



# Spartan 2 OEM I2C Manual

# Read First:

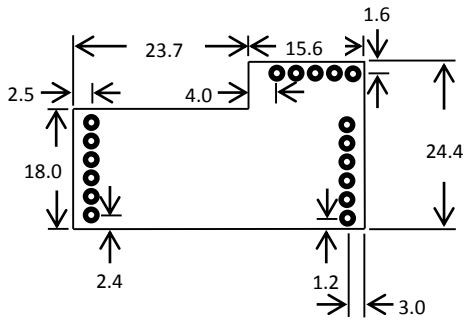
**Spartan 2 OEM I2C has I2C communications only, it does not have; Linear Output, or Simulated Narrowband Output, or LED output. The default I2C Address is 1, this address can be changed to between 1 to 16 inclusive.**

# Specifications:

## Spartan 2 OEM I2C Specifications:

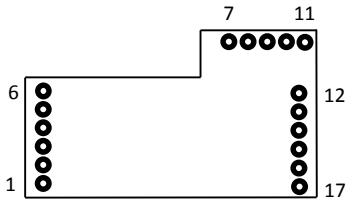
- Dimensions: 40mm x 24mm
- Compatible with Bosch LSU 4.9
- Utilizes Bosch LSU 4.9's built in calibration resistor; does not require Free Air Calibration
- Manufactured with all High Temperature Automotive Qualified (AEC Q100) components
- Accuracy: 0.01[Lambda]
- Typical Response Time, Free Air to 0.8[Lambda]: 150[ms]
- Integrated Power Supply Over-Voltage, Over-Current, and Reverse Polarity Protection
- Outputs: Digital I2C
- Integrated 5v Power Supply
- Operating Voltage 8[V] to 18[V]
- Typical 12[V] Operating Current: 1[A]
- Max 12[V] Operating Current: 3[A]
- Operating Temperature: High Temperature, -40[C] to +125[C]
- Lambda Range I2C: 0.376[Lambda] to Free Air
- Up to 16 Spartan 2 OEM I2C can share the same I2C Bus

## Dimensions:




All dimensions in mm. All pinheader pitch is 2.54mm.

## Pinout:




| Pin # | Name | Note |
|---|---|---|
| 1 | LSU IA | Connects to LSU terminal without wire |
| 2 | LSU H+ | Connects to Grey wire on LSU |
| 3 | LSU IP | Connects to Red wire on LSU |
| 4 | LSU UN | Connects to Black wire on LSU |
| 5 | LSU H- | Connects to White wire on LSU |
| 6 | LSU VM | Connects to Yellow wire on LSU |
| 7 | 5v | Leave disconnected |
| 8 | Ground | Leave disconnected |
| 9 | XRES | Leave disconnected |
| 10 | I2C SCL | I2C SCL (requires 4.7k pullup) |
| 11 | 12C SDA | I2C SDA (requires 4.7k pullup) |
| 12 | 12V | Connects to 8[V] to 18[V] power source capable of supplying 3[A], a 5[A] inline fuse should be used. |
| 13 | E Ground | Electronics ground, 100[mA] max |
| 14 | H Ground | LSU Heater Ground, 3[A] max |
| 15 | NB Out | Simulated Narrowband Output, Not Available on Spartan 2 OEM I2C, only available on Spartan 2 OEM |
| 16 | Lin Out | Linear Output, Not Available on Spartan 2 OEM I2C, only available on Spartan 2 OEM |
| 17 | I2C_Address0 | Internally pulled up, pull to ground during power on to force Spartan 2 OEM to communicate using I2C Address 0. |

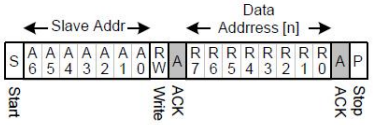
# I2C Operation:

Spartan 2 OEM does not include pull up resistors on the I2C lines, it is recommended that 4.7k pull up resistors be used.

