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SE-330 SERIES (NEW REVISION) MODBUS/TCP INTERFACE

Revision 0-E-121117

Document Number: PM-1204-EN

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DISCLAIMER

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1. GENERAL

This document describes the Modbus/TCP features supported by the new revision SE-330, SE-330AU, and SE-330HV. Unless otherwise indicated, "SE-330" refers to all three monitor series in general. The Ethernet network communications interface supports the Modbus-RTU protocol over TCP/IP using an encapsulating protocol called Modbus/TCP.

SE-330 ordering options 3, 4, 5, 6, 7 and 8 include dual Ethernet ports with support for fiber-optic or RJ45 interfaces. See Figs. 1, 2, and 3.

2. MODBUS PROTOCOL

The SE-330 implements the Modbus® TCP protocol on port 502. The SE-330 is a server (slave) and can communicate simultaneously with 5 clients (masters).

Modicon Modbus® is a registered trademark of Schneider Electric.

All Modbus/TCP messages are essentially Modbus-RTU messages encapsulated with a Modbus/TCP header, both of which are encapsulated in a TCP and an IP header. The TCP/IP-header and Modbus RTU framing is beyond the scope of this document.

2.1 PROTOCOL SETUP

The SE-330 can be configured using SE-MON330 (version 3.2 or higher). The IP address, subnet mask, and gateway can all be set for each of the network ports.

For more information, see the SE-MON330 help file.

Note: Ensure that each port is configured with a unique IP address even if not used.

2.2 ERROR CHECKING

Modbus/TCP uses the TCP/IP checksum and error correction techniques to ensure reliable communications.

If the checksum is correct but the internal data in the message is not correct, the SE-330 will respond with an exception code.

2.3 FUNCTION CODES SUPPORTED

The SE-330 Modbus Protocol supports the following function codes:

- Read Holding Registers (Function Code 3)
- Read Input Registers (Function Code 4)
- Write Single Register (Function Code 6)
- Write Multiple Registers (Function Code 16)
- Command Instruction (Function Code 5)

2.3.1 READ INPUT/HOLDING REGISTERS (CODE 4/3)

Function Codes 3 and 4 are used to read the register attributes listed in Appendix A.

Function Codes 3 and 4 perform the same function in the SE-330.

Registers in Modbus start at 40001 decimal and this register address refers to register/attribute 0.

Note: For hexadecimal numbers, 0x precedes the value.

2.3.2 WRITE SINGLE REGISTER (CODE 6)

Function Code 6 writes a single 16-bit value to the SE-330.

Provided no errors occurred, the slave (SE-330) will return the original message to the master. The response message is returned only after the 'write' has been executed by the slave.

2.3.3 WRITE MULTIPLE REGISTERS (CODE 16)

Function Code 16 is used to write multiple registers to the SE-330.

The slave will reply with the slave address, function code, register address, and the quantity of registers written.

2.3.4 COMMAND INSTRUCTION (CODE 5)

Modbus Function Code 5 (Force Single Coil) is used to issue commands to the SE-330. The command code actions and corresponding coil number are listed in Table 1.

TABLE 1. SUPPORTED COMMANDS

COMMAND CODE	COIL NUMBER	ACTION
0x0001	2	Remote Trip
0x0002	3	Clear Event Records
0x0005	6	Set to Defaults
0x0008	9	Remote Reset
0x0010	17	Remote Calibration

Except for a broadcast address, the slave will return the original packet to the master.

2.3.5 COMMAND INSTRUCTIONS USING REGISTER WRITES

For PLCs not supporting Function Code 5, commands can be issued using Write Single Register (Code 6) and Write Multiple Register (Code 16).

Commands are written to SE-330 register 6 (Modbus register 40007). Supported commands are listed in the COMMAND CODE column in Table 1.

When using the Write Multiple Registers function code, the write should be to the single SE-330 Register 6. If multiple registers are written starting at SE-330 Register 6, the first data element will be interpreted as the command code but no other registers will be written. If the command is successful, the SE-330 will return a valid response message.

