Tecnología Aplicada
a la Información

Preliminary

1-Wire® Pressure Sensor

TAI8570

Features

- **Pressure range 300-1100mbar**
- **15 bit a/d converter.**
- **Temperature sensor included.**
- **No external power supply needed**
- **Calibration constants included on ROM memory.**
- **DS2406 1-Wire® based front end**
- **Available option with Dallas Semiconductors TAG-ID standard for electronic identification of function.**
- **Simple interconnect through RJ11 connectors.**
- **Unique 1-WireÒ address permits multiple sensors on network**

Description

The TAI8570 1-wire pressure sensing module is a fully integrated device that allow pressure measurement on 1-wire based networks. The module is based on the INTERSEMA MS5534A pressure sensing IC. This integrated device has a measure range of 300 to 1100 mbar .

The integrated circuit has a 3-wire interface to a microcontroller host. The conversion from 3-wire interface to 1-wire interface is made by means of two DS2406 Dallas Semiconductor 1-wire switches. One switch is used to write to the pressure sensor, the other switch used to read the different values from the sensor . The unit is fully identified and addressed by the DS2406 unique 64 bit serial numbers. The DS2406 used to write to the sensor has the Vcc tied to 5 volts the PIO A connected to the CLK and PIO B to the data in pins of the MS5534A sensor The DS2406 used to read information

from the sensor has the Vcc pin connected to ground, the PIOA pin to the SCLK pin and the PIOB to the DOUT pin of the sensor.

To allow simple identification of which DS2406 belong to each TAI8570 adapter on a network with multiple modules, two different options are available. The simplest one and is included on all TAI8570 modules is a TMEX format file named 8570.000 present on one of the DS2406. This file contains the unique serial number of the second DS2406 available on the module. In this way both DS2406 that belong to each TAI8570 can be identified.

The second method is only available on the TAI8570-T wich includes a XML tag file on a 1-Wire EPROM memory DS2505 that identifies the module, this function and components to the 1-Wire network host. More information about the file can be found in the application note "AP158 1-Wire Tagging with XML" at www.dalsemi.com .

The power needed by the unit to work is obtained directly from the 1-wire bus without need of an external power supply.

More information about the MS5534A can be obtained at www. aagelectronica.com or directly at www.intersema.com , the recomended documents are DA5534_022.doc and the AN501 "Using MS5534 for Altimeters and Barometers "

Information about DS2406s can be found at. www.aagelectronica.com or www.dalsemi.com. Sample code in Delphi and Java can be obtained at www.aagelectronica.com

