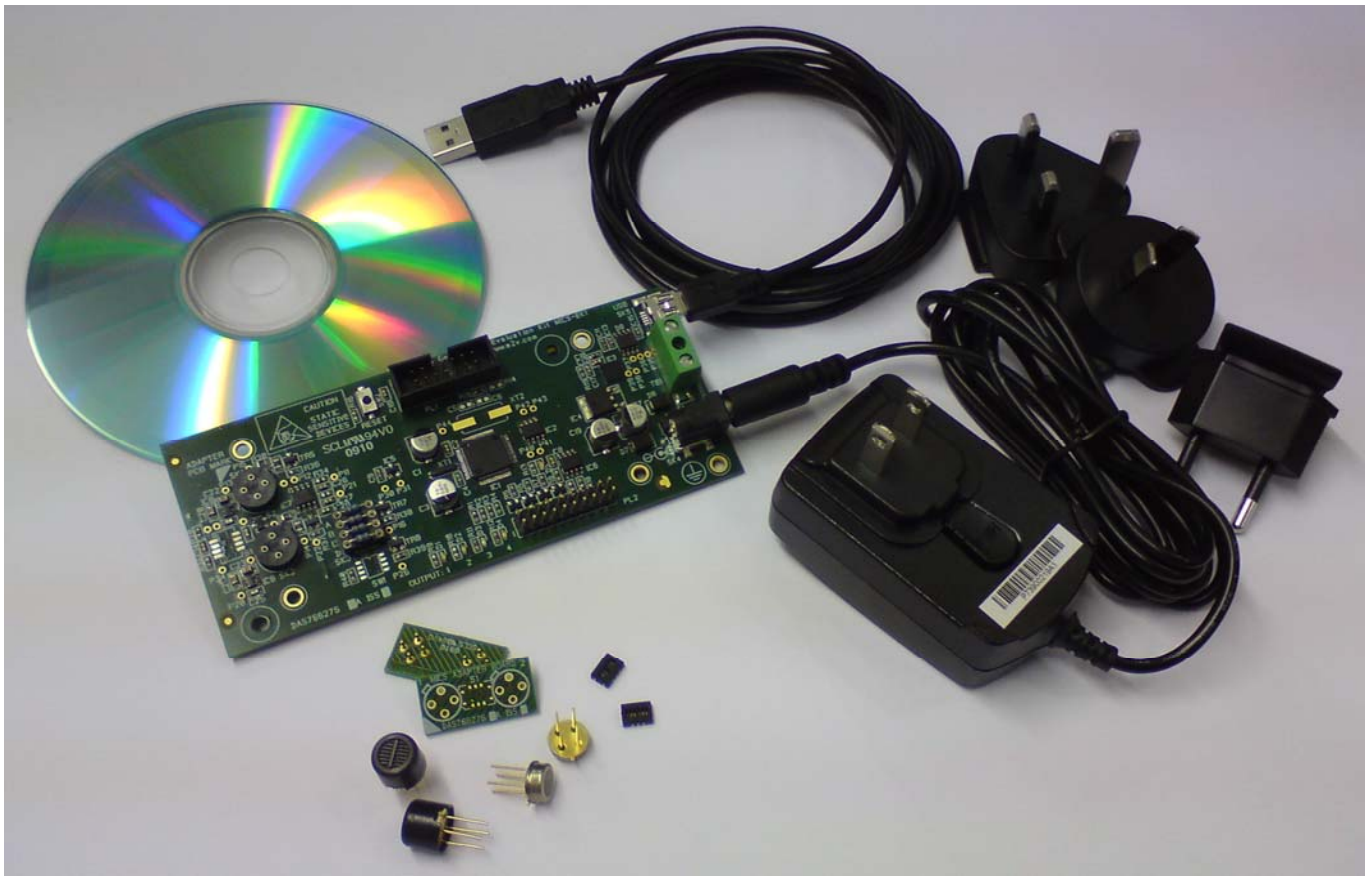
e2v Metal Oxide Semiconductor (MOS) Gas Sensor Evaluation Kit MICS-EK1

User Guide



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DAS766841AA Version 2, February 2010
Template: DF764388A-3
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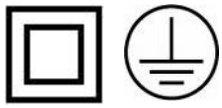
IMPORTANT INFORMATION

Before using this product, please read and understand all the instructions and warnings. e2v technologies does not accept responsibility for damage or injury resulting from failure to follow the instructions provided.

