Datasheet ESCP2 - MIS2

MEMS Capacitive Pressure Sensor

- Capacitive Pressure Sensor
- Absolute operation
- Calibrated & Temperature Compensated
- High Resolution
- Pressure range : up to 30 bara
- Digital interface (I^2C)
- RoHS COMPLIANT
- Small Size

* Image for illustration purposes only, the product may vary according to customer configuration

Product Summary

ES Systems has developed a series of pressure sensor modules targeting a variety of markets. Each module integrates an oil filled pressure capsule equipped with a medium isolation diaphragm that protects the MEMS capacitive pressure sensor die. The capsule housing is manufactured from stainless steel. The module can be fitted on a larger housing with a pressure port either by welding or by fitting and O-ring sealing.

The ESCP-MIS2 sensor incorporates the ES Systems capacitive MEMS sensor which is based on ES' proprietary SOI micro-fabrication TM30 process for absolute capacitive pressure sensors.

The digital output is fully calibrated and temperature compensated based on the internal temperature sensor and the factory calibration coefficients which are stored in the embedded memory.

The sensor provides high accuracy 32-bit pressure and temperature outputs.

Typical Applications

- Medical
- Industrial
- Consumer goods
- General instrumentation

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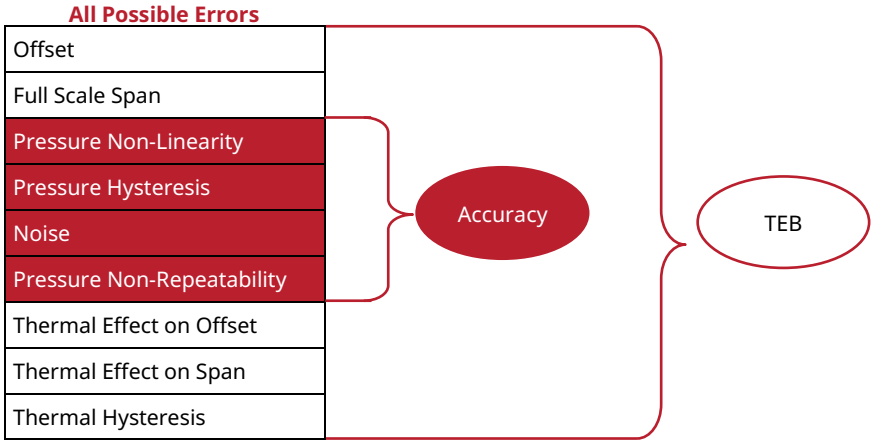
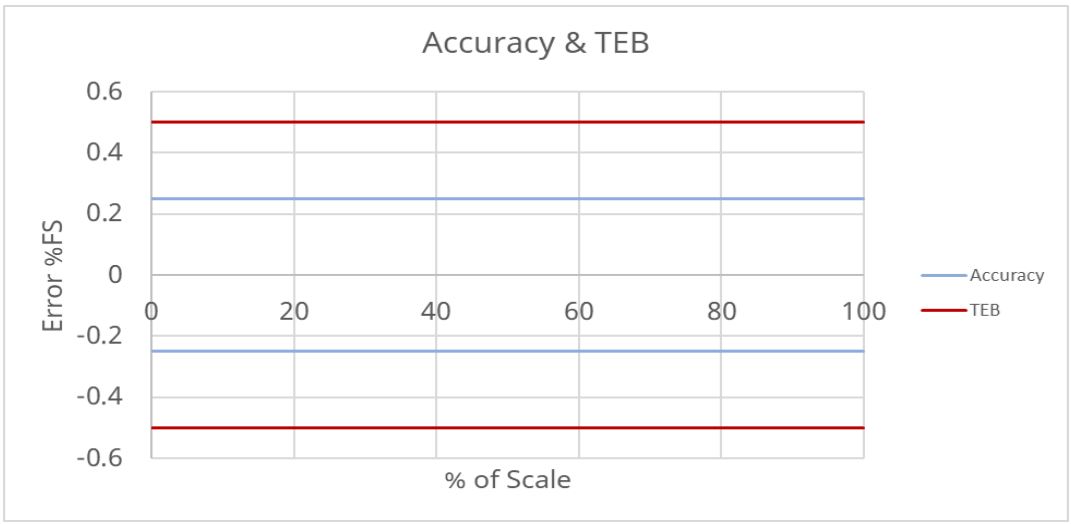
1. Total Error Band

