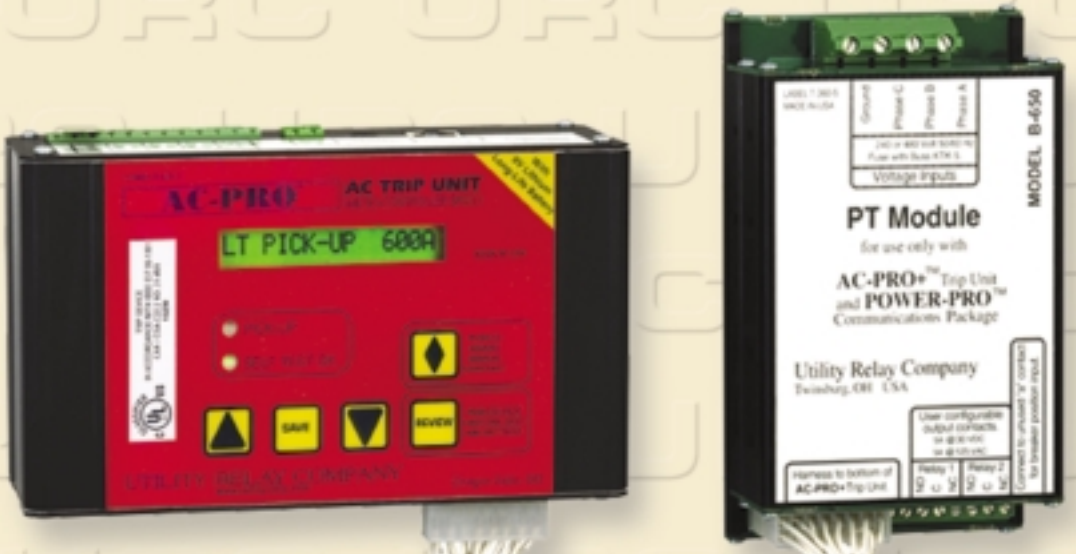
COMMUNICATIONS

I-COMM MANUAL | MODBUS / RS-485



AC-PRO Communicating Trip Units

INSTRUCTION MANUAL

ZERO-Hertz Communicating Trip Units

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1.0 Introduction

Creating a complete power monitoring and communications system for a low voltage power distribution systems is easy with Utility Relay Company's AC-PRO+ and ZERO-Hertz communicating trip unit. The trip units communicate using industry standard MODBUS protocol through a single shielded twisted pair wire connected to the RS-485 port. A number of trip units can be daisy-chained together to simplify installation. Information available from an AC-PRO+ trip unit at each breaker includes:

- ?? Currents, 3-phase
- ?? Voltages, 3-phase
- ?? KW, 3-phase
- ?? KWH, Total
- ?? KVA, 3-phase
- ?? Power Factor Data
- ?? Breaker Position
- ?? Overload and Alarm Conditions
- ?? Last Trip Data
- ?? Phase Currents at the Time of Trip
- ?? Trip Counter

Information available from a ZERO-Hertz trip unit at each breaker includes:

- ?? DC Current
- ?? Ground Fault Current (if applicable)
- ?? Current Direction
- ?? Overload and Alarm Conditions
- ?? Last Trip Data
- ?? Trip Current at the Time of Trip
- ?? Trip Counter

A host PC running a MODBUS DDE driver collects information from the trip units. The driver interrogates each trip unit individually and reports that information back to the host PC on a continual basis. Additional trip units can be added to the system by simply providing the new trip unit's ADDRESS to the MODBUS DDE driver.

AC-PRO+ and ZERO-Hertz trip units are compatible with the MODBUS drivers supplied with most MMI systems such as Wonderware's *INTOUCH*™, *Intellution*™, Square D's *PowerLogic SMS-3000*™, and Power Measurements *PEGASYS*™.

2.0 AC-PRO+ Comm Components

An AC-PRO+ MODBUS Communications system consists of the following hardware components:

1. AC-PRO+ Trip Unit and breaker retrofit components.
2. Host PC (supplied by others).
3. Cabling Topology (supplied by others).

Additional considerations include the system software. Software components include:

1. MODBUS DDE Driver (supplied by others).
2. Man-Machine Interface (MMI) System (supplied by others).

2.1 AC-PRO+ Trip Unit

The AC-PRO+ is an enhanced version of the standard AC-PRO trip unit with the addition of power monitoring and communications capability. The AC-PRO+ trip unit contains a communications circuit board, which incorporates an RS-485 port and a PT Module connector; both located on the bottom of the trip unit.

In addition to its power monitoring and communications capability, the AC-PRO+ has all of the protective functions and features of a standard AC-PRO trip unit. Two addition setpoints must be programmed in to the trip unit during commissioning to enable the communications functions. See Section 5.1 Trip Unit Programming.