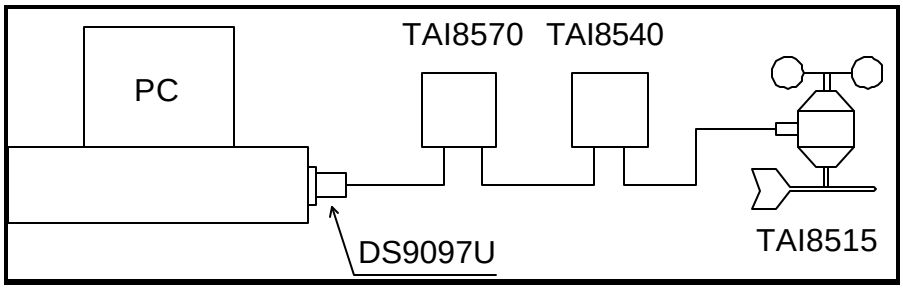
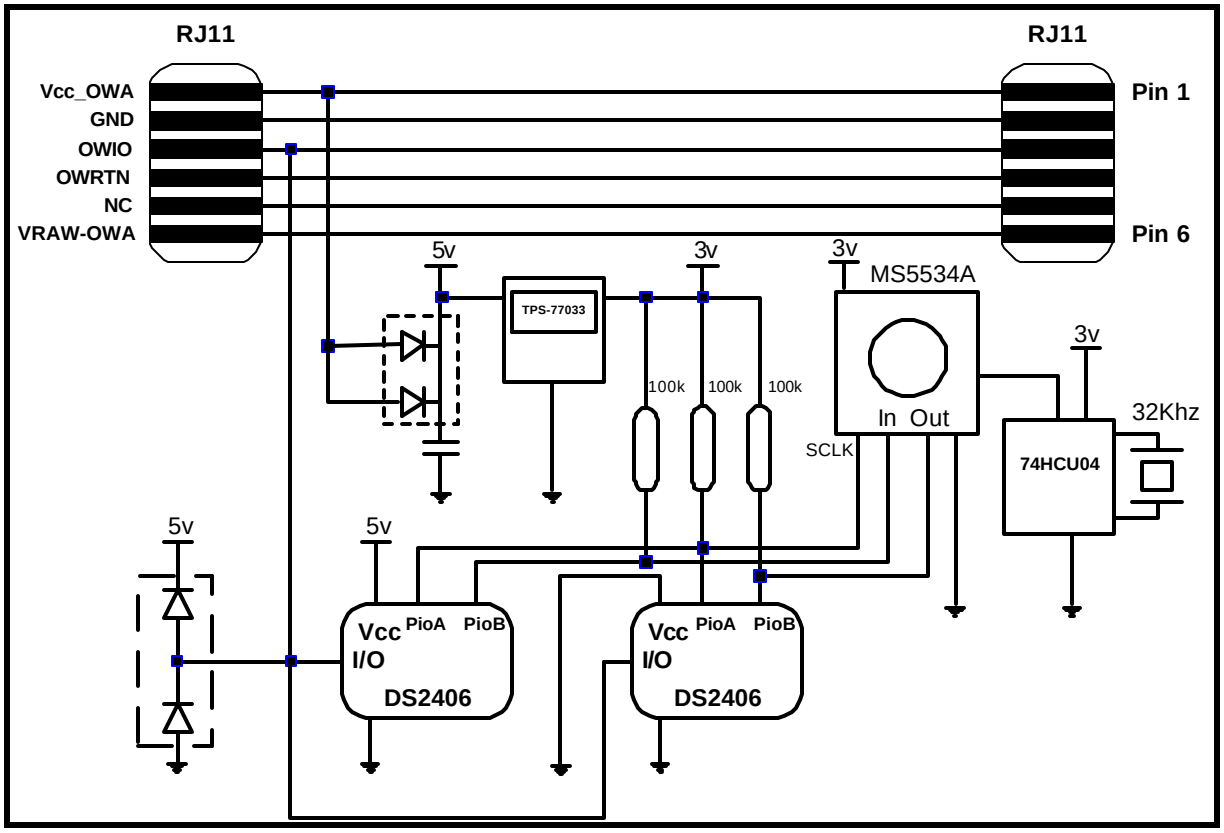


Fig #1
Possible 1-wire network configuration

Schematic:



Operation:

As previously mentioned the MS5534 consists of a piezoresistive sensor and sensor interface IC. The main function of the MS5534 is to convert the uncompensated analog output voltage from the piezoresistive pressure sensor to a 16-Bit digital value, and provide a 16-Bit digital value for the sensor temperature.

- measured pressure (16-Bit) "D1"
- measured temperature (16-Bit) "D2"

As the output voltage of a pressure sensor is strongly dependent on temperature and

process tolerances, it is necessary to compensate for these effects. This compensation procedure must be performed by the software on the host computer.

Factory calibration

Every module is individually factory calibrated at two temperatures and two pressures. As a result, 6 coefficients necessary to compensate for process variations and temperature variations are calculated and stored in the 64- Bit PROM of each module. These 64-Bit (partitioned into four words of 16-Bit) must be read by the host software and used in the program converting D1 and D2 into compensated pressure and temperature values.