2.4 Error Responses

The SE-330 supports the following exception responses:

- 01: Illegal Function – The function code (Byte 2 of the Modbus-RTU packet or Byte 8 of the entire Modbus/TCP message) is not supported
- 02: Illegal Data Address – All accesses to communication registers must be within the specified address range
- 03: Illegal Data Value – This error code is returned if there is a data value outside the allowable value for the slave

2.5 SE-330 Database

Appendix A contains the Modbus Register Table. The table starts at register 0 (Modbus 40001) and each register/attribute is 16-bits wide. Types "long" and "float" are 32-bit values. For both long and float types, the low-order word is transmitted first followed by the high-order word. Word values have the high byte followed by the low byte. Float types are per the IEEE 754 Floating-Point Standard. All bytes of long and float types must be written using one message or an error will result. This does not apply for read commands.

For compatibility with the previous Modbus TCP/IP implementation, registers 80 through 90 are provided. The previous trip record format is not supported.

2.6 Network Status and Indication

Communication status LED's are located on the top panel of the SE-330. The Network Status (NS) LED will indicate solid green when there is link activity, flashing green when there are no active connections and will flash red when any link has timed out.

3. Data Records

Event record information is located starting at SE-330 register 60.

Only one event record can be read at a time. Record data is for the record indicated by the Record Selector. To select a record, write the record number to Record Selector with the first message and then read the values in the record with a second message. Record Head points to the most recent record. If there are no records available, Record Head returns a value of 100.

The Record Selector must be in the range of 0 to 99. Values outside this range will select record 0.

4. Specifications

Protocol	Modbus/TCP
Ports	2
IP Addresses	1 per port
Port 1 Default	192.168.1.100
Port 2 Default	192.168.2.100
Number of Connections	8 total
Connectors	Copper and/or fiber, refer to Figs. 1, 2, and 3 and ordering information in the product manual

Copper:

Connector	RJ45
Cable	CAT5
Length	100 m (328')
Interface	10BASE-T, 100BASE-Tx

Fiber:

Connector	SC
Cable	SC Multimode
Length	2,000 m (6,561') per segment
Interface	100BASE-Fx
Center Wavelength	1300 nm
Operating Wavelength	1270 to 1380 nm

