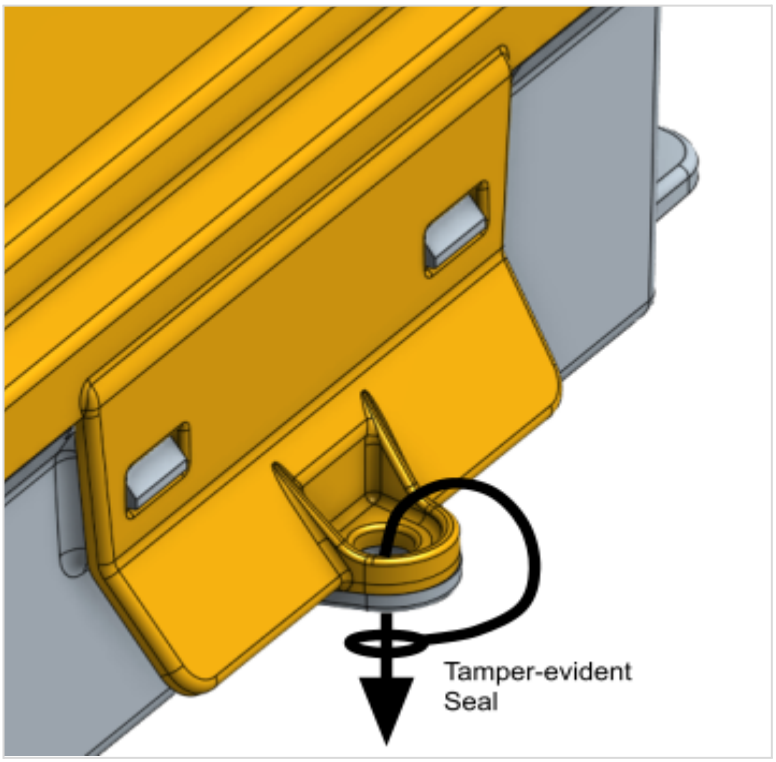
To make connections to the ZDR, it is necessary to open the lid of the enclosure. This is fastened with a latch on the right hand side of the lid. This should only be done by qualified personnel, and only when the ZDR has been isolated from any high voltage supplies. Please consult the safety notes at the start of this user guide for more information.

Important Safety Note
 EpiSensor equipment should be installed, operated, serviced and maintained only by qualified personnel. There are no user-serviceable parts inside the ZDR enclosure, and it should always be isolated from mains voltages before opening the enclosure lid.

When closing the lid, take care to ensure that no wires or cable ties are obstructing the gasket of the enclosure.

Tamper Evident Seals

Some applications (particularly applications where data is used for billing purposes) will require tamper evident seals to be attached to the ZDR enclosure. These seals can easily be attached to the clamp on the right hand side of the ZDR enclosure, as shown on the diagram below.



An example of a suitable tamper-evident seal is as follows:

Image	Parameter	Description
	Manufacturer	ACME Seals Limited
	SKU	NPX30
	Body Material	Polypropylene
	Insert Material	Spring Stainless Steel
	Ribbon Diameter	2mm
	Average Breaking Strength	15kg

Compliance Label

There is a compliance label on the back of the ZDR enclosure that has important regulatory and node identification information.

The label material is gloss white PVC foil with permanent adhesive and gloss overlaminate. The following table lists the certification and safety symbols that appear on the certification labels of EpiSensor products. Please refer to it for a definition of each symbol.

Symbol	Name	Description
	**CE Mark**	This marking certifies that a product has met EU consumer safety, health or environmental requirements.
	**WEEE Symbol**	The directive imposes the responsibility for the disposal of waste electrical and electronic equipment on the manufacturers of such equipment.
	**Class II IEC Protection**	This certifies that this product has been designed in such a way that it does not require a safety connection to electrical earth/ground.
CAT III (480V)	**Overvoltage Category**	Describes where within an electrical system the product can be connected. CAT III means that the device can be connected to a three phase mains distribution board within a building. For more information, see standard IEC 61010-1.
	**IP / NEMA Rating**	Water and dust ingress protection standard. IP67 / NEMA 4 means complete protection against contact with dust, and protected from ingress of water when immersed in up to 1 metre depth for up to 30 minutes. For more information, see IEC 60529.
	**RoHS Directive**	Restriction of Hazardous Substances Directive restricts (with exceptions) the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment.
	**Safety Alert**	This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.
	**Danger / Warning**	The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.
	**Electrostatic Sensitive Device**	This symbol notes that Electrostatic discharge (ESD) events can harm electronic components inside this product. Protect against ESD and discharge static electricity from your body before you interact with this product.