WARNINGS

- The Evaluation Kit is despatched from e2v technologies in a safe condition. Any unauthorised modifications may compromise safety and invalidate the warranty.
- The supplied power supply adapter is double insulated, indicated by the double square symbol. If the Evaluation kit is used with a power supply which is not double insulated, connect a Protective Earthing Connection to the Protective Earth terminal on the PCB indicated by the Protective Earth symbol in case of power supply faults.



- The Evaluation Kit is not certified as intrinsically safe and therefore must not be operated in potentially flammable or explosive atmospheres.
- **Neglecting the above may result in injury or death.**

CAUTIONS

- The Evaluation Kit is intended for engineering development, demonstration or evaluation purposes only. It is not considered to be suitable for general consumer use and should be handled by people with suitable electronics training.
- The Evaluation Kit contains electrostatic discharge sensitive devices. Always observe handling precautions.

- The Evaluation Kit and MOS Gas Sensor Devices should always be used within their ratings as given in their data sheets.

COMPLIANCE

- The Evaluation Kit is intended for engineering development, demonstration or evaluation purposes only and not for sale on the open market.
- This Evaluation Kit has been tested (but not certified) and deemed to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules and European Union directives on electromagnetic compatibility. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. The user is responsible for providing reasonable protection against interference with other electronic equipment.
- The Evaluation Kit is not intended for automotive use. It does not contain protection devices against vehicle supply transient voltages and must not be used for the control of a vehicle, a vehicular safety system or in a way that may disturb the driver, data bus or statutory devices fitted to a vehicle.

ENVIRONMENTAL

- e2v technologies declares that the Evaluation Kit complies with EC directive 2002/95/EC (the RoHS Directive) restricting the use of certain hazardous materials in electrical and electronic equipment. See section 16 for China RoHS information.

- The Evaluation Kit is classified as Electronic and Electrical Equipment according to directive 2002/96/EC (the WEEE Directive) and should be segregated from domestic waste for disposal. Contact your local e2v sales office for disposal instructions.

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1 Introduction

Thank you for purchasing the e2v Metal Oxide Semiconductor (MOS) Gas Sensors Evaluation Kit.

e2v MOS Gas Sensors are low power, low cost devices capable of detecting a range of gases. These devices can be used in many different applications and this Evaluation Kit from e2v will allow you to experiment and find the most suitable mode of operation for your particular use.

This Evaluation Kit allows you to:

- Test two leaded sensors or one single/dual surface mount sensor*
- Set the heater powers to two preset levels, or change these levels for your application using plug-in resistors.
- Measure the sensor resistance and ambient temperature.
- Set four alarm levels (2 per channel) which drive on-board LEDs and open collector outputs.
- Measure relative humidity by fitting a humidity sensor (not supplied).
- Drive two analogue outputs
- Connect additional circuits to an expansion port
- Log sensor outputs, temperature and humidity using the supplied PC Data Logging Program.

**Adapter PCBs are required to enable a single or dual surface mount sensor to be plugged into the pair of sensor sockets on the Evaluation Kit. These are available in packs of 5 from e2v or a distributor, part number MICS-SMD-PCB5.*

Contents of Evaluation Kit

- Evaluation PCB
- Mains Power Adapter
- USB Lead
- CD containing User Manual, e2v Data Logging Software and USB Drivers

2 Quick Start Guide

1. Read the Manual!

The supplied CD should auto-run on your PC when inserted into a CD drive.
Select 'User Guide' from the CD menu.
Before using this product, please read and understand all the instructions and warnings. e2v technologies does not accept responsibility for damage or injury resulting from failure to follow the instructions provided!

2. Install the e2v Data Logging Software & USB Drivers on your PC

Select 'Install Data Logging Software and USB Drivers' from the CD menu.
Follow the on-screen instructions.