Total Error Band (TEB) is a single specification that includes all possible sources of error in a pressure measurement. TEB should not be confused with accuracy, which is actually a component of TEB. TEB is the worst error that the sensor could experience. The TEB specification on a datasheet may be confusing. ES Systems uses the TEB specification in its datasheet because it is the most comprehensive measurement of a sensor's true accuracy. ES Systems also provides the accuracy specification in order to provide a common comparison with competitors' literature that does not use the TEB specification.



The figure below, illustrates the accuracy as well as the total error of the pressure measurement of ESCP-MIS2 sensors.



Accuracy Performance

Range: 2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 18, 20 bar

0% FS to 100%FS = ±0.25%FS

Total Error Band Performance

Range: 2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 18, 20 bar

0% FS to 100%FS = ±0.5%FS

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2. Absolute Maximum Ratings[1]

Characteristic	Min.	Max.	Unit
Supply voltage (V_{supply})	2.7	5.6	Vdc
Voltage on any pin	-0.3	5.5	V
Current on any pin	-	5	mA
Burst pressure	-	50	bara
Storage temperature	-30[-22]	+100[+212]	°C[°F]
Maximum pressure applied	-	50	bara

[1] Absolute maximum ratings are the extreme limits the device will withstand without damage. The electrical and performance characteristics are not guaranteed as the maximum limits are approached, nor will the device necessarily operate as specified at absolute maximum ratings. Prolonged operation at absolute maximum ratings will degrade the device performance

CAUTION
IMPROPER HANDLE
Do not touch the sensing membrane.
Failure to comply with the instructions may result in product damage.

CAUTION
PRODUCT DAMAGE
Do not disassemble these products.
Failure to comply with the instructions may result in product damage.

3. Operating Specifications

Characteristic	Min.	Typ.	Max.	Unit
Supply voltage (V_{supply})[1]	2.7	3.3	5.3	V
Supply current	-	-	4.0	mA
Output	Calibrated Pressure			-
Output Interface	I^2C			-
Digital bus frequency	-	-	100	kHz
I^2C/SPI voltage Level Low High	 - 80	 - -	 20 -	 %V_{supply}
Pull up on SDA / SCL	4.7	-	-	kOhm
Start-up time[2]	-	100	-	msec
Operating temp. range	-20[-4]	-	+80[+176]	°C[°F]
Relative humidity (non-condensing)	0	-	95	% RH Non Condensing
Material	Stainless Steel 316Ti			-
Filling Oil	Silicon oil			
Sealing type	O-ring			-
Media Compatibility	Gases, liquids			-

[1]The sensor is not reverse polarity protected. Incorrect application of supply voltage or ground to the wrong pin may cause electrical failure.
[2]After 95% of V_{supply} reached.

4. Pressure Sensor Specifications

Characteristic	Absolute			Unit
	Min.	Typ.	Max.	
Pressure Type	absolute			-
Pressure Range	Up to 30			bara
Full scale ranges	2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 18, 20, 28, 30			bara
Compensated temp range[1] Option 01	5[41]	-	+50[+122]	°C[°F]
Effective Resolution Response Time (15Hz)	-	13	-	bits
Total error band[2] 5 to +50 °C	-	±0.5	-	%FS[3]
Accuracy[4]	-	±0.25	-	%FS
Long term stability[5]	-	-	±0.25	%FSS[6]

[1] The temperature range over which the sensor will produce an output proportional to pressure within the specified performance limits. Note that for valid datasheet values, ambient and medium temperatures must be the same

[2] The maximum deviation from ideal transfer function over the entire compensated temperature and pressure range. Includes all errors due to offset, full scale span, accuracy, thermal effect on offset, thermal effect on span and thermal hysteresis

[3] % of the full scale

[4] The maximum deviation in output from a Best Fit Straight Line (BFSL) fitted to the output measured over the pressure range at 21°C [69.8°F]. Includes all errors due to pressure non-linearity, pressure hysteresis, non-repeatability and noise

