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FEATURES

- Supports all 4 Wire Pt-100 RTD Transducers.
- Uses 1-Wire communication protocol.
- Compatible with all EDS and Dallas Semiconductor 1-Wire bus masters.
- Optional Relay may be controlled independently or by alarm status.
- LED may be controlled independently or by alarm status.
- Supports Conditional Search with user-selectable conditions
- Automatic unique 64-Bit device addressing.
- Pass-through 1-Wire connection.
- Applications include thermostatic controls, industrial systems, consumer products, thermometers, or any thermally sensitive system.

DESCRIPTION

The new RTD Transmitter line offers an innovative and highly accurate way to monitor and control temperature throughout a wider temperature range than previously possible with 1-Wire networks. Each variation of the RTD Transmitters includes a highly accurate RTD sensor input, an LED, conditional search support and a pass-through 1-Wire connection allowing easy daisy chaining of additional devices. An optional latching relay is offered which provides additional flexibility for alarm notifications and control applications. These features combine to offer a flexible system for monitoring and controlling numerous data points throughout a 1-Wire network in an efficient manner. The conditional search support allows a host adapter to quickly identify whether any alarm parameters have been met. The LED and optional latching relay are configurable to behave in a variety of ways:

- Activate when an alarm becomes active and automatically deactivate when the alarm is cleared
- Activate when within alarm parameters and deactivate when within normal range
- Independently controlled

The nearly instant automated responses made by the LED and optional relay allows appropriate reactions (activate fan/alarm siren/etc) to occur before the monitoring application is aware of the alarm. Any general-purpose 1-Wire host adapter is able to read the RTD Sensors. The RTD Transmitter line has been designed to simplify the reading and controlling process.

RTD Selection

The RTD Transmitter will work with any 4 wire Pt-100 sensor that complies with European Fundamental Interval which is the 0.385/°C (0.00385ohms/ohms/°C). An RTD sensor with a different temperature coefficient will require the temperature to be calculated from the RTD resistance reported.

Memory Map

The memory consists of 3 pages of 32 bytes. Page 0 is the tag, page 1 and 2 contain operational data. Only page 2 can be written, pages 0 and 1 are read only.

Page 0

Addr	b7	b6	b5	b4	b3	b2	b1	b0		
0 - 27	-	-	-	-	-	-	-	-	Tag	R
28	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	Version, low	R
29	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	Version, high	R
30	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	ID, low	R
31	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	ID, high	R

Page 1

Addr	b7	b6	b5	b4	b3	b2	b1	b0		
32	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	ID, low	R
33	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	ID, high	R
34	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	Temp, C	R
35	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	Temp, C	R
36	s	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	Temp, C	R
37	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	RTD Resistance	R
38	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	RTD Resistance	R
39	s	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	RTD Resistance	R
40	-	-	-	-	-	-	-	-	*For Internal Use Only*	R
41	-	-	-	-	-	-	-	-	*For Internal Use Only*	R
42	-	-	-	-	-	-	-	-	*For Internal Use Only*	R
43 - 47	0	0	0	0	0	0	0	0	Reserved for Future	R
48	F^7	F^6	F^5	F^4	F^3	F^2	F^1	F^0	Calibration	R
49	F^{15}	F^{14}	F^{13}	F^{12}	F^{11}	F^{10}	F^9	F^8	Calibration	R
50	F^{23}	F^{22}	F^{21}	F^{20}	F^{19}	F^{18}	F^{17}	F^{16}	Calibration	R
51	F^{31}	F^{30}	F^{29}	F^{28}	F^{27}	F^{26}	F^{25}	F^{24}	Calibration	R
52	0	0	0	0	0	0	0	0	Reserved for Future	R
53	0	0	0	0	0	0	LED	Rly	Relay / LED State	R
54	0	0	0	0	RTD Low	RTD High	Temp Low	Temp High	Alarm states	R
55	0	0	0	0	0	0	0	0	Reserved for Future	R
56	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Conversion Counter	R
57	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	Conversion Counter	R
58	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	Conversion Counter	R
59	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	Conversion Counter	R
60	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Seconds counter	R
61	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	Seconds counter	R
62	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	Seconds counter	R
63	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	Seconds counter	R