Pressure and temperature measurement

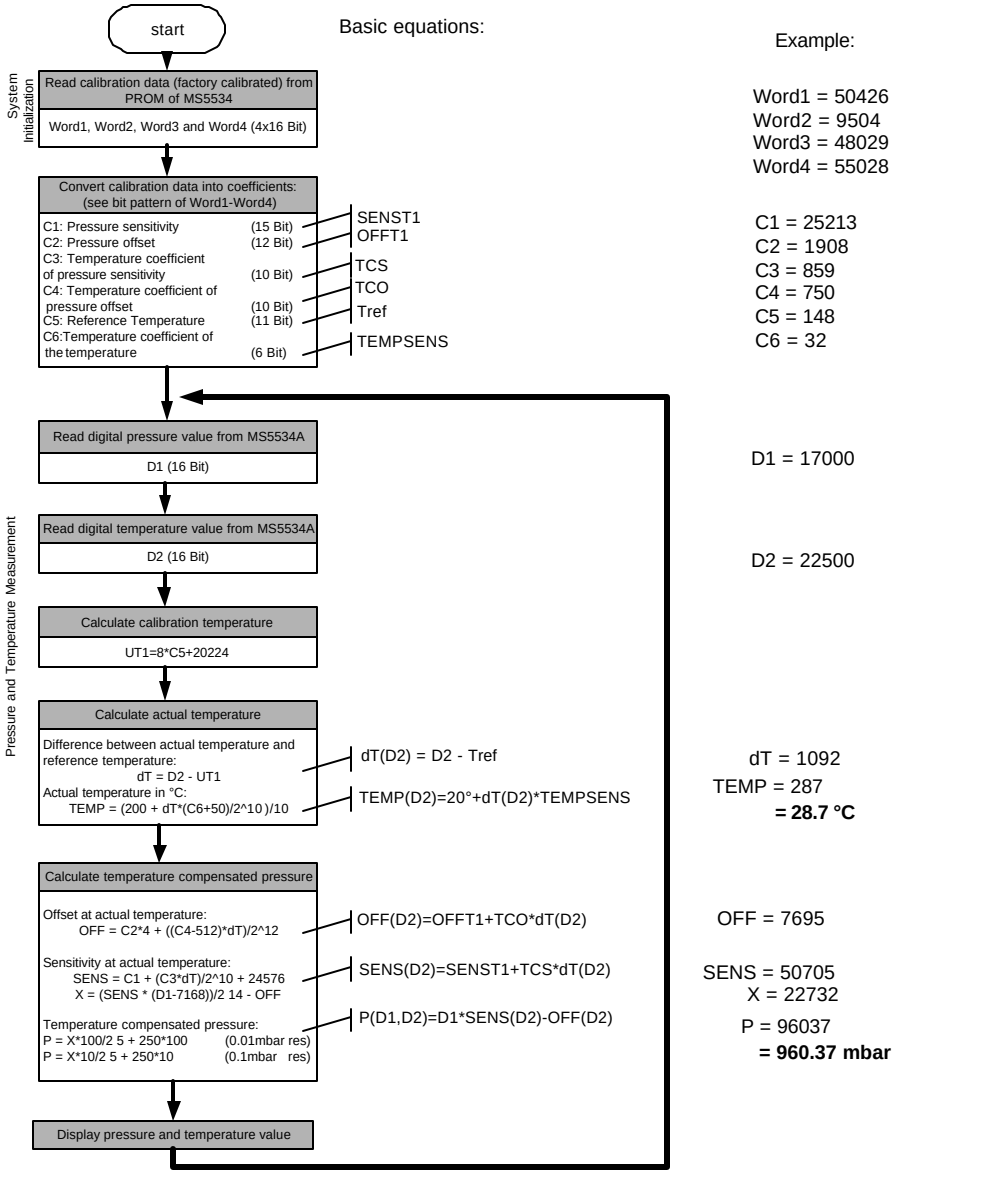
The sequence of reading pressure and temperature as well as of performing the software compensation is depicted in flow chart, Fig. 2 .

First the WORD1 to WORD4 have to be read through the serial interface. This can be done once after reset of the computer that interfaces to the MS5534. Next the compensation coefficients C1 to C6 are extracted using Bit-wise logical- and shift-operations (refer to Fig#3 for the Bit-pattern of word 1 to word 4).

For the pressure measurement the host has to read the 16 Bit values for pressure (D1) and temperature (D2) via the 1-Wire interface in a loop (for instance every 10 seconds). Then, the compensated pressure is calculated out of D1, D2 and C1 to C6 according to the algorithm in Fig. 2 . All calculations can be performed with signed 16-Bit variables.

Results of multiplications may be up to 32-Bit long (+sign). In the flow according to Fig. 2 each multiplication is followed by a division. This division can be performed Bit wise by shifting (divisors are to the power of 2).
It is ensured that the results of these divisions are less than 65536 (16-Bit).

For the timing of signals to read out WORD1 to WORD4, D1, and D2 please refer to the paragraph “Serial Interface”.



Notes:
1. Readings of D2 can be done less frequently, but the display will be less stable in this case
2. For a stable display of 0.1mbar resolution, it is recommended to display the average of 8 sequential pressure values.