2.2 PT Module

The PT Module mounts directly on the circuit breaker and connects to the AC-PRO+ via a preassembled wiring harness. In addition to monitoring the individual phase voltages, the PT Module also provides continual power to the AC-PRO+ so that the trip unit can continue to communicate its status even if the breaker is open or not carrying current.

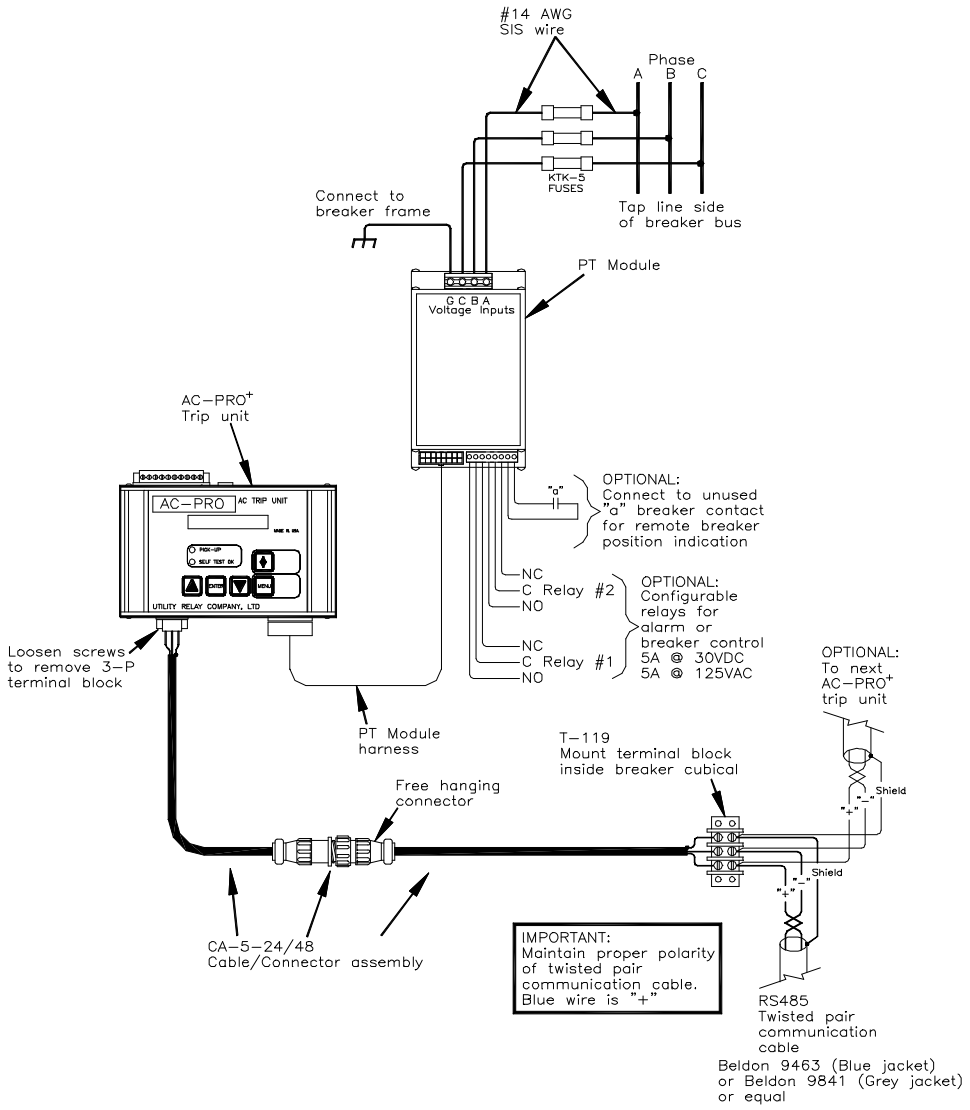
The PT Module also features two addressable relays which can be used to establish a “mini-SCADA system” to control electrical operated breakers from one central PC location.

A PT Module, wiring harness, and mounting hardware are provided with each AC-PRO+ complete retrofit kit.

2.3 AC-PRO+ Breaker Wiring

The AC-PRO+ is provided with a quick disconnect communications cable assembly. The cable assembly features a heavy-duty twist-lock connector and a terminal block, which mounts inside the switchgear.

The purpose of the terminal block is to provide a connection location for the twisted pair wire as it is daisy-chained from cell to cell in a switchgear lineup. This enables any individual AC-PRO+ (mounted on a circuit breaker) to be removed without disrupting communications between the other AC-PRO+ trip units.



3.0 ZERO-Hertz Comm Components

A ZERO-Hertz MODBUS Communications system consists of the following hardware components:

1. ZERO-Hertz Trip Unit and breaker retrofit components.
2. Host PC (supplied by others).
3. Cabling Topology (supplied by others).