[5] Accelerated Life Test Profile: 100hours at 90°C

[6] Full Scale Span (FSS): The algebraic difference between the output signal measured at the maximum (P_{max}) and the minimum (P_{min}) limits of the pressure range

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5. Pressure Range Specifications

Pressure Range	Pressure Range		Unit	Proof Pressure[1]	Burst Pressure[2]
	P_{min}	P_{max}		Port	Port
Absolute					
002BA	0.25	2	bar	10	10
005BA	0.25	5	bar	20	30
006BA	0.25	6	bar	20	30
007BA	0.25	7	bar	20	30
008BA	0.25	8	bar	20	30
009BA	0.25	9	bar	20	30
010BA	0.25	10	bar	30	30
012BA	0.25	12	bar	30	30
014BA	0.25	14	bar	30	30
018BA	0.5	18	bar	30	30
020BA	0.5	20	bar	30	30

[1] Overpressure: The maximum pressure which may safely be applied to the product for it to remain in specification once pressure is returned to the operating pressure range. Exposure to higher pressures may cause permanent damage to the product. Unless otherwise specified this applies to all available pressure ports at any temperature with the operating temperature range

[2] Burst pressure: The maximum pressure that may be applied to the specified port (P1 or P2) of the product without causing escape of pressure media. Product should not be expected to function after exposure to any pressure beyond the burst pressure

6. Wetted Matterials[1]

Component	Pressure Port Dry Gas or Liquid Media
Material	Stainless Steel 316Ti
O-ring	FKM[3]
Weight	10g

[1] Contact ESS Customer Service for detailed material information

[2] Titanium, Hastelloy are also available

[3] EPDM, NBR, VMQ, HNBR are also available

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7. Data & Register Description

The ESCP2-MIS2 sensors provide measurement for **Pressure** and **Temperature**. The data are stored in specific data registers as described below. It provides a 32-bit, 2's complement, fixed-point digital output which corresponds to the calibrated and temperature compensated data. The calibrated data are calculated by the calibration and temperature compensation logic unit, after the programming of the proper calibration coefficients (Factory Programmed). The calibrated data can be read as described in the following pseudo code. The four registers which compose the 32-bit calibrated data should be read using a multiple read transaction of 4 bytes in order to assure that the 4 bytes read correspond to the same data sample. In the case of temperature readout the user must perform an 8 byte read transaction to get all the information of the current sample measurement .

The standard slave address is 0x5A, with standard 7-bit addressing and write/read bit.

Pressure & Temperature Result Registers [0x00]

After every conversion is completed, based on the programed rate and data output, ECSP-MIS1 sensor updates the corresponding data registers values. Data are in 32-bit, 2's complement, fixed-point and are read MSB first . The minimum value of the Calibrated Data Register is 0x80000000 (-2147483648 in Dec) and the maximum value is 0x7FFFFFFF (2147483647 in Dec). In order to transform this code to the real calibrated value, the following equation should be used:

ADDRESS	REGISTER NAME	TYPE	DEFAULT VALUE (Hex)	MNEMONIC
0x00	Calibrated Pressure Byte 1	R	Variable	CAL_PRESS_DATA[31:24]
	Calibrated Pressure Byte 2	R	Variable	CAL_PRESS_DATA[23:16]
	Calibrated Pressure Byte 3	R	Variable	CAL_PRESS_DATA[15:8]
	Calibrated Pressure Byte 4	R	Variable	CAL_PRESS_DATA[7:0]

After every conversion is completed, based on the programed rate and data output, ECSP-MIS1 sensor updates the corresponding data registers values. Data are in 32-bit, 2's complement, fixed-point and are read MSB first . The minimum value of the Calibrated Data Register is 0x80000000 (-2147483648 in Dec) and the maximum value is 0x7FFFFFFF (2147483647 in Dec). In order to transform this code to the real calibrated value, the following equation should be used:

$$\text{Real Calibrated Value} = \frac{\text{Register Value}}{2^{22}}$$

ADDRESS	REGISTER NAME	TYPE	DEFAULT VALUE (Hex)	MNEMONIC
0x02	Calibrated Temperature Byte 1	R	Variable	CAL_TEMP_DATA[31:24]
	Calibrated Temperature Byte 2	R	Variable	CAL_TEMP_DATA[23:16]
	Calibrated Temperature Byte 3	R	Variable	CAL_TEMP_DATA[15:8]
	Calibrated Temperature Byte 4	R	Variable	CAL_TEMP_DATA[7:0]

The contents of the temperature registers hold the temperature result in degrees Celsius . The conversion obeys the following formula.

$$Calibrted\ Temperature = \left(\frac{Register\ Value}{2048}\right) - 4096$$

Serial Number Register [0x01]

Each sensor has a unique serial number which is factory programmed on the permanent memory of the sensor and it cannot be altered by the user. The same serial number is also printed on each sensor.