Fig #2

	C1 (15 Bit)														C5/I 1 bit
Word 1	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	DB10
	C5/II (10 Bit)										C6 (6 Bit)					
Word 2	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	DB5	DB4	DB3	DB2	DB1	DB0
	C4 (10 Bit)										C2/I (6 Bit)					
Word 3	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	DB11	DB10	DB9	DB8	DB7	DB6
	C3 (10 Bit)										C2/II (6-Bit)					
Word 4	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	DB5	DB4	DB3	DB2	DB1	DB0

Fig.#3

Serial interface

The MS5534 communicates with the host and other digital systems via a 3-wire synchronous serial interface as shown in Fig. 1. The SCLK (Serial Clock) signal initiates the communication and synchronizes the data transfer with each Bit being sampled by the MS5534 on the rising edge of SCLK and each Bit being sent by the MS5534 on the rising edge of SCLK. The data should thus be sampled by the host on the falling edge of SCLK and sent to the MS5534 with the falling edge of SCLK. The SCLK-signal is generated by the host system. The digital data provided by the MS5534 on the DOUT pin is either the conversion result or the software calibration data. In addition the signal DOUT (Data Out) is also used to indicate the conversion status (conversion-ready signal, see below). The selection of the output data is done by sending the corresponding instruction on the DIN (Data Input) pin.

Following is a list of possible output data instructions:

- Conversion start for pressure measurement and ADC-data-out “D1” (Figure 4a)
- Conversion start for temperature measurement and ADC-data-out “D2” (Figure 4b)
- Calibration data read-out sequence for word 1 (Figure 4c)
- Calibration data read-out sequence for word 2 (Figure 4d)
- Calibration data read-out sequence for word 3 (Figure 4c)
- Calibration data read-out sequence for word 4 (Figure 4d)
- RESET sequence (Figure 4e)

Every communication starts with an instruction sequence at pin DIN. Fig. 4 shows the timing diagrams for the MS5534. The device does not need a ‘Chip select’ signal. Instead there is a Start Sequence (3-Bit high)

before each Setup Sequence and Stop Sequence (3-Bit low) after each Setup Sequence. The Setup Sequence consists in 4-Bit that select a reading of pressure, temperature or calibration data. In case of pressure- (D1) or temperature- (D2) reading the module acknowledges the start of a conversion by a low to high transition at pin DOUT during the last bit of the Stop Sequence.

Two additional clocks at SCLK are required after the acknowledge signal. Then SCLK is to be held low by the host until a high to low transition on DOUT indicates the end of the conversion.

The host may now read out the 16-Bit word by giving another 17 clocks on the SLCK pin. It is possible to interrupt the data read-out sequence with a hold of the SCLK signal.

It is important to always read out the last conversion result before starting a new conversion.

The RESET-sequence is special as its unique pattern is recognized by the module in any state. By consequence it can be used to restart if synchronization between the microcontroller and the MS5534 has been lost. This sequence is 21-Bit long. The DOUT signal might change during that sequence (see Fig. 4e).

It is thus recommended to send the RESET-Sequence before each Conversion Sequence to avoid hanging up the protocol permanently in case of electrical interference.

