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Working with the T8A 1-Wire 8-Channel Analog Input using the HA7

Submitted by chaywesley on Sat, 2006-01-28 16:15. [App Note](#) | [HA7E](#) | [HA7MP](#) | [HA7S](#) | [T8A / T8D / T8AD](#)

This document discusses the communications protocol and techniques required to interact with the T8A. Included are annotated examples and pseudo-code including the specific data to transmit, and typical responses received from an Embedded Data Systems HA7 1-Wire Bus Master to access the analog functionality of the T8A / T8AD.

The T8A / T8AD is a member of the EDS Analog family of devices which contains an 8 channel, 12 bit analog input module that has been outfitted with a Dallas Semiconductor 1-Wire front-end. The T8A incorporates a DS2406 Addressable Switch that sits on the 1-Wire bus and provides a 1-Wire gateway to the underlying 12-Bit analog subsystem. The DS2406 is also used to provide each T8A with a globally unique identifier, and other discovery / calibration data.

In the examples below, TX= data transmitted to the HA7, RX= the parsed data received from the HA7.

Discovering the Device.

During the manufacturing process, data is written into the OTP memory of the DS2406 that is on the T8A. By searching for all of the DS2406 devices on the 1-Wire bus and parsing their memory contents, application software can automatically locate and identify each of the T8A devices present on the 1-Wire bus.

Each T8A will have the following data written into memory page 1 on its DS2406 during the manufacturing process:

```
Bytes 2-5: 0x1D, 0x41, 0x31, 0x38 ("A189" -  
Indicates the DS2406 is connected as a gateway  
to a T8A)  
Bytes 11-14: 0x23, 0x4D, 0x35, 0x5A ("#M5Z" -  
Indicates the device was programmed by EDS)
```

The HA7's Read Page command can be used to easily read the contents of the DS2406 memory pages which can then be parsed for this information.

Initializing communications.

Communication with the analog subsystem on the T8 is accomplished by transmitting and receiving data on the PIO_A line of an onboard DS2406. All communications with the T8A's analog system begin by issuing the channel access command (0xF5) to the onboard DS2406, followed by channel control bytes of 0xA6 and 0xFF. This places the DS2406 in PIO toggle write/read mode, with a CRC-16 after every 8 bytes. Note that anytime the 1-Wire bus is reset, the DS2406 will exit this mode. It is therefore generally necessary to include this step at the beginning of every communication cycle with the T8A.

Determining the analog level present at any of the 8 input channels.

After initializing the DS2406, the analog value at any of the 8 input channels can be read. Data is read at the rate of one channel per write/read cycle, but any number of these cycles can be performed without need for resetting the 1-Wire bus and re-initializing the DS2406.

The entire write/read cycle (excluding the DS2406 initialization, above) consists of 8 data bytes and 2 CRC bytes. The first 4 bytes start the process by multiplexing the onboard A/D circuit to the desired input channel and triggering the A/D conversion. The second 4 bytes are where the results of the A/D process are read back from the T8A. The final two bytes of the 10 byte sequence contain the CRC-16 of the previous 8 bytes.

Byte 0 in this sequence is where you specify which of the 8 analog channels you want to sample. Specifically, the most significant 6 bits represent a 0-based analog channel number. The two least significant bits are always 0x02. In other words:

```
byte0 = (((channelNumber - 1) << 2) + 0x02);
```

The entire 10 byte cycle is detailed here, with an example following:

Byte Sequence for T8A Series Analog Data Read

Byte	Read / Write	Value	Example	Function
0	W	AAAAAA10	0x02	A5-A0,1,0 (start bit + 0 based analog channel address)

1	R	-----	0x00	Read, meaningless
2	W	-----	0xFF	Write, meaningless
3	R	-----	0xFF	Read, meaningless
4	W	11111111	0xFF	Write, must be all ones
5	R	a4-a11	0xBE (10111110)	Read, raw analog msb bits a4-a11
6	W	11111111	0xFF	Write, must be all ones
7	R	1111,a0- a3	0xF8 (11111000)	Read, 1111, raw analog lsb bits a0-a3
8	R	-----	0x7E	Read, CRC-16 MSB
9	R	-----	0x3E	Read, CRC-16 LSB

An annotated example showing how to initialize the DS2406 and sample the analog value of channel 1 using the HA7's Write Block command is as follows:

Start by configuring the DS2406 as discussed in 'Initialize communications', above. This properly configures the DS2406 to allow you to communicate with the T8A analog subsystem.

```
TX: W04F5A6FFFF (the trailing FF is needed
to read back the channel info byte.)
RX: F5A6FFC7
```

Now perform a 10 byte write/read cycle, instructing the T8A to perform an A/D conversion on channel 1, and read the results back:

```
TX: W0A02FFFFFFFFFFFFFFFFFFFFFFF (0x02 =
(((channelNumber - 1) << 2) + 0x02)
RX: 0200FFFFFFFFBEFFF87E3E
```

Parsing the response received, the following is determined:

Raw analog bits 4-11 = 0xBE

Raw analog bits 0-3 = Contained in byte 0xF8 (This byte also contains other bits which must be masked out.)

Other channels could now be read in succession without resetting the 1-Wire bus. The example above could move on to read channel two on the T8A by issuing the following to the HA7:

```
TX: W0A03FFFFFFFFFFFFFFFFFFFFF
RX: 0300FFFFFFBEBFF87E3E
```

Interpreting the Results

The analog data a4-a11 and a0-a3 are in one's complement form and bit backwards in the received bytes. The actual raw analog value can be derived by performing a one's complement, reversing the bits in both bytes, multiply the first byte by 16 and add the second byte divided by 16, or; Reverse and compliment, [a4-a11] becomes [A11-A4] and [1111,a0-a3] becomes [A3-A0,0000], shift the entire word [A11-A4][A3-A0,0000] right 4 places. The result is [0,0,0,0,A11,A10,A9,A8,A7,A6,A5,A4,A3,A2,A1,A0] .

Annotating the example above:

```
[a4-a11] = 0xBE = 10111110 (Parsed from data
stream)
[1111,a0-a3] = 0xF8 = 11111000 (Parsed from data
stream)
[A11-A4] = 0x82 = 10000010 (One's complement and
reversed)
[A3-A0, 0000] = 0xE0 = 11100000 (One's complement
and reversed)
[0,0,0,0,A11,A10,A9,A8,A7,A6,A5,A4,A3,A2,A1,A0]
= 0x082E (Assemble word and shift right 4 bits.)
```

The raw data is scaled 0-4096, so a conversion to engineering units (volts) is typically desired. For the T8A, this can be performed as follows:

Volts = AnalogValue * (5 / 4096).

For the example above: Volts = 0x082E * (5 / 4096) = 2.556

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