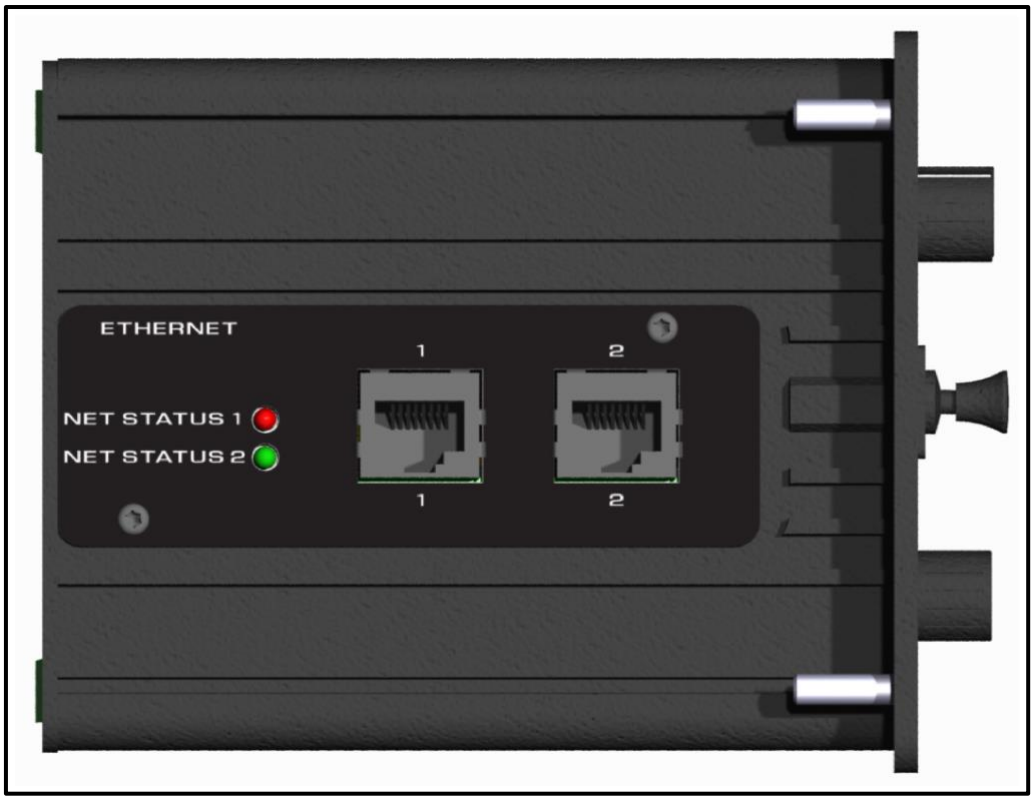

FIGURE 1. Top View of SE-330 (SE-330-X3-XX) with Dual RJ-45 Ethernet Network Communications.

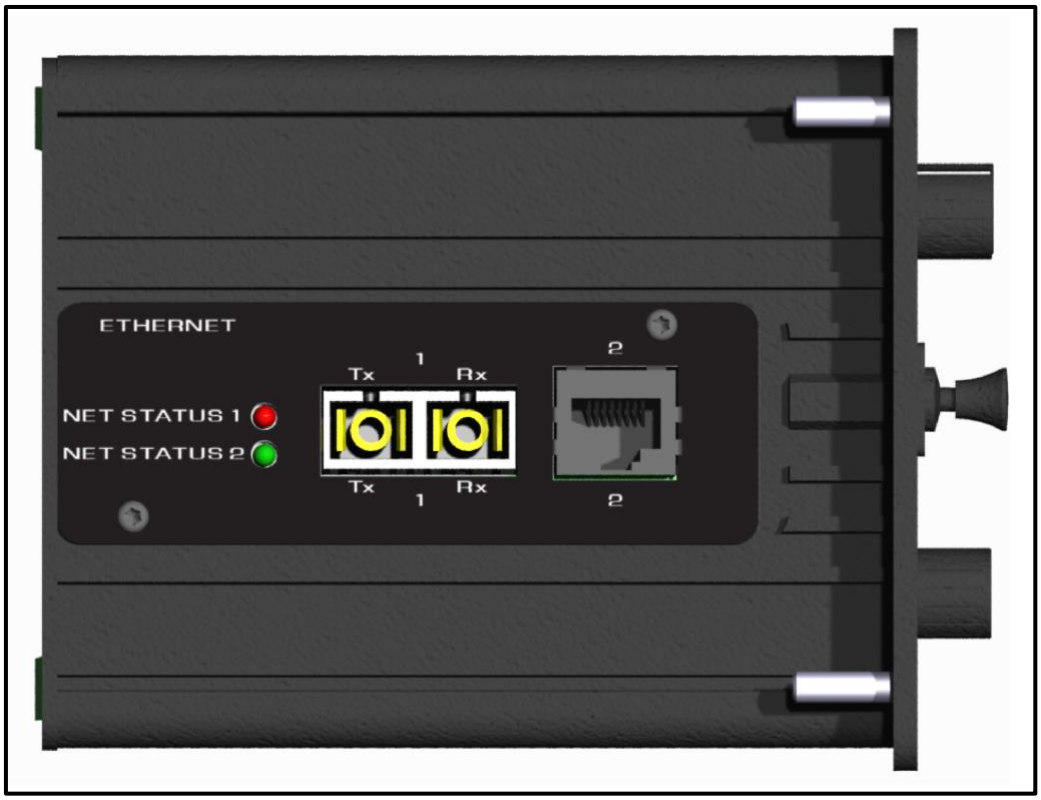

FIGURE 2. Top View of SE-330 (SE-330-X4-XX) with Single Fiber SC and Single RJ-45 Ethernet Network Communications.

FIGURE 3. Top View of SE-330 (SE-330-X5-XX) with Dual Fiber SC Ethernet Network Communications.