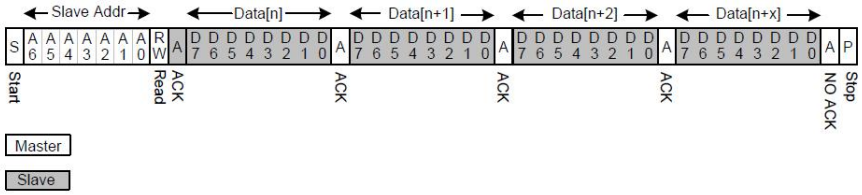
Spartan 2 OEM is designed for an I2C clock of 400khz, however you should be able to go down to DC without problems.

## I2C Format:

Set Slave Data Pointer




Read x Bytes from I2C Slave




## I2C Data Address Table:

| Data Address | Variable Name | Size | Read/Write | Note |
|---|---|---|---|---|
| 0 | I2C_Address | 8 bit unsigned | Read & Write | |
| 1 | ID8 | 8 bit unsigned | Read | Hardware/firmware version |
| 2 | Pump_Current16 | 16 bit unsigned | Read | Pump Current |
| 4 | Ri | 8 bit unsigned | Read | Nernst resistance |
| 5 | Status8 | 8 bit unsigned | Read | To be Disclosed |

**I2C_Address:**
This is the I2C_Address stored on Spartan 2 OEM. Normally I2C_Address will be the same I2C Address that you are currently using to communicate with Spartan 2. I2C_Address with be different from the I2C Address you are currently using when the I2C_Address0 Pin is grounded during power on, in that case the I2C Address for communication will be 0, I2C_Address stored on Spartan 2 OEM will be 1-16. See next section for how to change I2C_Address.

**ID8:**
An unsigned byte value representing the Spartan 2 OEM Hardware/Firmware version. First version starts @ 40 (Decimal)

**Pump_Current16:**
A 16 bit unsigned integer value representing LSU pump current.

[Byte0][Byte1]=[Bit15 Bit14 … Bit8][Bit7 Bit6 … Bit0]
*Byte0 is the first byte received, Byte0 is the high byte

Pump_Current16 needs to be converted to Lambda using a lookup table. Please see Pump_Current16_to_Lambda.txt for lookup table. Table size is 409 entries.

Lambda = Pump_Current16_to_Lambda[Pump_Current16]/1000

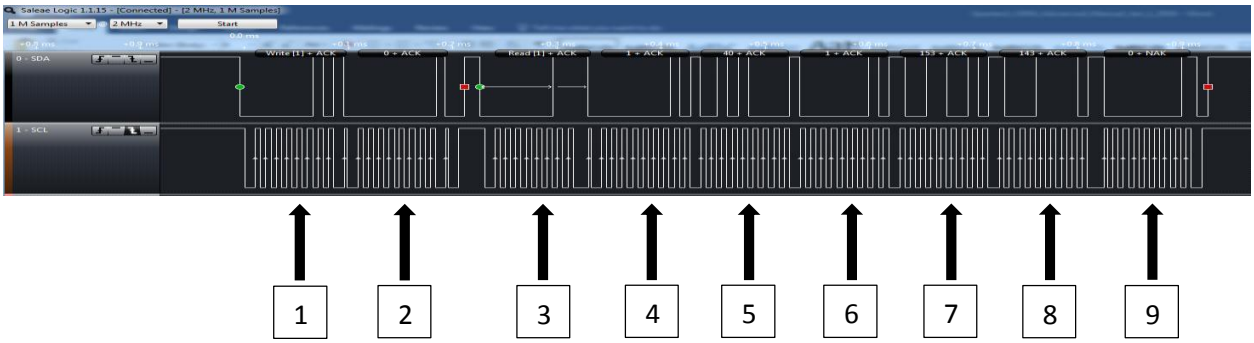
**Ri:**
An unsigned byte representing LSU Nernst Resistance which represents LSU temperature.