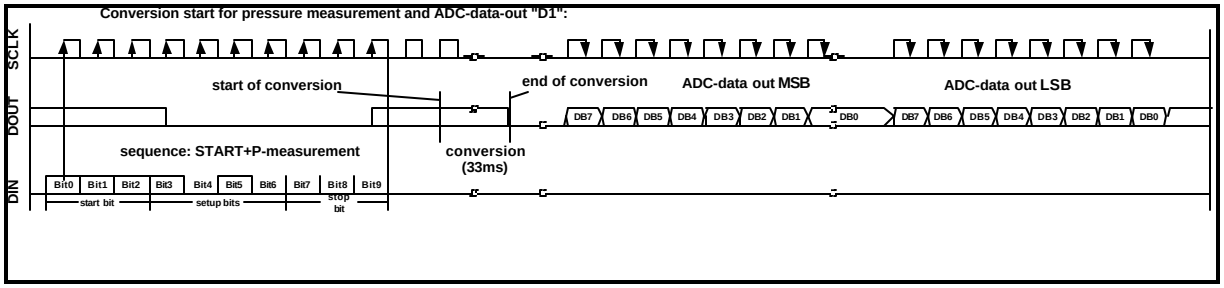


Fig. #4a

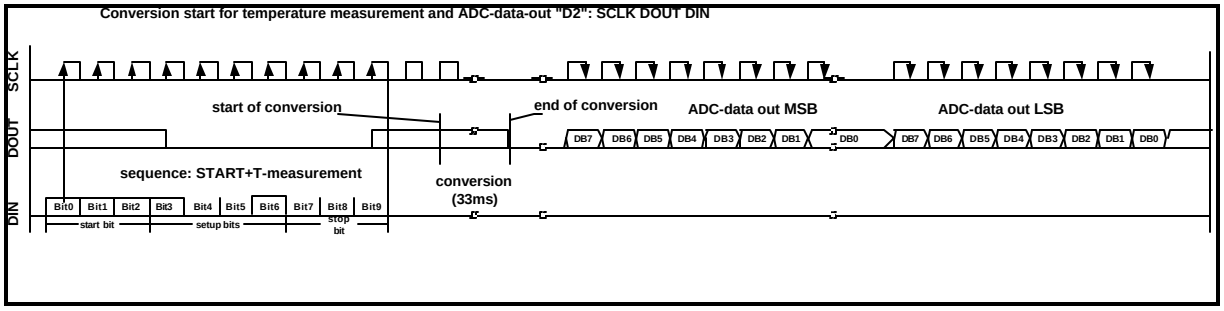


Fig.#4b

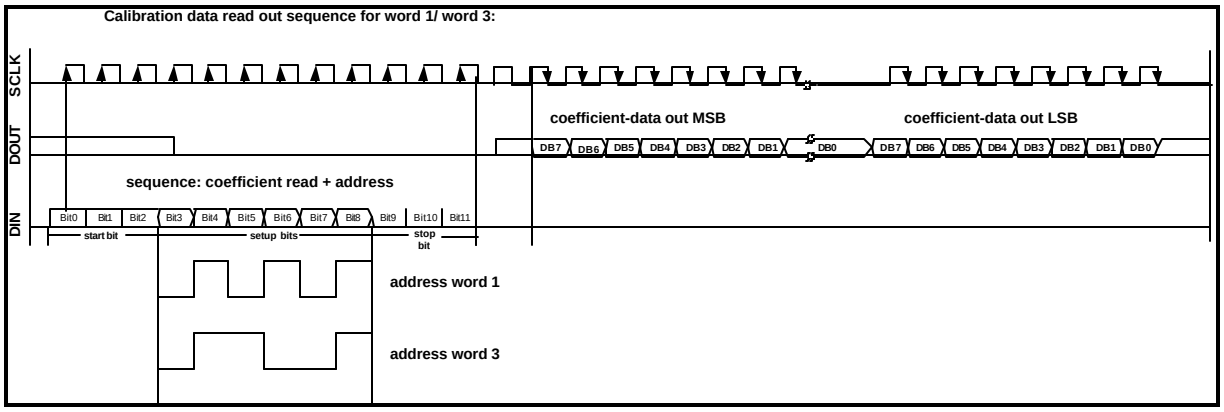


Fig.#4c

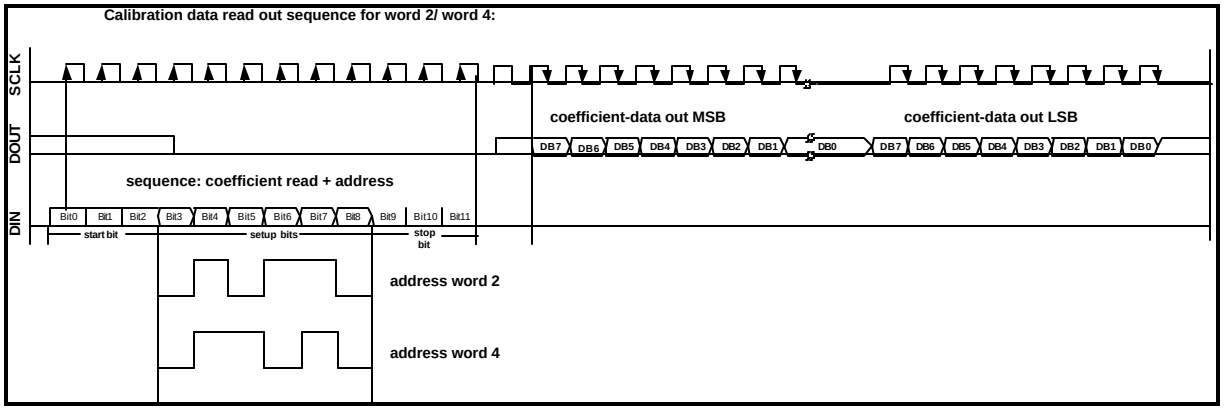


Fig.#4d

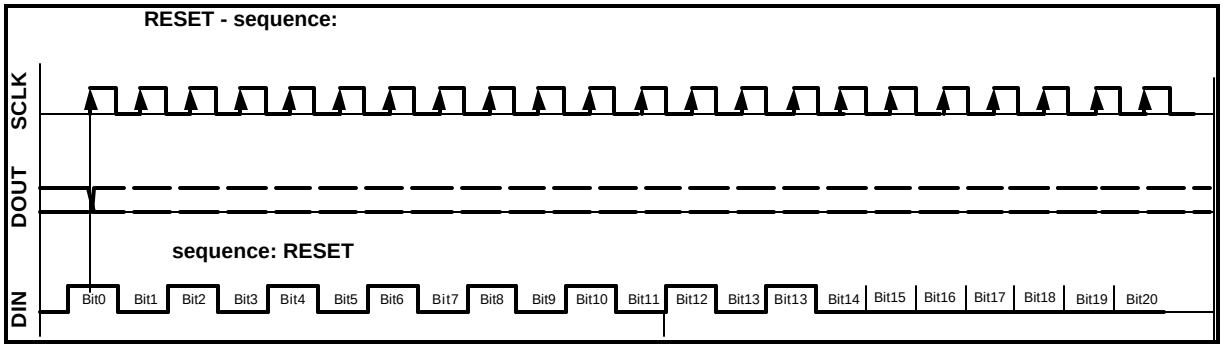


Fig.#4e

1-Wire Serial Interface.

As mentioned before, the conversion between 1-Wire protocol and 3-Wire protocol is realized using two DS2406 1-Wire switches. One switch provides the CLK and DOUT signals, and we call it the WRITE_DS2406.

The second DS2406 provides the CLK and DIN signals, and we call it the READ_DS2406.

To find the two DS2406 that belong to a particular TAI8570 module, the software should look for a file named 8570.000 on all the DS2406 connected to the network. Once found, in this file address of the associated DS2406 for this module is located. To identify which DS2406 is the WRITE_DS2406 and which one is the READ_DS2406 the status word