APPENDIX A
MODBUS REGISTER TABLE

ATTRIBUTE NUMBER	ATTRIBUTE NAME	SERVICES	DATA TYPE	NOTES
0	Model Code	Read Only	T1	Always Reads 330
1	Software Version	Read Only	T1	Where 100 = 1.00
2	Serial Number	Read Only	T2 (Low)	
3		Read Only	T2 (High)	
4	Model Type	Read Only	T3	
5	Communication Code	Read Only	T4	
6	Command Register	Write Only	T5	
7				
8				
9				
10	Date	Read Only	T6 (Low)	
11		Read Only	T6 (High)	
12	Time	Read Only	T7 (Low)	
13		Read Only	T7 (High)	
14	EF/GF Trip Time (s)	Read Only	T15	
15	EF/GF Trip Level (%)	Read Only	T16	
16	EF/GF MEM Trip Level (%)	R/W	T1	
17	Pulse Period (s)	Read Only	T19	Not used on SE-330AU or SE-330HV.
18	Vn Trip Level (V)	Read Only	T1	
19	NGR Calibration Value	Read Only	T20	Signed 16-Bit Value
20	K1 Configuration	Read Only	T8	
21	K1 Mode	Read Only	T9	Not used on SE-330AU or SE-330HV.
22	EF/GF-Trip Latch	Read Only	T10	Not used on SE-330AU or SE-330HV.
23	RF-Trip Latch	Read Only	T10	
24	Sensing Resistor Selection	Read Only	T11	
25	Frequency	Read Only	T12	
26	Spare	Read Only	T1	
27	Upgrade Enable	Read Only	T13	
28	Pulse Enable State	Read Only	T14	Not used on SE-330AU or SE-330HV
29	SD Card Status	Read Only	T17	
30	Remote Reset State	Read Only	T14	
31	Calibration State	Read Only	T14	
32	K2 Mode	R/W	T18	
33	K3 Mode	R/W	T18	
34	CT Primary	R/W	T1	See “Effective CT Primary” Setting in SE-MON330.
35	NGR Current (%FS)	Read Only	T1	
36	NGR Voltage (% Setting)	Read Only	T1	
37	Resistance Change (Ohms)	Read Only	T20	
38	CT Detection	Read Only	T1	SE-330AU Only
39	Geo-Magnetic Filter	R/W	T31	
40	Resistor-Fault Trip Time (s)	R/W	T1	
41	Resistor-Fault Trip Level (ohms)	R/W	T1	
42	Diagnostic LED behavior	R/W	T34	
43				
44				
45				
46	K1 Trip Relay	Read Only	T21	
47	K2 GF Relay	Read Only	T21	
48	K3 RF Relay	Read Only	T21	
49	Drive Polarity Output	Read Only	T1	1 = Negative 0 = Positive
50				

ATTRIBUTE NUMBER	ATTRIBUTE NAME	SERVICES	DATA TYPE	NOTES
51				
52				
53				
54	Diagnostic	Read Only	T30	
55	Trip Status	Read Only	T22	
56	Set-Point Status	Read Only	T23	
57				
58				
59				
60	RECORDHEAD	Read Only	T1	
61	RECORDCOUNT	Read Only	T1	
62	RECORD_INDEX	R/W	T1	
63	RECORD_DATE	Read Only	T6 (Low)	
64	RECORD_DATE	Read Only	T6 (High)	
65	RECORD_TIME	Read Only	T7 (Low)	
66	RECORD_TIME	Read Only	T7 (High)	
67	RECORD_NGRCURRENT	Read Only	T1	
68	RECORD_NGRVOLTAGE	Read Only	T1	
69	RECORD_NGRCHANGE	Read Only	T20	
70	RECORD_TRIPSTATUS	Read Only	T22	
71	RECORD_SETPOINTSTATUS	Read Only	T23	
72				
73				
74				
75	Watchdog	Read Only	T1	Always reads 0. Consult factory if not 0.
76	Flash Healthy	Read Only	T24	
77	Boot Section	Read Only	T25	
78				
79				
80	Firmware Version	Read Only	T1	Start of SE-330 Backwards Compatibility Register Block
81	Trip Status	Read Only	T22	
82	Setpoint Status	Read Only	T23	
83	EF/GF Trip Time (s)	Read Only	T15	
84	EF/GF Trip Level (%)	Read Only	T16	
85	Pulse Period (s)	Read Only	T19	
86	NGR Current (%FS)	Read Only	T1	
87	NGR Voltage (% Setting)	Read Only	T1	
88	Resistance Change (Ohms)	Read Only	T20	
89	Relay Status	Read Only	T26	
90	Switches	Read Only	T27	End of SE-330 Backwards Compatibility Register Block
91				
92				
93				
94				
95				
96				
97				
98				
99				
100				
101	IP Address 1	R/W	T28 (Low)	
102		R/W	T28 (High)	
103	Subnet Mask 1	R/W	T28 (Low)	
104		R/W	T28 (High)	