Ri needs to be converted to LSU Temperature[C] using a lookup table. Please see Ri_to_Temperature_C.txt for lookup table. Table size is 75 entries.

LSU Temperature[C]=Ri_to_Temperature_C[Ri-113]

**Status8:**
To be disclosed

## I2C Example: Read from Spartan 2 OEM with I2C Address = 1



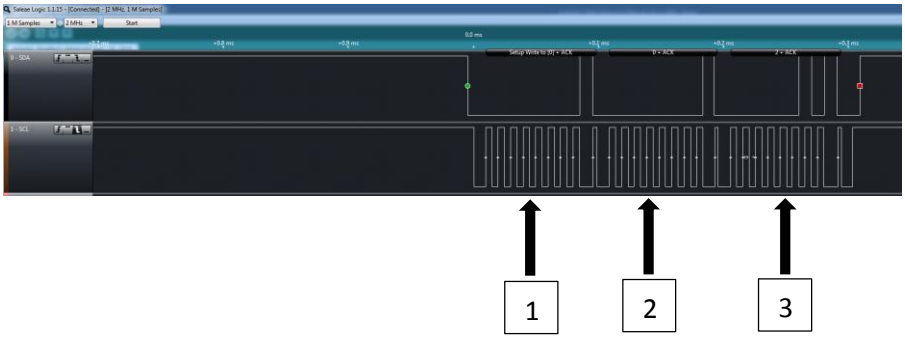

In this example 6 Bytes of data are read from Spartan 2 OEM.

**1:** Setup a write to device with 12C Address = 1, Assuming your Spartan is operating with an I2C Address of 1
**2:** Write Data Address = 0, this will tell Spartan 2 OEM that you want to read/write starting from Address 0
**3:** Start read from device with I2C Address = 1
**4:** Byte[0] is 1 (decimal), I2C_Address
**5:** Byte[1] is 40 (decimal), ID8
6: Byte[2] is 1(decimal),high byte of Pump_Current16
**7:** Byte[3] is 153 (decimal), low byte of Pump_Current16
**8:** Byte[4] is 144 (decimal), Ri
9: Byte[5] is 0 (Decimal), Status8

**I2C_Address = 1**
**ID8 = 40**
**Pump_Current16 = [Byte2] [Byte3] = 409 (use this as index for Pump_Current16_to_Lambda lookup table)**
**Lambda = (Pump_Current_to_Lambda[409])/1000 = 61.299 (LSU is in Free Air)**
**Ri = 144 (subtract 113 from this value and use the value as index for Ri_to_Temperature_C lookup table)**
**LSU Temperature [C] = Ri_to_LSU_Temperature_C[144-113] = Ri_to_Temperature_C[31] = 779**
**Status8 = 0**

## I2C Example: Writing a new I2C_Address to Spartan 2 OEM

The suggested procedure is to write a new I2C_Address to Spartan 2 OEM is to ground the I2C_Address0 Pin then power on Spartan 2 OEM. When Spartan 2 OEM detects that the I2C_Address0 Pin is grounded on startup; Spartan 2 OEM will operate with an I2C Address of 0. Then you write a new I2C_Address to Spartan 2 OEM, upon next power up; Spartan 2 will have an I2C Address of I2C_Address.




Assuming you have grounded I2C_Address0 Pin and then powered on Spartan 2 OEM.
**1:** Setup a write to device with 12C Address = 0
**2:** Write Data Address = 0, This will tell Spartan 2 that you intend to read/write to Data Address 0, I2C_Address is at Data Address 0
**3:** Write a new value to Data Address 0, I2C_Address is at Data Address 0. Valid values for I2C_Address is 1-16 (decimal). In this example I am writing an I2C_Address =2.

Unground the I2C_Address0 pin, then power cycle, now Spartan 2 OEM will operate with an I2C Address of 2.