on each switch need to be read. For the WRITE_DS2406 the Vcc line is connected to 5 volts and on the READ_DS2406 the Vcc line is connected to ground.

So once the WRITE_DS2406 and the READ DS2406 are located, the host must be ensure that on both ICs the CLK line (PioA) is high. This is very important because the CLK line is a "wired-and" of the PioA of the two IC. If one of the DS2406 keeps the CLK line in '0' this prevents the associated DS2406 from interacting with the CLK line.

PioA Read DS2406	PioA Write DS2406	CLK
LOW	LOW	LOW
LOW	HIGH	LOW
HIGH	LOW	LOW
HIGH	HIGH	HIGH

Write cycles with the WRITE DS2406:

As mentioned before the WRITE_DS2406 is used to generate the waveforms needed to write the different values to the MS5534.

The following is a suggested algorithm to write bits to the MS5534 in pseudocode:

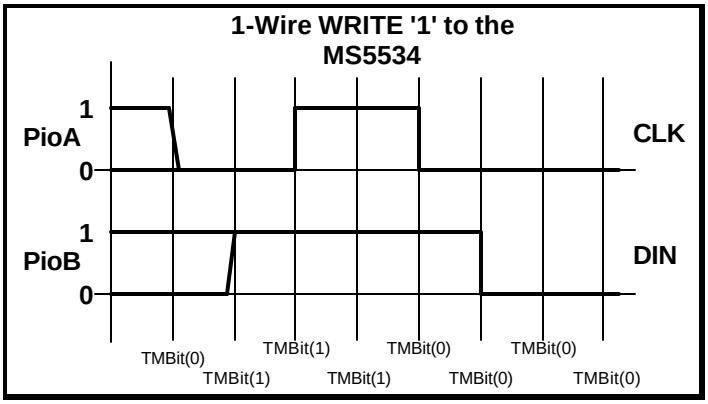
Previously the following code should be executed.