Additional considerations include the system software. Software components include:

1. MODBUS DDE Driver (supplied by others).
2. Man-Machine Interface (MMI) System (supplied by others).

3.1 ZERO-Hertz Trip Unit

The ZERO-Hertz trip unit is available in four models:

	Method of DC Current Sensing		
Model Number:	Transducers Only	Transducer or Shunt Input	Communications
B-201	**YES**		
B-202	**YES**		**YES**
B-203		**YES**	
B-204		**YES**	**YES**

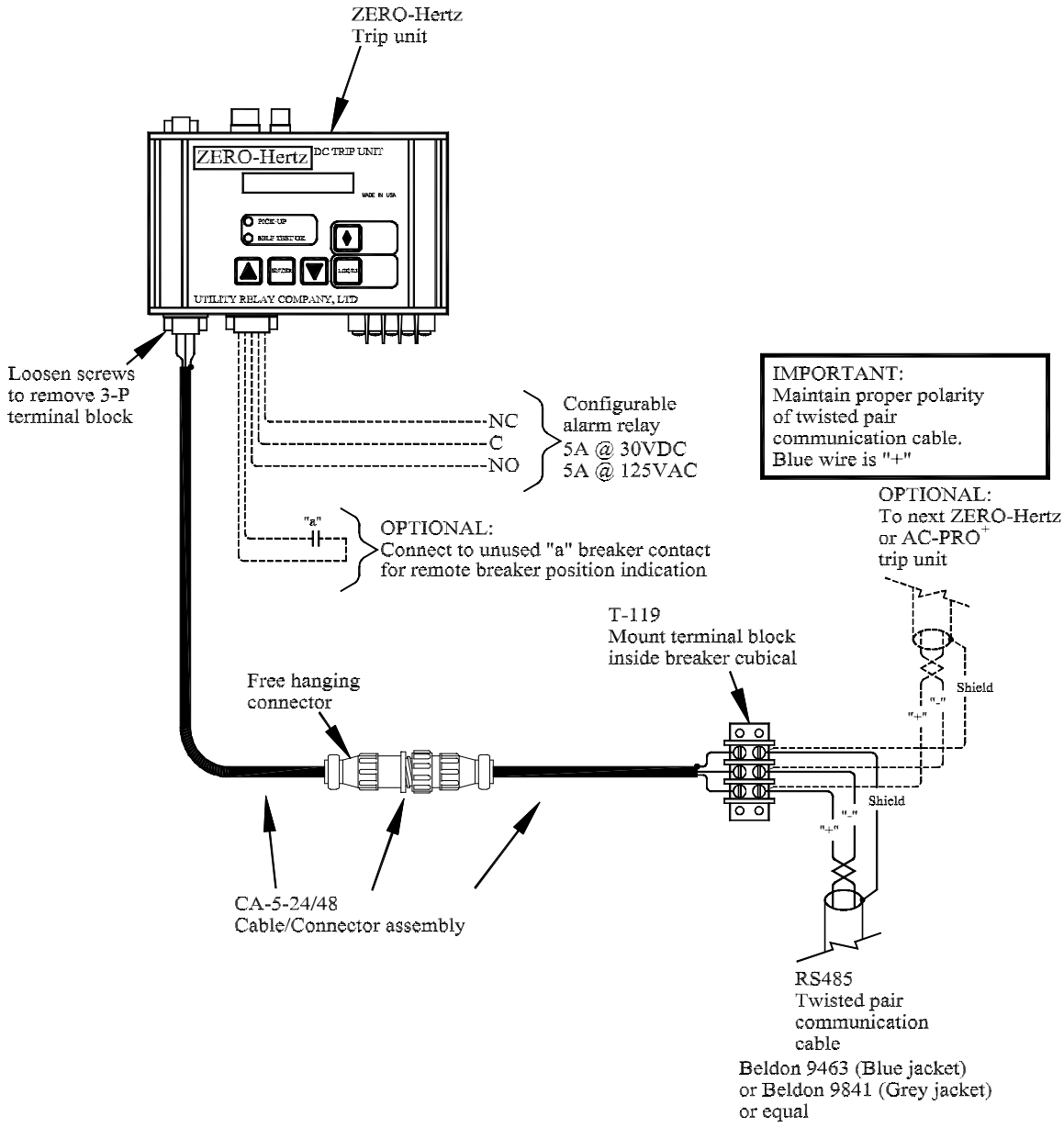
Trip unit models **B-202** and **B-204** are equipped with an RS-485 MODBUS communications port. This port allows the trip unit to communicate with a host PC or other RS-485-based communications system. In addition to its continuous DC current monitoring and communications capability, the ZERO-Hertz has all of the protective functions and features of a non-communicating ZERO-Hertz trip unit.

Two addition setpoints must be programmed in to the trip unit during commissioning to enable the communications functions. See Section 5.1 Trip Unit Programming.

3.2 Breaker Wiring

The ZERO-Hertz is also provided with a quick disconnect communications cable assembly for trip unit models **B-202** and **B-204** equipped with communications. The cable assembly features a heavy-duty twist-lock connector and a terminal block, which mounts inside the switchgear.