ATTRIBUTE NUMBER	ATTRIBUTE NAME	SERVICES	DATA TYPE	NOTES
105	Gateway 1	R/W	T28 (Low)	
106		R/W	T28 (High)	
107	MAC Address 1	Read Only	T29 (Word0)	
108		Read Only	T29 (Word1)	
109		Read Only	T29 (Word2)	
110	IP Address 2	R/W	T28 (Low)	
111		R/W	T28 (High)	
112	Subnet Mask 2	R/W	T28 (Low)	
113		R/W	T28 (High)	
114	Gateway 2	R/W	T28 (Low)	
115		R/W	T28 (High)	
116	MAC Address 2	Read Only	T29 (Word0)	
117		Read Only	T29 (Word1)	
118		Read Only	T29 (Word2)	
130	Hardware Version	Read Only	T32 (char 0 + 1)	
131		Read Only	T32 (char 2 + 3)	
132		Read Only	T32 (char 4 + 5)	
133		Read Only	T32 (char 6 + 7)	
160	SNTP IP Address	R/W	T28 (Low)	
161		R/W	T28 (High)	
162	SNTP Poll Rate	R/W	T6 (Low)	
163		R/W	T6 (High)	
164	SNTP Time Out	R/W	T6 (Low)	
165		R/W	T6 (High)	
166	SNTP Status	Read Only	T33 (Low)	
167		Read Only	T33 (High)	
168	SNTP Enable	R/W	T31	

Data Types

TYPE	C TYPE	DESCRIPTION	NOTES
T1	Short	16-Bit Unsigned Integer	
T2	Long	32-Bit Unsigned Integer	
		(High) Bits 31..16	
		(Low) Bits 15..0	
T3	Short	1 = Standard	
		2 = AU	
		3 = HV	
T4	Short	0 = No Communications	
		1 = DeviceNet	
		2 = Reserved	
		3 = Ethernet (Dual RJ45)	
		4 = Ethernet (Fiber and RJ45)	
		5 = Ethernet (Dual Fiber)	
		6 = 61850 (Dual RJ45)	
		7 = 61850 (Fiber and RJ45)	
		8 = 61850 (Dual Fiber)	
T5	Short	SE-330 Command	
		1 = Remote Trip	
		2 = Clear Event Records	
		5 = Return to Default Values	
		8 = Remote Reset	
		16 = Remote Calibration	

Data Types (continued)