3. Set up the Evaluation PCB

a. Plug one or two e2v MOS Gas Sensors into SK1 and/or SK2 on the Evaluation PCB. Ensure the orientation tab on the sensor matches the tab on the socket.
b. Set SW1 on the PCB as follows:
   - SW1-1 and SW1-2: The Evaluation Kits are initially set in 'automatic heater mode' for driving low power sensors. For high power sensors, override this mode and force the heater power to continuous high power mode as follows:
     SW1-1 ON - for high power sensor in SK1 (see over for diagram & sensor list)
     SW1-2 ON - for high power sensor in SK2 (see over for diagram & sensor list)
   - SW1-3 Off
   - SW1-4 Off
c. Connect the supplied USB lead from SK5 to a USB socket on your PC

4. Connect the 9 V Power Supply Unit

a. Connect the DC output of the Power Supply Unit to SK4
b. Slide the correct pinned mains adapter to the Power Supply Unit to suit the mains sockets in your country. Plug in the Power Supply Unit. Green LED D5 should be flashing. Other LEDs may also come on.
c. The PC may take a minute to recognise and initialise the new hardware drivers.

5. Run the e2v Data Logging Software

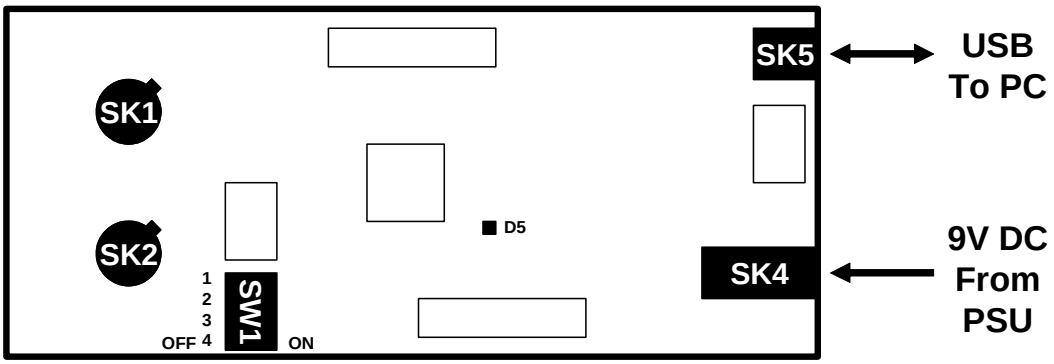
a. Run the program from the start menu.
b. The software will automatically detect which 'Com Port' is being used for the USB connection. (If this does not happen, a Com Port can be manually selected by unticking 'Automatically search for connected device' on the 'Hardware' menu.
c. The outputs of the Evaluation Kit will now be displayed on the PC monitor.

Congratulations! You are now evaluating e2v Metal Oxide Semiconductor Gas Sensors.

Please refer to the full User Guide on the CD for more detailed instructions

Quick Start Guide (Continued)

Basic Interfaces and Controls of Evaluation Kit



Using MICS Sensors with the Evaluation Kit

Leaded Sensors

Part No.	Type	Gases	Power	Automatic operation: SW1-1 (if fitted in SK1) SW1-2 (if fitted in SK2)
MICS-2610	Leaded Single	Ozone	High	ON
MICS-2611	Leaded Single	Ozone	High	ON
MICS-2710	Leaded Single	NO2	Low	OFF
MICS-5121	Leaded Single	CO/HC/VOC	High	ON
MICS-5132	Leaded Single	CO/HC/VOC	High	ON
MICS-5135	Leaded Single	CO/HC/VOC	High	ON
MICS-5521	Leaded Single	CO/HC/VOC	High	ON
MICS-5525	Leaded Single	CO/HC/VOC	High	ON

SMD Sensors

Part No.	Type	Gases	Power	SW1-1	SW1-2
MICS-2614	SMD Single	Ozone	High	ON	ON*
MICS-4614	SMD Dual	Ozone	High	ON	ON
		Ozone	High		
MICS-2714	SMD Single	NO2	Low	OFF	OFF*
MICS-4514	SMD Dual	NO2	Low	OFF	ON
		CO/HC/VOC	High		
MICS-5134	SMD Single	CO/HC/VOC	High	ON	ON*
MICS-5524	SMD Single	CO/HC/VOC	High	ON	ON*
MICS-5914	SMD Single	NH3	Medium	ON**	ON*