The user can read this serial number, if necessary, by performing a 7 byte long read transaction from register 0x01.

The first and the last byte are not part of the serial number. The first byte must always be 0x00 and the last byte must always be 0xFF. To construct the real serial number from the hex data read from the sensor use the following example:

HEX DATA	0x00	0x8D	0xA9	0x00	0x00	0x64	0xFF
SN DATA		141	169	00	01	00	

Hence the serial number is the decimal equivalent of the read hex numbers and grouped as described above.

The sensor now has changed mode of operation and provides its SN on consecutive read sequences. To read calibrated data perform a write transaction to select register 0x00 again

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Slave Address Register [0x02]

Each sensor is pre-programmed with a default slave address (0x5A). This address can be changed by the user if necessary. This can be achieved by performing a write sequence to register 0x02 with the desired slave address.

The new slave address is immediately effective and can be changed only by following the above sequence.

*Warning: In the case that the user forgets the programmed address there is no way to revert to the factory default address. The only way to regain communication is by trial and error amongst the 127 possible slave address combinations.

The sensor now has entered the mode of operation to change its slave address. To revert to the mode where the sensor produces its calibrated data the user must select again the 0x00 register by performing a write sequence at this address (register address definition).

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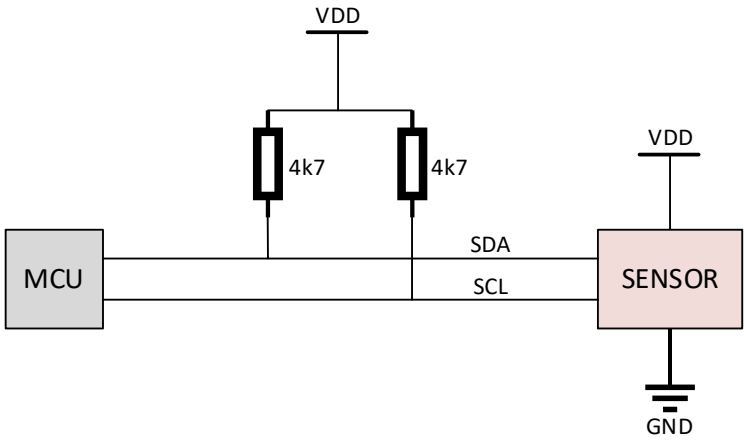
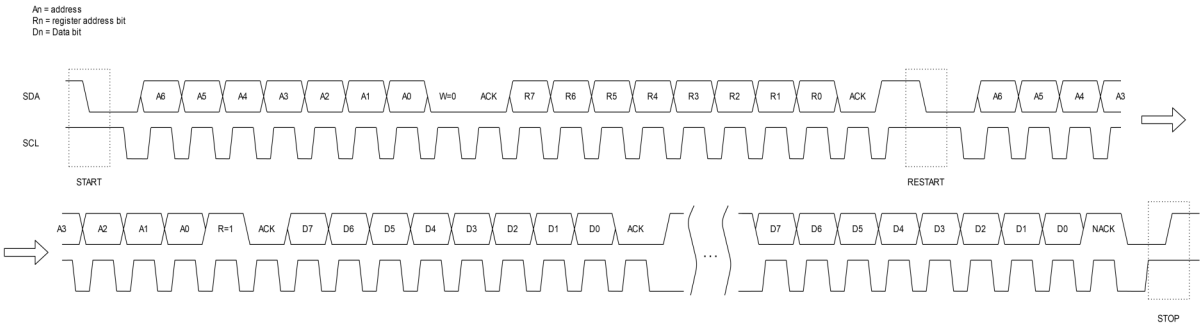
8. I²C Interface



At power on reset, the sensor needs 100ms to initialize. After that time the device is ready to communicate as an I2C slave device with address **0x5A.**

If the master device transmits the selected sensor 7-bit address (**0xB5**) with R/W bit **set**, and the appropriate register address, the sensor returns the result specified in the previous section after acknowledging (ACK) by holding the SDA line low. In order for the master to receive the data requested, should send 8 clock pulses for each data byte and provide an acknowledge bit at the 9th clock cycle by holding the SDA line low. When the last byte is received a stop condition is issued from the master indicating the termination of the transaction.