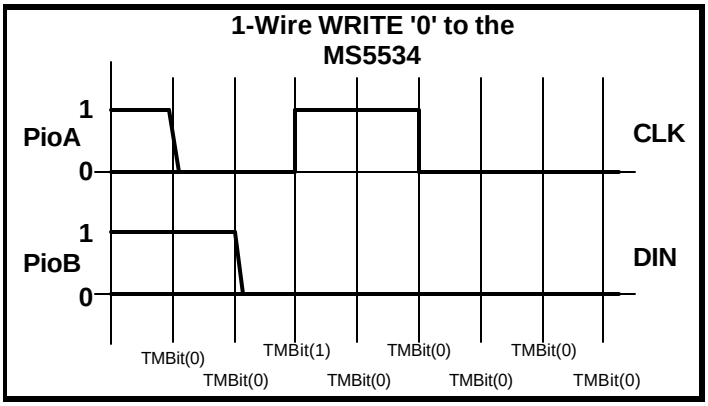
```
Select (WRITE DS2406)
Control 1 = 0x8C     { Activity Latch Reset + CHS1 + CHS0 bits }
Control 2 = 0xFF     { All bits in '1' }
DS2406ChannelAccess(Control 1 ,Control 2, ACInfo)
```

```
Procedure SendBit(Value : Boolean);
        Begin
          if Value  Then
           Begin
                  TMBit(0);    {write PIOA }        {TMEX  API Function }
                  TMBit(1);    {write PIOB }
                  TMBit(1);    {write PIOA }
                  TMBit(1);    {write PIOB }
                  TMBit(0);    {write PIOA }
                  TMBit(0);    {write PIOB }
                  TMBit(0);    {write PIOA }
                  TMBit(0);    {write PIOB }
           End
          Else
           Begin
                  TMBit(0);    {write PIOA }
                  TMBit(0);    {write PIOB }
                  TMBit(1);    {write PIOA }
                  TMBit(0);    {write PIOB }
                  TMBit(0);    {write PIOA }
                  TMBit(0);    {write PIOB }
                  TMBit(0);    {write PIOA }
                  TMBit(0);    {write PIOB }
           End;
        End;
```

Explanation :

First the WRITE_DS2406 is selected, and the channel access mode is selected. The DS2406 is configured to write each received bit on the 1-wire interface with the following sequence : (write a , write b) four times. This is done with the command code 0x8C. (for more information about this operation mode please refer to de document "DS2406 Dual Addressable Switch Plus 1K–Bit Memory" data sheet, this document can be found at www.dalsemi.com) . Follows a time diagram with the results of this operations:





IMPORTANT: Remember after the last write cycle to set the PioA of the WRITE_DS2406 to the High State, to allow the READ_DS2406 to operate.

Read cycle with the READ DS2406:

The read cycle is similar to the write cycle, in this case the READ_DS2406 is used and the Control 1 command on the channel access is different. Remember that for reading the PioB on the READ DS2406 should be in high state.

The following is a suggested algorithm to read bits from the MS5534 in pseudocode:

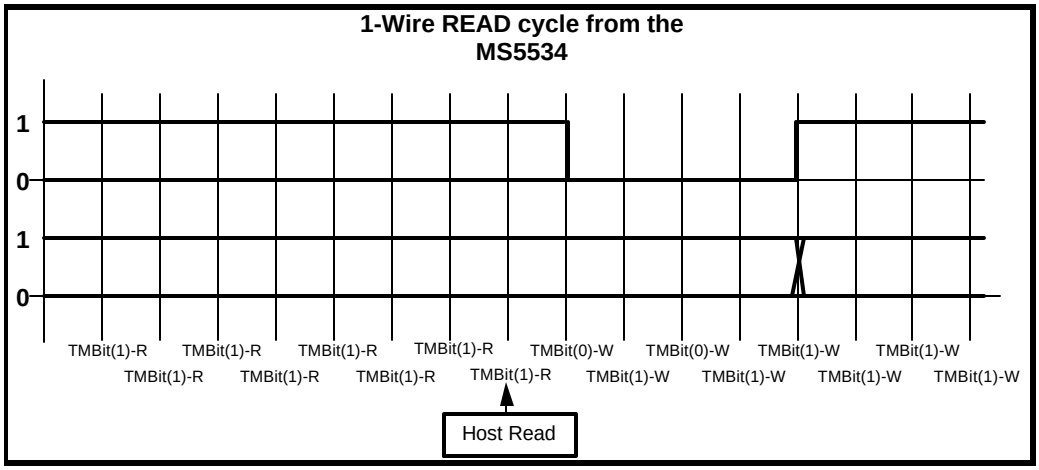
Previously the following codes should be executed.

```
Select (READ DS2406)
Control 1 = 0xEC     { Activity Latch Reset + IM+ TOG + CHS1 + CHS0 bits }
Control 2 = 0xFF     { All bits in '1' }
DS2406ChannelAccess(Control 1 ,Control 2, ACInfo)

Function  ReadPressureBit: Byte;
        Var Res : Byte;

        Begin
            Res = 0;
            TMBit(1); {READ PioA}        // TMEX API Function
            TMBit(1); {READ PioB}
            TMBit(1); {READ PioA}
            TMBit(1); {READ PioB}
            TMBit(1); {READ PioA}
            TMBit(1); {READ PioB}
```

```
                TMBit(1);          {READ PioA}
                Res = TMBit(1);    {READ PioB}
                TMBit(0);          {WRITE PioA}
                TMBit(1);          {WRITE PioB}
                 TMBit(0);         {WRITE PioA}
                 TMBit(1);         {WRITE PioB}
                 TMBit(1);         {WRITE PioA}
                 TMBit(1);         {WRITE PioB}
                 TMBit(1);         {WRITE PioA}
                 TMBit(1);         {WRITE PioB}
                  Result = Res;
End;
```