Page 2

Addr	b7	b6	b5	b4	b3	b2	b1	b0		
64	0	0	0	0	RTD Low	RTD High	Temp Low	Temp High	Conditional search	RW
65	0	0	0	0	0	0	0	0	Reserved for Future	RW
66	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	Temp alarm high	RW
67	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	Temp alarm high	RW
68	S	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	Temp alarm high	RW
69	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	Temp alarm low	RW
70	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	Temp alarm low	RW
71	S	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	Temp alarm low	RW
72	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	*For Internal Use Only*	RW
73	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	*For Internal Use Only*	RW
74	S	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	*For Internal Use Only*	RW
75	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	*For Internal Use Only*	RW

76	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	*For Internal Use Only*	RW
77	S	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	*For Internal Use Only*	RW
78 -91	0	0	0	0	0	0	0	0	Reserved for Future	RW
92	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Calibration Key	RW
93	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	RTD Read Delay	RW
94	0	0	0	0	L1	L0	R1	R0	Relay / LED Function*	RW
95	0	0	0	0	0	0	LED	Rly	Relay / LED State*	RW

* If the relay is not populated the bits pertaining to the Relay Function and LED State should be ignored.

Temperature
Temperature readings are stored in 3 bytes of data on page 1 with the least significant byte first (LSB). The temperature reading are stored as a 24-bit two's complement number. The most significant bit defines whether the number will be negative (1) or positive (0). Readings can be calculated taking the given value and dividing the number by 2048. For example, if 00FCFFh (LSB) was read the value could be calculated as such:

00FCFFh (LSB) = FFFC00h (MSB)	Converting LSB to MSB
1111 1111 1111 1100 0000 0000 (binary) = FFCF00h	Converting from hex to binary
0000 0000 0000 0011 1111 1111	Inverting data
0000 0000 0000 0100 0000 0000	Add 1
0000 0000 0000 0100 0000 0000 = 400h = 1024 (decimal)	Converting to decimal
1024/2048 (decimal) = 0.5	Divide by 2048 (decimal)
-0.5	Apply sign designated by most significant bit

Temperature	Digital Output MSB (binary)	Digital Output MSB (hex)
+800 °C	0001 1001 0000 0000 0000 0000	190000h
+85 °C	0000 0010 1010 1000 0000 0000	02A800h
+25.0625 °C	0000 0000 1100 1000 1000 0000	C80080h
+10.125 °C	0000 0000 0101 0001 0000 0000	005100h
+0.5 °C	0000 0000 0000 0100 0000 0000	000400h
0 °C	0000 0000 0000 0000 0000 0000	000000h
-0.5 °C	1111 1111 1111 1100 0000 0000	FFFC00h
-10.125 °C	1111 1111 1010 1111 0000 0000	FFAF00h
-200 °C	1111 1001 1100 0000 0000 0000	F9C000h

To obtain the best performance, operate the RTD Transmitter at a constant temperature, preferably room temperature. By keeping the precision reference resistor temperature constant, its value will remain stable. In addition, place the RTD Transmitter, the RTD element and cable in a low noise environment. Do not jar or mechanically shock the RTD element or transmitter. To avoid self-heating, extend the time between readings as much as possible.

RTD Resistance
The data is stored in bytes 37-39. The reading is the calculated resistance of the RTD element. The data could be used to calculate the temperature reading from 4 Wire RTD not following the European Standard (DIN or IEC 60751). The resistance data is stored like the temperature data as a 24-bit two's complement number. Please see the *Temperature* section calculating the RTD resistance.

Alarms
Alarm values for Temp Alarm High and Temp Alarm Low are programmed as integers, some are signed. They are stored in non-volatile memory from byte 66 to 77.

Alarm States
Alarms are calculated every time a reading is made from the RTD element, which is every second by default. If the reading is above the high alarm value, the corresponding high alarm bit is set, and if the reading is below the low alarm value, the low alarm bit is set. Alarm bits can only be cleared by sending the clear alarms command (0x33), which clears all alarm bits. No provision is made to clear individually selected alarm bits.