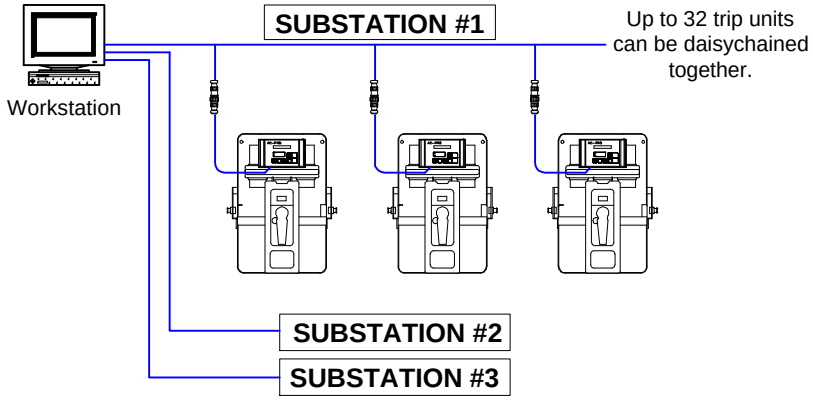
The purpose of the terminal block is to provide a connection location for the twisted pair wire as it is daisy-chained from cell to cell in a switchgear lineup. This enables any individual ZERO-Hertz to be disconnected without disrupting communications between the other trip units.



4.0 System Components - Computer Hardware

4.1 RS-485 Direct

Connecting trip units directly to a PC is an easy way to set up a stand-alone system. The major benefit is that a stand-alone system is that it does not require a large initial investment in hardware. The system can start out small, yet it is flexible enough to allow additional trip units to be added to the system at any time.



As system demands grow, additional twisted pairs of wire can be added, each twisted pair capable of supporting an additional 32 AC-PRO+ or ZERO-Hertz trip units. The host PC can also be connected to a Local Area Network (LAN), allowing other computer sites access to AC-PRO+ information.

Cable requirements:

- ?? Belden 9463 shielded twisted pair (or equivalent) cabling is recommended
- ?? Maximum cable length is 4000 feet.

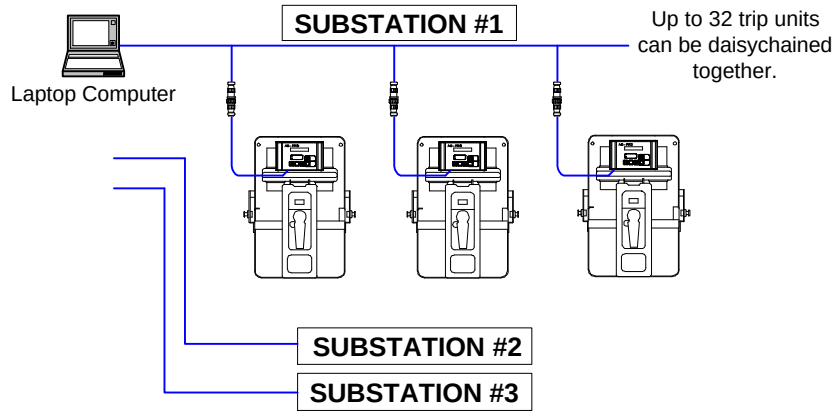
4.2 RS-232 to RS-485 Conversion

RS-232 communications is a convenient method to periodically monitor trip units without incurring the expense of a network. RS-232 to RS-485 converters and hardware are readily available and inexpensive.

Using a Laptop

When continual power monitoring and communications is not necessary, a laptop computer is a very useful tool. A substation can be wired for communications with the communications cable terminating at an inexpensive RS-232 to RS-485 converter located in the substation. When required, a laptop computer can be connected directly to the RS-232 computer for periodic monitoring.

At any time, the RS-232 to RS-485 converter can be removed, and the substation can be connected to a larger power monitoring system with the addition of an LCI or other RS-485 to Ethernet Converter.



RS-232 Converters

Most, if not all, RS-232 to RS-485 converters and boards will have 4 wire connections TX+, TX- RX+, and RX-. The trip units use a 2 wire connection system, so at some convenient point, usually right at the converter or board connector, connect as follows:

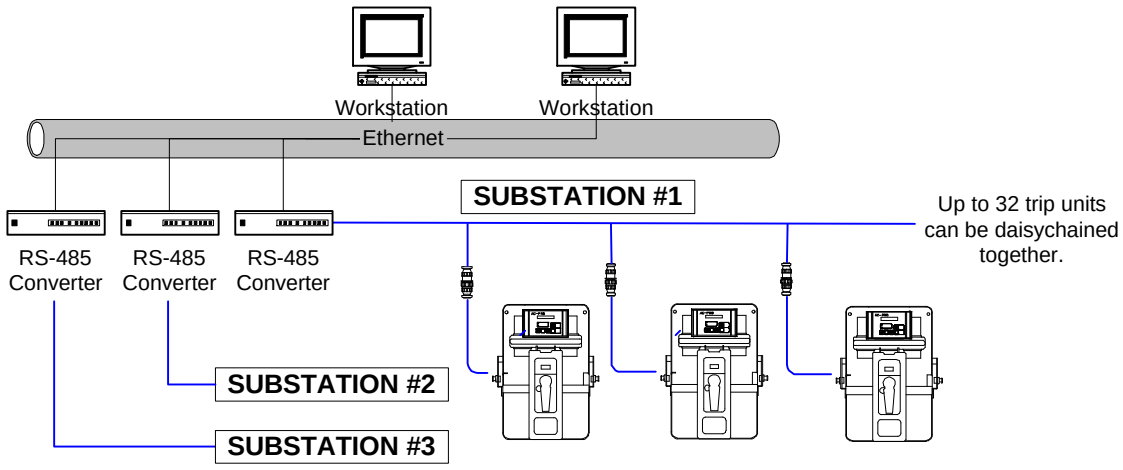
TX+ and RX+ together
TX- and RX- together

Shielded twisted pair cable should be used between the RS-232 to RS-485 converter and the trip units (Belden 9463 or equivalent cable is recommended).

4.3 Ethernet

With the addition of an RS-485 to Ethernet Converter an existing Local Area Network (LAN) can be used to carry data between trip units and the PC. Converters are widely available from a variety of industrial computer manufacturers.

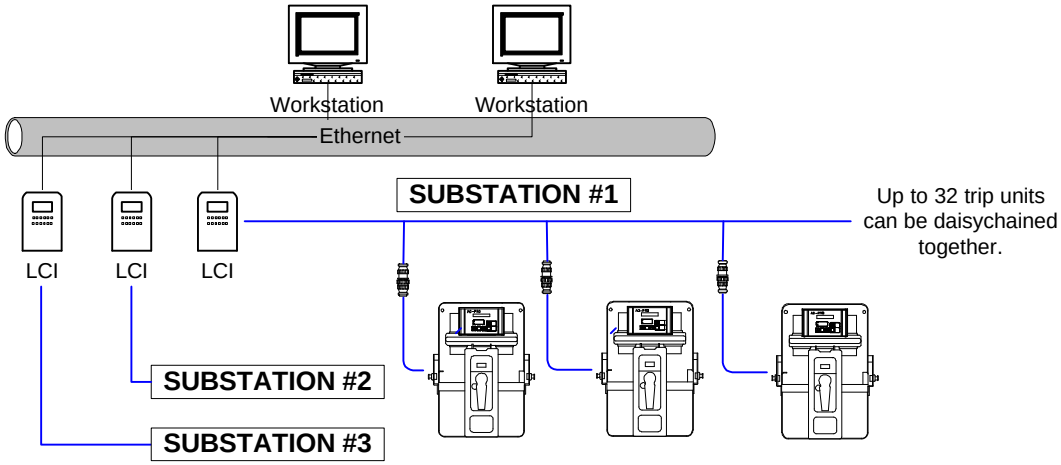
RS-485 to Ethernet Converters are designed to be compatible with a TCP/IP network environment and typically connect to a LAN using standard 10Base-T modular CAT-5 cabling. These converters offer a relatively inexpensive means of connecting to a LAN.



4.4 LCI Ethernet

The LCI (Local Communications Interface), manufactured by Utility Relay Company, is a substation monitor that continuously monitors up to 32 **AC-PRO** and/or **ZERO-Hertz** trip units that are connected to the LCI's RS-485 port. The LCI offers three key benefits:

1.) The 4-line X 20-character display provides easy monitoring of a critical power and trip data from any trip unit connected to the RS-485 port.
2.) The built-in Ethernet port acts as an "RS-485 to Ethernet Converter" and easily connects to a LAN with a simple CAT-5 cable. A unique IP address for the LCI is user-programmable from the LCI's front panel.
3.) Embedded Web Pages in the LCI provide critical information across the LAN with no additional software to install or setup. Information can be accessed by typing the LCI's IP address in the command line of any standard web browser on the LAN.



See Appendix C for additional information on the LCI

5.0 System Components - Software

In addition to AC-PRO+ and/or ZERO-Hertz trip units equipped with an RS-485, the following additional software may be required:

1. MODBUS-DDE Driver
2. *EXCEL*™ or *LOTUS 1-2-3*™ can be used to view information provided by the MODBUS-DDE Driver.
3. Man-Machine Interface (MMI) System. These systems are used to view trip unit information graphically and often contain their own compatible MODBUS-DDE Driver.

5.1 Trip Unit Programming

Both the AC-PRO+ and the ZERO-Hertz trip units have two additional programmable setpoints that are not found on the standard trip units. Those two setpoints are

?? ADDRESS
?? IDLE LINE

These setpoints need to be programmed during the normal commissioning of the trip unit (Refer to the section on Commissioning in the AC-PRO or ZERO-Hertz Instruction Manual). The setpoints appear after all of the Pick-Up and Delays settings have been made.