TYPE	C TYPE	DESCRIPTION	NOTES
T6	Long	Date	
		Bits 31..16: Year in Binary	
		Bits 15..8: 1-12 Months in Binary	
		Bits 7..0: 1-31 Days in Binary	
T7	Long	Time	
		Bits 31..24: 0-23 Hours in Binary	
		Bits 23..16: 0-60 Minutes in Binary	
		Bits 15..8: 0-60 Seconds in Binary	
		Bits 7..0: 0-99 Hundredths of Seconds in Binary	
T8	Short	1 = Trip Configuration (K1)	
		0 = Pulsing Configuration (K1)	
T9	Short	1 = Fail Safe Trip-Relay Operation	
		0 = Non Fail Safe Operation	
T10	Short	1 = Latched	
		0 = Not Latched	
T11	Short	1 = 20 k Sensor (200 k for SE-330HV)	
		0 = 100 k Sensor	
T12	Short	1 = 50 Hz	
		0 = 60 Hz	
T13	Short	1 = Run Mode	
		0 = Upgrade Enable	
T14	Short	1 = Open	State of External Contact
		0 = Closed	
T15	Short	SE-330/SE-330HV	SE-330AU
		0 = 0.1 s	100 ms
		1 = 0.2 s	120 ms
		2 = 0.3 s	140 ms
		3 = 0.4 s	160 ms
		4 = 0.5 s	180 ms
		5 = 0.7 s	200 ms
		6 = 1 s	250 ms
		7 = 2 s	300 ms
		8 = 3 s	350 ms
		9 = 5 s	400 ms
		10 = 10 s	500 ms
T16	Short	SE-330/SE-330HV	SE-330AU
		0 = 2%	0 = 0.125 A
		1 = 4%	1 = 0.25A
		2 = 6%	2 = 0.3 A
		3 = 8%	3 = 0.4 A
		4 = 10%	4 = 0.5 A
		5 = 20%	5 = 1 A
		6 = 40%	6 = 2 A
		7 = 60%	7 = 3 A
		8 = 80%	8 = 4 A
		9 = 100%	9 = 5 A
		10 = MEM	
T17	Short	0 = No Card	5 = Card Format Error
		1 = Card Inserted	6 = Card Initialization Error
		2 = Card Logging	7 = Card Format in Progress
		3 = Card Full	
		4 = Card Error	
T18	Short	0 = Non-Fail-Safe	
		1 = Fail-Safe	

Data Types (continued)

TYPE	C TYPE	DESCRIPTION	NOTES
T19	Short	0 = 1.0	
		1 = 1.2	
		2 = 1.4	
		3 = 1.6	
		4 = 1.8	
		5 = 2.0	
		6 = 2.2	
		7 = 2.4	
		8 = 2.6	
		9 = 2.8	
		10 = 3.0	
T20	Short	16-Bit Signed Integer	
T21	Short	0 = De-Energized	
		1 = Energized	
T22	Short	Bit 0, EF/GF	1 = Earth/Ground Fault Trip
			0 = No Trip
		Bit 1, RF	1 = Resistor Fault Trip
			0 = No Trip
		Bit 2, CAL	1 = Calibration Error
			0 = No Error
		Bit 3, ADC	1 = A/D Error
			0 = No Error
		Bit 4, GRV	1 = Voltage Trip
			0 = No Trip
		Bit 5, NVRam Error	1 = NVRam Error
			0 = No Error
		Bit 6, Watchdog	1 = Internal Fault
			0 = No Internal Fault
			(Will cause a EF/GF and RF trip)
		Bit 7, RMT	1 = Remote Trip
			0 = No Trip
			(Will cause a EF/GF and RF trip)
		Bit 8, Hardware Error	1 = Internal Fault
			0 = No Internal Fault
			(Will cause a EF/GF and RF trip)
T23	Short	Bit 0, EF/GF	1 = Earth/Ground Fault Current >= Setting
			0 = Earth/Ground Fault Current < Setting
		Bit 1, RF	1 = Resistance >= Trip Level
			0 = Resistance < Trip Level
		Bit 2, CAL	1 = Calibration Error
			0 = No Error
		Bit 3, ADC	1 = A/D Error
			0 = No Error
		Bit 4, GRV	1 = NGR Voltage >= Vn Trip Setting
			0 = NGR Voltage < Vn Trip Setting
		Bit 5, Not Used	
		Bit 6, CT Error	1 = CT Error (SE-330AU Only)
			0 = No CT Error
		Bit 7, CT Latch	1 = CT Trip (SE-330AU Only)
			0 = No CT Trip
		Bit 8, SD Card Error	1 = SD Card Error/Full
			0 = No Error
		Bit 9, Upgrade Error	1 = Upgrade Error
			0 = No Error

Data Types (continued)