Conditional Search
The device will respond to the conditional search command from a master if any or all of the conditional search bits are set. The conditional search bits are set when an alarm becomes active and are cleared only under program control, by writing to the appropriate bit(s) at location 64.

Seconds Counter
The 32 bit counter (bytes 60 to 63) is set to zero at power up and increments approximately once per second.

Conversion Counter
The 32 bit counter (bytes 56 to 59) is set to 0 at power up and increments each time the RTD element is read.

Relay and LED
The relay and LED may operate in any of the following modes:

Mode	Bit L1 (LED) or R1 (Relay)	Bit L0 (LED) or R0 (Relay)
(0) On with any alarm, off if no alarms active*	0	0
(1) On with any alarm, off when clear alarms command received*	0	1
(2) On and Off under command using State bit (address 95)	1	0
(3) Always off	1	1

* Mode 0 and 1 uses hysteresis to avoid rapid changes in the LED and/or relay. The parameter is in alarm when it is greater than (high alarm) or less than (low alarm) the threshold value. It moves out of alarm when it is less than (high alarm) or greater than (low alarm) the threshold value plus the hysteresis:

- Temperature - 1°C
- RTD Resistance – 1 ohm

The relay is a latching relay; it retains its state when power is lost. The states of the relay and LED are stored in non-volatile memory and are restored at power-up. Since the relay is latching, its state remains the same, even when power is removed.

RTD Read Delay
This byte specifies a delay between reads of the RTD element; if set to 0, the RTD element is read every second. Each count adds about a second between reads, except the first count, which adds 2.6 seconds. (The additional 1.6 seconds is due to the setup time necessary to turn on the power to the RTD element.)

When the RTD element is to be read, a current source of 420 µAmp is turned on, then the device is read, and then the current source is turned off (unless the RTD Read Delay is zero, in which case the current source is on all the time). The current source is on about 1 second for each read, plus 1.6 seconds, of the RTD element. Without any delay programmed, reads occur continuously. With a 1 programmed, reads occur about every 2.6 seconds. Delays and duty cycles are related as follows:

RTD Read Delay	Time Between Reads* (Seconds)	Duty Cycle
0	1	100.00%
1	2.6	56.30%
2	3.6	41.40%
3	4.6	32.10%
4	5.6	26.50%
5	6.6	22.00%

* Note that the time between reads is not constant. It is variable on 1-Wire traffic, oscillator frequency of the process, etc. The above times and duty cycles are averages.

1-WIRE COMMUNICATIONS
The device communicates via 1-wire at standard speed only; overdrive is not supported. All memory pages are 32 bytes, CRC16 and a 32 byte scratchpad is used to write data to the device.

ROM Commands
After the bus master has detected a presence pulse, it can issue a ROM command. These commands operate on the unique 64-bit ROM codes of each slave device and allow the master to single out a specific device if many are present on the 1-Wire bus. These commands also allow the master to determine how many and what types of devices are present on the bus or if any device has experienced an alarm condition. There are five ROM commands, and each command is 8 bits long. The ROM commands function the same as on other 1-wire devices. The master device must issue an appropriate ROM command before issuing a function command.

Alarm Search ROM – 0xEC
The operation of this command is identical to the operation of the Search ROM command except that only slaves with a set alarm flag (bit 0-3 of byte 64) will respond. This command allows the master device to determine if any EDS Environmental sensor is in an alarm. After every Alarm Search cycle (i.e., Alarm Search command followed by data exchange), the bus master must return to Step 1 (Initialization) in the transaction sequence. See the Operation—Alarm Signaling section for an explanation of alarm flag operation.

Search ROM – 0xF0
When a system is initially powered up, the master must identify the ROM codes of all slave devices on the bus, which allows the master to determine the number of slaves and their device types. The master learns the ROM codes through a process of elimination that requires the master to perform a Search ROM cycle (i.e., Search ROM command followed by data exchange) as many times as necessary to identify all of the slave devices. If there is only one slave on the bus, the simpler Read ROM command (see below) can be used in place of the Search ROM process. For a detailed explanation of the Search ROM procedure, refer to the iButton® Book of Standards at www.maxim-ic.com/ibuttonbook. After every Search ROM cycle, the bus master must return to Step 1 (Initialization) in the transaction sequence.