ADDRESS
Each trip unit that shares the same twisted pair must have a unique address. The address is selectable from 1 to 127 in increments of 1. In most applications only addresses 1 thru 32 will be used due to the limitations of RS-485 communications.

The ADDRESS identifies each individual trip unit connected to the same twisted pair wire. NOTE: Two trip units can have the same ADDRESS as long as they are not connected to the same twisted pair cable run connecting that group of trip units to the PC, ethernet converter or RS-232 converter.

IDLE LINE
The IDLE LINE Detect setpoint enables the trip unit to operate properly with all manufacturers' computer hardware. This setpoint is selectable ON / OFF.

When Idle Line detect is ON, the trip unit waits until the host PC releases the serial line after a transmission before sending the reply message. This allows for faster communications with minimal dead time. However, for some host PCs, the serial line does not go to a known idle state when not driving the serial line. The Idle line detect circuitry in the trip unit therefore cannot detect an Idle condition. In this case, the user must set the Idle Line Detect setpoint to OFF. In this case, the trip unit waits a set delay time before sending a reply message.

This setpoint is set to factory default of ON. Depending on the manufacturer of the communications expansion cards being used, the IDLE LINE may need to be set to OFF. See the Troubleshooting section of this manual for when to set the Idle Line Detect to OFF.

5.2 MODBUS-DDE Driver

The MODBUS-DDE Driver runs on the Host PC and communicates with the trip units. It creates the communications messages, sends them, and retrieves the responses. This data can then be shared with most *WINDOWS*™ programs requesting information in a DDE format. This includes most MMI systems such as Wonderware's *INTOUCH*™, Square D's *PowerLogic SYSTEM MANAGER*™, and Power Measurements *PEGASYS*™ and *ION*™. Most of these MMI systems already include a MODBUS-DDE Driver which is compatible with trip units.

Other programs which accept DDE include *EXCEL*™, *WORD*™ and *LOTUS 1-2-3*™ These programs do not contain a MODBUS-DDE Driver. A downloadable MODBUS-DDE Driver from *KEPWARE*™ (along with installation instructions) is available at:
http://www.utilityrelay.com/comm_sys_software.htm

This driver provides a 2-hour continuous runtime environment with an unlimited number of restarts.

The MODBUS-DDE Driver runs in the background on the host PC and immediately begins to communicate with all of the trip units connected to the PC when the Driver program is started The only time that the Driver needs to be modified is when a trip unit is added or removed from the system.

5.3 DDE Addressing with *EXCEL*™

Dynamic Data Exchange (DDE) is a programming format that allows most programs running under *WINDOWS*™ to pass specific requests for data from one program to another. It is by using DDE that programs such as *EXCEL*™ or *LOTUS 1-2-3*™, can get specific data from a MODBUS DDE Driver.

DDE commands are programmed in to the spreadsheet being used. *WINDOWS*™ is responsible for processing those requests and retrieving data from the MODBUS-DDE Driver.

DDE data consists of the following components:

1. DDE Source Name
2. Topic Name
3. Item Name

DDE Source Name – This is the name of the DDE Driver being used.

Topic Name – This is the name of the trip unit to be addressed. The Topic Name is defined in the MODBUS-DDE Driver by its ADDRESS and COM port or TCP/IP settings.

Item Name – The data point to read or write.

The format is as follows:

DDE Source Name | Topic Name !'Item Name'

For example, in *Microsoft Excel*™, the following command could be typed into a cell to retrieve a piece of data (NOTE: The following *syntax* is for the *InTouch WonderWare* MODBUS driver):

```
MODBUS|BREAKER1!'256 IR'
```

Where:

`MODBUS`	is the DDE Source Name.
`BREAKER1`	is the Topic Name defined by the user using MODBUS.
`256`	is the Item Name of the desired piece of information from the trip unit.

NOTE: The AC-PRO+ and ZERO-Hertz are compatible with most MODBUS drivers. You will need to consult the specific MODBUS driver manufacturer for the proper *syntax*.

See Appendix A for a complete list of available Item Names for AC-PRO+ trip units.
See Appendix B for a complete list of available Item Names for ZERO-Hertz trip unit.s

6.0 Technical Support

For technical support, contact Utility Relay Company 888-289-2864
Or visit us on the web at www.utilityrelay.com

APPENDIX A

AC-PRO+ MODBUS
DDE Item Names

Rev 1.4

****** IMPORTANT NOTICE – PRODUCT UPDATE ******

AC-PRO+ Trip Units manufactured after February 1, 2003 have been enhanced to included KWH.

Due to this enhancement, some of the Item Name registers may have changed. Please refer to the Item Name list below.