EpiSensor products are not suitable or specifically designed, manufactured or licensed for use in military, aviation, powerplant, medical or in other inherently dangerous or safety critical applications.

Ordering Information

EpiSensor products are available to order directly or via EpiSensor's distribution partners. The following tables describe the product code structure and list the available ZDR options.

	Product Code Example:	ZDR -	16 -	r1k
Product Line	**ZDR:** Wireless Demand Response Controller			
Version	**10:** Version 1.0 **15:** Version 1.5 **16:** Version 1.6			
CT Current Rating	**120:** 120A per-phase, 16mm aperture, split-core mA CT's **r1k:** 1000A per-phase, flexible Rogowski coil CT's **r3k:** 1000A per-phase, flexible Rogowski coil CT's **1A:** suitable for 5A output current transformers, no CT's included **5A:** suitable for 5A output current transformers, no CT's included **MCT:** mini CT's for monitoring the secondary output of existing 1A or 5A CT's			

SKU	Description
ZDR-16-120	120A per-phase, 16mm aperture, split-core mA CT's
ZDR-16-r1k	1000A per-phase, flexible Rogowski coil CT's
ZDR-16-r3k	3000A per-phase, flexible Rogowski coil CT's
ZDR-16-1A	Suitable for 1A output current transformers, no CT's
ZDR-16-5A	Suitable for 5A output current transformers, no CT's
ZDR-16-mCT	Mini CT's designed for monitoring the secondary output of an existing current transformer
ZDR-17-mCT	Battery / UPS Control firmware w/ Modbus, mini-CT's

Accessories & Add-Ons

SKU	Description
ZDR-16-FP	Front panel user interface for ZDR with keyswitch, status LEDs, local event override
ZDR-16-420mA	Dual channel 4-20mA inputs for ZDR (note: must be ordered with ZDR-16)
ZDR-16-PULSE	Dual channel pulse inputs, up to 40Hz (note: must be ordered with ZDR-16)
ZDR-16-MOD	Modbus RTU for ZDR, max 4 Modbus slaves (note: must be ordered with ZDR-16)
ZDR-16-HSDM	High Speed Data Module, 20ms data recording capability, GPS time sync, U.FL connector

Troubleshooting & Support

If you are experiencing problems with the ZDR or any other part of your EpiSensor system, or you notice something unusual - please contact EpiSensor support at the following email address, phone number or via live chat on our website.

- Email: support@episensor.com
- Tel: +353 61 512 500
- Website: http://episensor.com

For customers and partners who are deploying systems in business-critical environments, there are a number of support packages available that offer a higher level of service and response time. For more information on EpiSensor Premium Support, visit: http://episensor.com/premium-support/

Address: EpiSensor Ltd. Georges Quay House, Georges Quay, Limerick, V94 YW9T, Ireland

Warranty

All EpiSensor products and provided with a 365 day limited warranty effective from the shipping/invoice date of an order. During the warranty period, under the conditions of normal use, EpiSensor will repair or replace any product that has a manufacturing defect.

Warranty can be extended by up to 4 years within 30 days of a purchase. For more information on warranty, visit: http://episensor.com/warranty/

Glossary

Definitions for terms and abbreviations used in this document are listed in the following table:

Term	Description
Sensor	Describes a feed of data within the EpiSensor system
Node	Used to describe a physical EpiSensor product
Gateway	The central computer that managed the EpiSensor system
ZigBee	IEEE 802.15.4 Wireless communications standard that EpiSensor nodes use
WSN	Wireless Sensor Network
CT	Current Transformer
Rogowski Coil	Large flexible current transducer typically used for measuring high currents

AC	Alternating Current
Reporting Mode	Defines how an EpiSensor node should report data to the Gateway
Reporting Interval	The length of time between each data point produced by a node
Snap to Clock	Reporting mode where data is ‘snapped’ to the nearest 1 minute / 5 minute / 15 minute interval etc.
Interval and Delta	Reporting mode where data is produced when the reporting interval has elapsed, unless a change is detected
Allow join mode	A mode that can be enabled on the Gateway that allows new wireless nodes to join