Match ROM – 0x55
The match ROM command followed by a 64-bit ROM code sequence allows the bus master to address a specific slave device on a multi-drop or single-drop bus. Only the slave that exactly matches the 64-bit ROM code sequence will respond to the function command issued by the master; all other slaves on the bus will wait for a reset pulse.

Skip ROM – 0xCC
The master can use this command to address all devices on the bus simultaneously without sending out any ROM code information. For example, the master can clear all alarming EDS Environmental sensors on the bus perform simultaneous temperature conversions by issuing a Skip ROM command followed by a Clear alarms [0x33] command.

Note that the Read Scratchpad [0xAA] command can follow the Skip ROM command only if there is a single slave device on the bus. In this case, time is saved, by allowing the master to read from the slave without sending the device's 64-bit ROM code. A Skip ROM command followed by a Read Scratchpad command will cause a data collision on the bus if there is more than one slave since multiple devices will attempt to transmit data simultaneously.

Read ROM – 0x33
This command can only be used when there is one slave on the bus. It allows the bus master to read the slave's 64-bit ROM code without using the Search ROM procedure. If this command is used when there is more than one slave present on the bus, a data collision will occur when all the slaves attempt to respond at the same time.

Memory / Control Commands
Write scratchpad – 0x0F
Read scratchpad – 0xAA
Copy scratchpad – 0x55
Read memory no CRC – 0xF0
Read memory with CRC – 0xA5
Clear alarms – 0x33

Write Scratchpad – 0x0F

After issuing the Write Scratchpad command, the master must first provide the 2-byte target address, followed by the data to be written to the scratchpad. The data will be written to the scratchpad starting at the byte offset (T4:T0). The ending offset (E4:E0) will be the byte offset at which the master stops writing data. Only full data bytes are accepted. If the last data byte is incomplete, its content will be ignored.

When executing the Write Scratchpad command, the CRC generator inside the RTD calculates a CRC of the entire data stream, starting at the command code and ending at the last data byte sent by the master. This CRC is generated using the CRC16 polynomial by first clearing the CRC generator and then shifting in the command code (0Fh) of the Write Scratchpad command, the Target Addresses TA1 and TA2 as supplied by the master and all the data bytes. The master may end the Write Scratchpad command at any time. However, if the ending offset is 11111b, the master may send 16 read time slots and will receive an inverted CRC16 generated by the RTD.

Read Scratchpad – 0xAA

This command is used to verify scratchpad data and target address. After issuing the Read Scratchpad command, the master begins reading. The first 2 bytes will be the target address. The next byte will be the ending offset/data status byte (E/S) followed by the scratchpad data beginning at the byte offset (T4:T0). Regardless of the actual ending offset, the master may read data until the end of the scratchpad after which it will receive an inverted CRC16 of the command code, Target Addresses TA1 and TA2, the E/S byte, and the scratchpad data starting at the target address. After the CRC is read, the bus master will read logical 1s from the RTD until a reset pulse is issued.

Copy Scratchpad – 0x55

This command is used to copy data from the scratchpad to the writable memory sections. Applying Copy Scratchpad to the Relay/LED State Byte can control the relay and/or LED provided that functionality has been enabled (see Relay and LED section for details). After issuing the Copy Scratchpad command, the master must provide a 3-byte authorization pattern, which can be obtained by reading the scratchpad for verification. This pattern must exactly match the data contained in the three address registers (TA1, TA2, E/S, in that order). A pattern of alternating 1s and 0s will be transmitted after the data has been copied until the master issues a reset pulse.

The data to be copied is determined by the three address registers. The scratchpad data from the beginning offset through the ending offset will be copied, starting at the target address. Anywhere from 1 to 32 bytes may be copied to memory with this command.

Read Memory no CRC – 0xF0

The Read Memory command may be used to read the entire memory. After issuing the command, the master must provide the 2-byte target address. After the 2 bytes, the master reads data beginning from the target address and may continue until the end of memory, at which point logic 0s will be read. It is important to realize that the target address registers will contain the address provided. The ending offset/data status byte is unaffected.