Trip Units manufactured before: Feb. 1,2003.	**Trip Units manufactured after: Feb. 1, 2003.**				
Item Name	**Item Name**	**Description (Data Point Name)**	**Unit**	**Size**	**Tag Type**
256	256	Current Phase A	Amps	Word	IR
257	257	Current_Phase_B	Amps	Word	IR
258	258	Current_Phase_C	Amps	Word	IR
259	259	Current_Phase_GF	Amps	Word	IR
260	260	Current_Phase_UB	%	Word	IR
262	262	Voltage_Phase_AG	Volts	Word	IR
263	263	Voltage_Phase_BG	Volts	Word	IR
264	264	Voltage_Phase_CG	Volts	Word	IR
265	265	Voltage_Phase_AB	Volts	Word	IR
266	266	Voltage_Phase_BC	Volts	Word	IR
267	267	Voltage_Phase_CA	Volts	Word	IR
268	268	KW_Phase_A	kW	Word	IR
269	269	KW_Phase_B	kW	Word	IR
270	270	KW_Phase_C	kW	Word	IR
272	271	KVA_Phase_A	kVA	Word	IR
273	272	KVA_Phase_B	kVA	Word	IR
274	273	KVA_Phase_C	kVA	Word	IR
	274	KW-Hrs Reg 3	.1 KWH * 2^{32}	Word	IR
	275	KW-Hrs Reg 2	.1 KWH * 2^{16}	Word	IR
	276	KW-Hrs Reg 1	.1 KWH	Word	IR
271	277	KW_Signs	**N/A**	Word	IR
	1:	*Phase A is Leading*			
	2:	*Phase B is Leading*			
	4:	*Phase C is Leading*			
	256:	*KW for Phase A is Positive*			
	512:	*KW for Phase B is Positive*			
	1024:	*KW for Phase C is Positive*			
	2048:	*KW-Hrs is Positive - **(N/A/ for trip units made before 2/1/2003)***			

275	278	Alarm Code	***N/A***	?	IR
	1:	*Trip*			
	2:	*Overload*			
	8:	*Actuator disconnected*			
	16:	*Memory error*			
	256:	*Breaker Closed*			
	512:	*x10 Range*			
276	279	CT_Rating	Amps	Word	HR
277	280	LT_PickUp	Amps	Word	HR
278	281	LT_Delay	Sec.	Word	HR
		Value stored is 2x the actual delay in seconds			
279	282	ST_PickUp	Amps	Word	HR
280	283	ST_Delay	Sec.	Word	HR
	0:	*.07 seconds*			
	1:	*.10 seconds*			
	2:	*.15 seconds*			
	3:	*.20 seconds*			
	4:	*.30 seconds*			
	5:	*.40 seconds - **(N/A for trip units made before 2/1/03)***			
281	284	ST_I_SQ_T		Word	HR
	0:	*Off*			
	1:	*On*			
282	285	I_PickUp	Amps	Word	HR
283	286	GF_PickUp	Amps	Word	HR
284	287	GF_Delay	Sec.	Word	HR
	0:	*.10 seconds*			
	1:	*.20 seconds*			
	2:	*.30 seconds*			
	3:	*.40 seconds*			
	4:	*.50 seconds*			
285	288	GF_I_SQ_T	ON/OFF	Word	HR
	0:	*Off*			
	1:	*On*			
286	289	UB_PickUp	%	Word	HR
287	290	UB_Delay	Sec.	Word	HR
288	291	Unit_Address	NA	Word	HR
289	292	Idle_Line	NA	Word	HR
290	293	Last_Trip_Current_Phase_A	Amps	Word	HR
291	294	Last_Trip_Current_Phase_B	Amps	Word	HR
292	295	Last_Trip_Current_Phase_C	Amps	Word	HR
293	296	Last_Trip_Current_Phase_GF	Amps	Word	HR
294	297	Last_Trip_Current_Phase_UB	%	Word	HR
295	298	Last_Trip_Code	NA	Word	HR
	0:	*Instantaneous*			
	1:	*LT*			
	2:	*ST*			
	3:	*GF*			
	4:	*Unbalanced*			
	5:	*Forced*			
	6:	*Close Fault*			
	65535:	*No Last Trip*			
296	299	Trip_Count_Instantaneous	NA	Word	HR
297	300	Trip_Count_LT	NA	Word	HR
298	301	Trip_Count_ST	NA	Word	HR
299	302	Trip_Count_GF	NA	Word	HR

300	303	Trip_Count_UB	NA	Word	HR
301	304	Trip_Count_Forced	NA	Word	HR
302	305	Trip_Count_CF	NA	Word	HR
303	306	Serial_Number Byte 0	NA	Word	HR
304	307	Serial_Number Byte 1	NA	Word	HR
305	308	Serial_Number Byte 2	NA	Word	HR
306	309	Serial_Number Byte 3	NA	Word	HR
307	310	Serial_Number Byte 4	NA	Word	HR
308	311	Serial_Number Byte 5	NA	Word	HR
309	312	Serial_Number Byte 6	NA	Word	HR
83	83	Force Reset			DO
84	84	Force Trip			DO
85	85	Force Battery Test			DO
86	86	Force Clear Last Trip			DO
	111	Force Clear KW-Hrs - **(N/A/ for trip units made before 2/1/2003)**			DO
112	112	Force Relay 1			DO
113	113	Force Relay 2			DO