An example of such a transaction is shown below.



I²C Read

I2C communication example

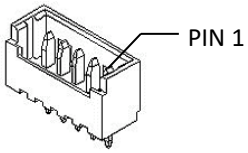
A typical use case is presented bellow. The user powers up the ESCP-MIS1 by applying power to the sensor. After initializing, the user reads the device's serial number and reads the pressure and temperature values periodically. The following example pseudo code read both the calibrated pressure and temperature of the sensor.

```
i2c_start;
i2c_write (0x5A<<1 | 1)
for (I = 0; I < 8; I ++)
{
  Data[i] = i2c_Read;
}
```

9. Pinouts[2]

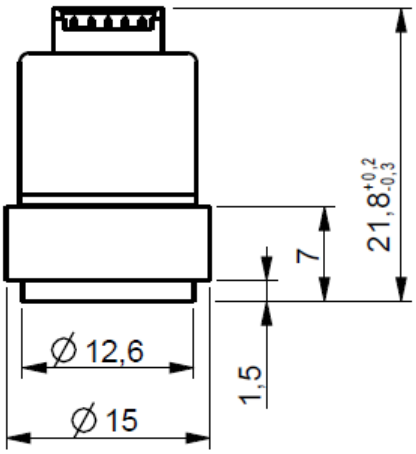
Output	PIN1	PIN2	PIN3	PIN4	PIN5	CHASSIS
I²C	SDA	SCL	VDD	GND	NC[1]	GND[3]

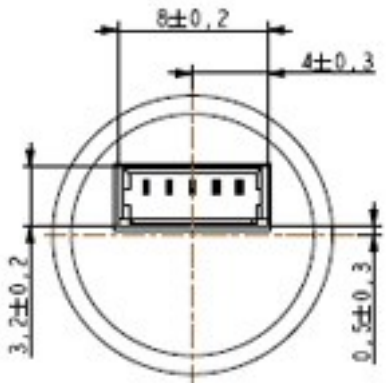
[1] Do not Connect
[2] Electrical Connection: Molex PicobBlade™ 1.25pitch vertical
[3] Chassis is connected to VSS. Avoid potential differences between VSS and CHASSIS GND



10. Mechanical Drawings (mm)

The drawings below show the standard mechanical dimensions of the ESCP-MIS2 sensor





11. Ordering Information

ESCP2-MIS2-N-NNNNN-NN-NN-NN-NN-NN-N-N

Pressure Type

1	Absolute

Pressure Range

Absolute	Full Scale
002BA	2 bar
005BA	5 bar
006BA	6 bar
007BA	7 bar
008BA	8 bar
009BA	9 bar
010BA	10 bar
012BA	12 bar
014BA	14 bar
018BA	18 bar
020BA	20 bar

Temperature Sensor

N	No

Pressure Response Time

1	15Hz

Output Type

01	I2C (address 0xB4)

Compensated Temperature

01	5°C to 50°C

Sealing Type

01	O-ring FKM
02	O-ring EPDM
03	O-ring NBR
04	O-ring VMQ
05	O-ring HNBR

Filling Oil

01	Silicon

Material

01	SS316L

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Important Notes

PERSONAL INJURY

DO NOT USE these products as safety or emergency stop devices, or in any other application where failure of the product could result in personal injury.

Failure to comply with these instructions could result in death or serious injury.

WARRANTY

ES Systems warrants this Product to be free of defects in materials and workmanship for a period of one (1) year from the date of purchase.

Upon examination by ES Systems, if the unit is found to be defective it will be repaired or replaced at no charge. ES Systems' WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration;
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In no event shall ES Systems be liable for consequential, incidental or special damages.

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