To safeguard data in the 1-Wire environment when reading and to simultaneously speed up data transfers, it is recommended to make use of the Read Memory with CRC (0xA5) whenever possible. The 16-bit CRC ensures rapid, error-free data transfers that eliminate having to read a page multiple times to verify whether if the received data is correct.

Read Memory with CRC – 0xA5

The Read Memory with CRC command works essentially the same way as the simple Read Memory, except for the 16-bit CRC that the RTD Transmitter generates and transmits following the last data byte of a memory page.

After having sent the command code of the Read Memory with CRC command, the bus master sends a 2-byte address (TA1 = T7:T0, TA2 = T15:T8) that indicates a starting byte location. With the subsequent read data time slots the master receives data from the RTD Transmitter starting at the initial address and continuing until the end of a 32-byte page is reached. At that point the bus master will send 16 additional read data time slots and receive an inverted 16-bit CRC. With subsequent read data time slots the master will receive data starting at the beginning of the next page followed again by the inverted CRC for that page. This sequence will continue until the bus master resets the device.

With the initial pass through the Read Memory with CRC flow, the 16-bit CRC value is the result of shifting the command byte into the cleared CRC generator followed by the 2 address bytes and the contents of the data memory. Subsequent passes through the Read Memory with CRC flow will generate a 16-bit CRC that is the result of clearing the CRC generator and then shifting in the contents of the data memory page. After the 16-bit CRC of the last page is read, the bus master will receive logical 0s from the RTD Transmitter until a reset pulse is issued.

Clear Alarms – 0x33
The Clear Alarms command is used to set all bits at byte 54 to 0. The clearing the alarms has the ability to effect relay state, and LED state depending on the configuration. Additional information on the possible effects is available in *Relay and LED* and/or *Conditional Search* sections of the manual.

Family Code
The family code is 0x7E.

Tag
The tag provides identification for each EDS device type. It consists of three parts: the description, followed by the firmware version number and then the device ID number. The description is the product name as an ASCII text string; i.e. EDS0071 RTD-4Wire. The firmware version is a 2 byte number provided in BCD format, LSB first. For example: 0x36,0x01 represents the firmware version 1.36. The 2 byte device ID uniquely identifies this device from others with the same family code. This is also presented in BCD format, LSB first. Therefore 0x71,0x00 represents Device ID 0072. The device ID portion of the tag is duplicated at the beginning of the next page so that the user can read one page and retrieve all necessary information to work with the device.

2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	Version, low
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	Version, high
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	ID, low
2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	ID, high

Current EDS Device IDs

TAG ID	Tag Hex	Tag Bin (LSB first)	Features
EDS0064	0064	0110 0100 0000 0000	Temp
EDS0065	0065	0110 0101 0000 0000	Temp, humidity
EDS0066	0066	0110 0110 0000 0000	Temp, barometric pressure
EDS0067	0067	0110 0111 0000 0000	Temp, light
EDS0068	0068	0110 1000 0000 0000	Temp, Hum, BAR pressure and light
EDS0071	0071	0111 0001 0000 0000	RTD transmitter 4-Wire
EDS0072	0072	0111 0010 0000 0000	RTD transmitter 3-Wire

Specifications

PARAMETER	MIN	TYP	MAX	UNITS
Operating Temperature Range	-40	-	85	°C
Temperature Accuracy: -200 to 200°C	-0.025%	-	+0.025%	°C
Temperature Accuracy: -200 to 850°C	-0.050%	-	+0.050%	°C
RTD Element -200 to + 200°C (Type A)	-0.47	-	+0.47	°C
RTD Element -200 to + 650°C (Type A)	-1.235	-	+1.235	°C
Temperature Resolution	-	0.0004882	-	°C
Supply Voltage	4	-	18	Volts DC
Active Current (LED On)	-	11.4	-	mA
Standby Current	-	2.1	-	mA
Enclosure Dimensions (L x W x H)	4.109	2.233	1.594	Inches