APPENDIX B

Zero-Hertz
MODBUS
DDE Item Names

Rev 0.6

Item Name	Description (Data Point Name)	Unit	Size	Tag Type
256	Largest Current	Amps	Word	IR
257	Current GF	Amps	Word	IR
258	Direction	NA	Word	IR
0:	*Forward*			
1:	*Reverse*			
259	Alarm Code			IR
1:	*Trip*			
2:	*Overload*			
4:	*Battery dead*			
8:	*Actuator not connected*			
16:	*Memory error*			
32:	*Xducer error*			
64:	*A/D error*			
128:	*Alarm Relay State*			
256:	*Breaker Closed*			
512:	*x10 Range for:*			
260	Last_Trip_Code	NA	Word	HR
0:	*Instantaneous*			
1:	*LT*			
2:	*ST*			
3:	*GF*			
4:	*Not used*			
5:	*Forced*			
6:	*Fast I*			
7:	*Reverse*			
8:	*UV OL*			
9:	*Rate of Rise*			
65535:	*No Last Trip*			
261	Last_Trip_Current	Amps	Word	HR
262	Last_Trip_Current_GF	Amps	Word	HR
263	Last_Trip_Direction	Amps	Word	HR
0:	*Forward*			
1:	*Reverse*			
264	Trip_Count_Instantaneous	NA	Word	HR
265	Trip_Count_LT	NA	Word	HR
266	Trip_Count_ST	NA	Word	HR
267	Trip_Count_GF	NA	Word	HR
268	Not used	NA	Word	HR
269	Trip_Count_Forced	NA	Word	HR
270	Trip_Count_Fast I	NA	Word	HR
271	Trip_Count_Reverse	NA	Word	HR
272	Trip_Count_UV OL	NA	Word	HR

273	Trip_Count_RR	NA	Word	HR	
274	Serial_Number Byte 0	NA	Word	HR	
275	Serial_Number Byte 1	NA	Word	HR	
276	Serial_Number Byte 2	NA	Word	HR	
277	Serial_Number Byte 3	NA	Word	HR	
278	Serial_Number Byte 4	NA	Word	HR	
279	Serial_Number Byte 5	NA	Word	HR	
280	Serial_Number Byte 6	NA	Word	HR	
282	DC Input	NA	Word	HR	Read only
0:	*Transducer*				
1:	*Shunt*				
283	XDucer_Rating	Amps	Word	HR	Read only
284	LT_PickUp	Amps	Word	HR	
285	LT_Delay	Secs.	Word	HR	
	Value stored is 2x actual delay in seconds				
286	LT_Thermal	Amps	Word	HR	
287	ST_PickUp	Amps	Word	HR	
288	ST_Delay	Secs.	Word	HR	
0:	*.07 seconds*				
1:	*.10 seconds*				
2:	*.15 seconds*				
3:	*.20 seconds*				
4:	*.35 seconds*				
289	ST_I_SQ_T	On/Off	Word	HR	
0:	*Off*				
1:	*On*				
290	Fast I_PickUp	Amps	Word	HR	
291	I_PickUp	Amps	Word	HR	
292	GF_PickUp	Amps	Word	HR	
293	GF_Delay	Secs.	Word	HR	
0:	.10 seconds				
1:	.20 seconds				
2:	.30 seconds				
3:	.40 seconds				
4:	.50 seconds				
294	GF_I_SQ_T	On/Off	Word	HR	
0:	*Off*				
1:	*On*				
295	RC_PickUp	Amps	Word	HR	
296	RC_Delay	Secs.	Word	HR	
0:	.10 seconds				
1:	.20 seconds				
2:	.30 seconds				
3:	.40 seconds				
297	RC_I_SQ_T	On/Off	Word	HR	
0:	*Off*				
1:	*On*				
298	R/R_PickUp	Amps	Word	HR	
299	dI/dT_PickUp	A/sec	Word	HR	
300	R/R_Delay	Secs.	Word	HR	
301	Unit_Address	NA	Word	HR	Read only
302	Idle_Line	NA	Word	HR	Read only
303	Alarm Relay Comm	NA	Word	HR	
0:	*Off*				
1:	*On*				

304	Alarm Relay Overload	NA	Word	HR
0:	*Off*			
1:	*On*			
305	Alarm Relay Trip	NA	Word	HR
0:	*Off*			
1:	*On*			
306	Alarm Relay Error	NA	Word	HR
0:	*Off*			
1:	*On*			
83	Force Reset			DO
84	Force Trip			DO
85	Force Battery Test			DO
86	Force Clear Last Trip			DO
87	Force Alarm Relay On			DO
88	Force Alarm Relay Off			DO