Explanation :

First the READ DS2406 is selected, and the channel access mode is selected. The DS2406 is configured to read the first four bits and then to write each received bit on the 1-wire interface with the following sequence : (read a, read b) four times then (write a , write b) four times. This is done with the command code 0xEC. (for more information about this operation mode please refer to de document "DS2406 Dual Addressable Switch Plus 1K–Bit Memory" data sheet, this document can be found at www.dalsemi.com) . Follows a time diagram with the results of this operations:

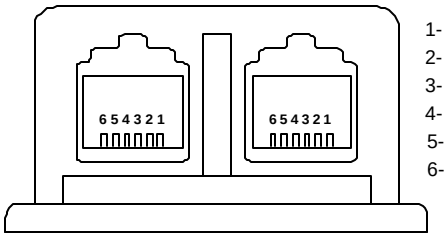


Note: From the diagram we can see that the moment when the host reads the bit value is with the CLK in high position instead of what is recommended on the MS5534 Time diagram. The reason for this is because the DS2406 is programmed to perform 4 reads and the 4 writes, that forces to make the reading at the first part of the total cycle, and this has the effect that the data bit is going to be read by the host at the end of the reading cycle just before the CLK changes. Because the cycles are so slow, we consider that the bit value is stable at this point.

Connector Pinout:

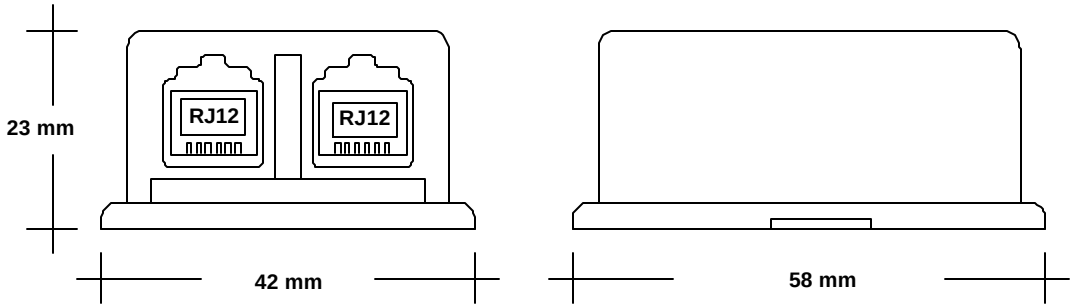
As all TAI85xx family of modules, two RJ12 female connectors are provided. This forms a "passthru" connection and that allow inserting the module on any 1-Wire network. Care should be taken when installing the module on a network that contains the TAI8515 1-Wire weather instrument. If only the Data and Ground conductors are going to be used there is no problem. But if the network is using the rest of the conductors, then care should be taken on the fact the TAI8515 is not fully compliant with the pinout convention for 1-Wire networks. Please verify this before applying power to the network. This situation can damage the module or other components on the network. For more information about this matter we recommend to read the FAQ section on www.aagelectronica.com site.

The pin distribution on the TAI8570 1-Wire pressure sensor is as follows:



1- 5v Reg. Input
2- GND
3- 1-Wire Data
4- 1-Wire GND
5- No Connect
6- 12v Unreg

Dimensions:



Important:

This product is not designed, intended or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of a product of could create a situation where personal injury or death may occur.

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Ordering Information :

TAI8570-X

T Option= DS2505 with TAG-ID &
TAG-XML files included