TYPE	C TYPE	DESCRIPTION	NOTES
T24	Short	1 = Healthy	
		0 = Not Healthy	
T25	Short	0 = NONE	
		1 = Factory Default 0	
		2 = Factory Default 1	
		3 = Upgrade 0	
		4 = Upgrade 1	
T26	Short	Bit 1, K3	1 = RF Indication Relay Energized
			0 = Not Energized
		Bit 2, K2	1 = EF/GF Indication Relay Energized
			0 = Not Energized
		Bit 3, K1	1 = Trip/Pulse Relay Energized
			0 = Not Energized
T27	Short	Bit 0, S4	1 = RF Latched
			0 = RF Not Latched
		Bit 1, S3	1 = EF/GF Latched
			0 = EF/GF Not Latched
		Bit 2, S5	1 = 20 k Sensor (200 k for SE-330HV)
			0 = 100 k Sensor
		Bit 3, S6	1 = 50 Hz
			0 = 60 Hz
		Bit 4, S2	1 = Fail Safe Trip-Relay Operation
			0 = Non Fail Safe Operation
			S2 not applicable to SE-330AU.
		Bit 5, S1	1 = Trip Configuration (K1)
			0 = Pulsing Configuration (K1)
			S1 not applicable to SE-330AU, SE-330HV.
		Bit 6, Not Used = 0	
		Bit 7, Not Used = 0	
T28	Long	IP Address (a.b.c.d)	
		(High) Bits 31..24 = a	
		(High) Bits 23..16 = b	
		(Low) Bits 15..8 = c	
		(Low) Bits 7..0 = d	
T29	Long Long	MAC Address (a:b:c:d:e:f)	
		(Word2) Bits 47..40 = a	
		(Word2) Bits 39..32 = b	
		(Word1) Bits 31..24 = c	
		(Word1) Bits 23..16 = d	
		(Word0) Bits 15..8 = e	
		(Word0) Bits 7..0 = f	
T30	Short	0 = None	
		1 = Calibration Error	
		2 = Remote Trip	
		3 = CT Latch Error	
		4 = ADC Error	
		5 = SD Card Error	
		6 = Watchdog Trip	
		7 = Hardware Error	
		8 = NVRAM Error	
		9 = Flash Upgrade Error	
		10 = USB Error	
T31	Short	0 = Disabled	
		1 = Enabled	

Data Types (continued)

TYPE	C TYPE	DESCRIPTION	NOTES
T32	Char	Register +0: Char[0] and Char[1]. Char[0] at MSByte	
		Register +1: Char[2] and Char[3]. Char[2] at MSByte	
		Register +N: Char[N*2] and Char[N*2+1]. Char[N*2] at MSByte	
T33	Long	-1 = Initializing	
		0 = SNTP Synced	
		4355 = Server Not Running	
		5122 = No Route to Host	
		5392 = No Route to Host	
T34	Short	0 = All Diagnostic Codes	
		1 = Critical Diagnostic Codes Only	

APPENDIX B
SE-330 SERIES (NEW REVISION) MODBUS/TCP INTERFACE REVISION HISTORY

MANUAL RELEASE DATE	MANUAL REVISION
December 11, 2017	0-E-121117
June 25, 2015	0-D-062515
July 17, 2014	0-C-071714
February 3, 2014	0-B-020314
November 29, 2013	0-A-112913

MANUAL REVISION HISTORY

REVISION 0-E-121117

SECTION 2

Note added in Section 2.1.

SECTION 4

Specifications updated.

REVISION 0-D-062515

SECTION 4

IP Addresses updated.

APPENDIX A

Modbus registers 34 and 39-41 updated. Registers 130-133 and 160-168 added.
Data types 31, 32 and 33 added.

REVISION 0-C-071714

Remote calibration feature added.

SECTION 2

Remote calibration added to Table 1.

APPENDIX A

Remote calibration added to data types.

REVISION 0-B-020314

SECTION 2

Figs. 1, 2, and 3 added.

SECTION 4

Specifications updated.

REVISION 0-A-112913

Initial release.