**Not critical as sensor position is empty*

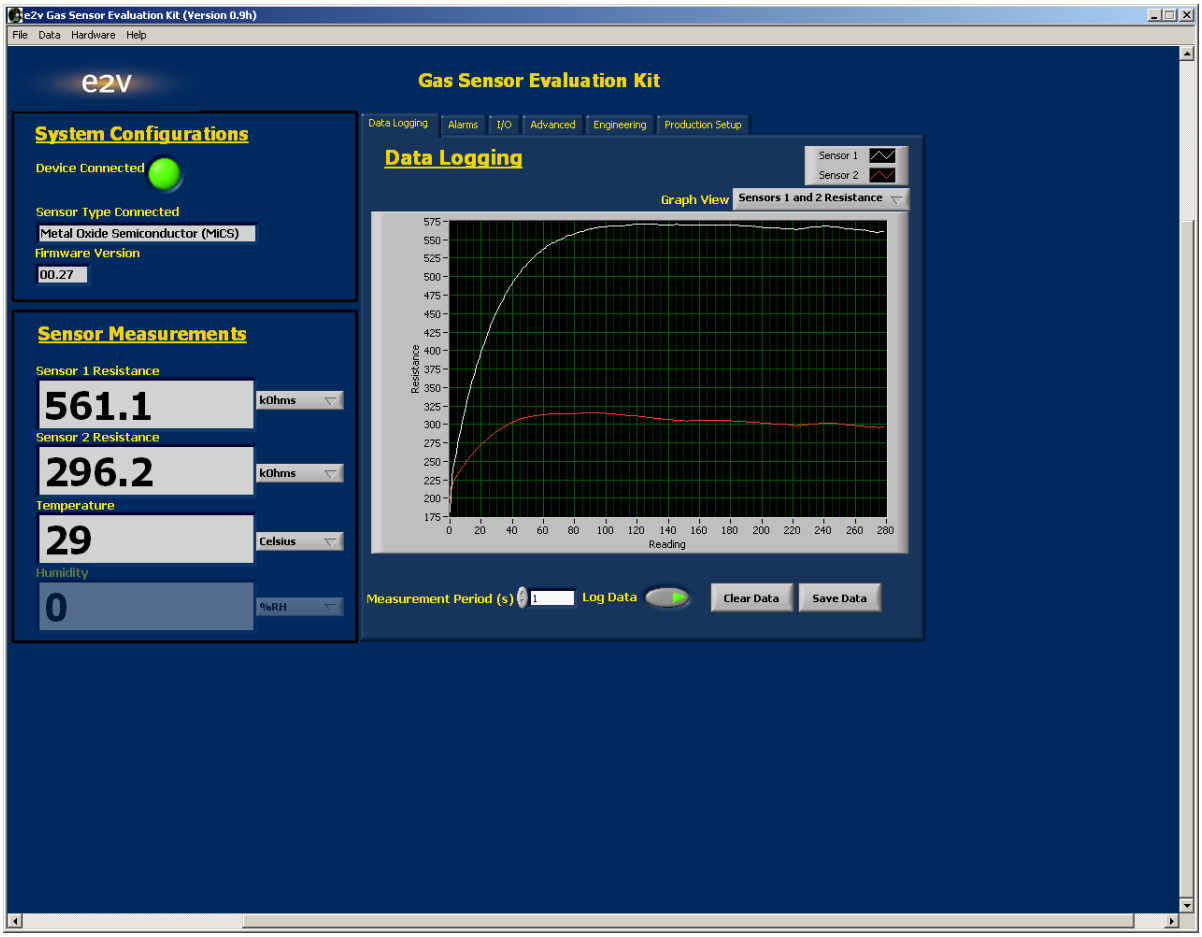
***Change Rb to 93.1R (E96 series resistor, not supplied) to operate at 66mW*

Evaluation Kit Default Power Levels:

- High Power: 76 mW
- Low Power: 43 mW

3 Using the e2v Data Logging Software

Follow the instruction in the Quick Start guide to get the software operating.
The screen should appear as follows:

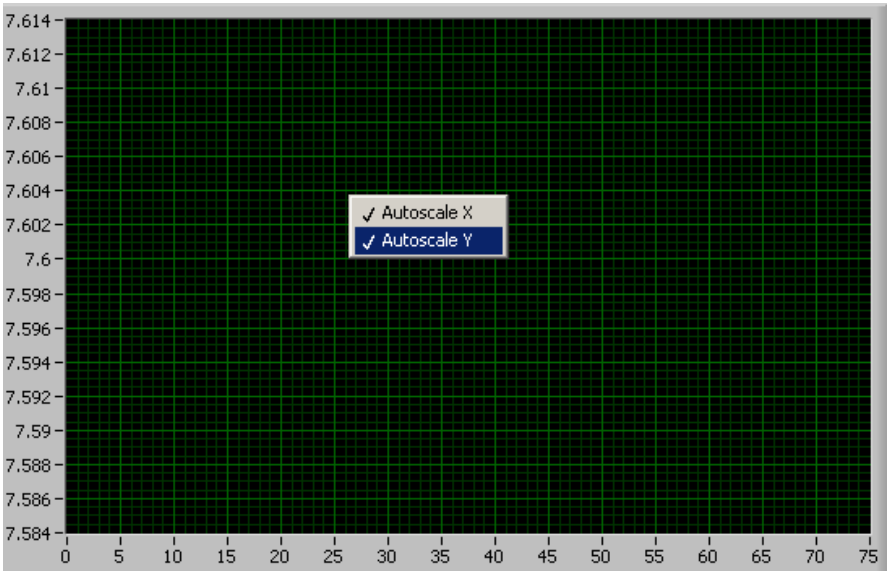


The USB interface to the Evaluation Kit appears as a virtual ‘Com Port’. When the program is started the software will automatically detect which ‘Com Port’ is being used for the USB connection. (If this does not happen, a Com Port can be manually selected by unticking ‘Automatically search for connected device’ on the ‘Hardware’ menu. The Com Port can be manually selected, using trial and error to identify the correct one. This is also useful when multiple Evaluation Kits are being used on one PC.

The main screen gives a continuous display of sensor resistances, temperature and optionally humidity (when a humidity sensor is fitted). The graph view can be changed to display all these parameters in real time. The data can also be saved to a file in ‘csv’ format which can be read by most spreadsheet programs. Note that many spreadsheets will read a maximum of 65536 lines (18 hours of data at 1 second intervals). The measurement period can be increased from 1 second to allow longer tests to be imported. For example, a 10 second measurement period allows 7.5 days of data to be read into a spreadsheet.

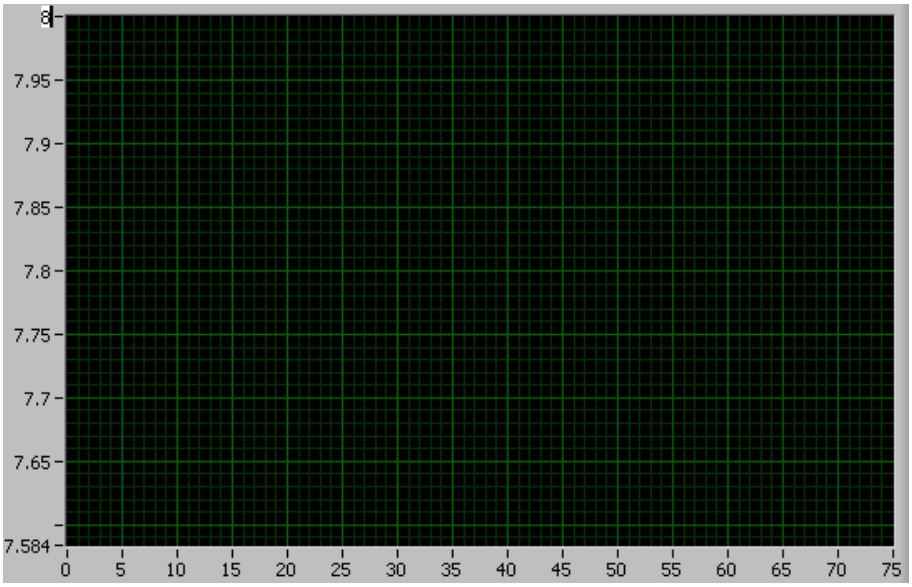
By default, the data logging software autoscales the output readings (i.e. the graph axes expand to show all of the readings on y and x axes). However, it is possible to change these values in order to ‘zoom in’ on certain readings.

In the Data Logging tab, right-click on the graph to be adjusted and untick ‘autoscale’ for the avis you want to change:



This stops the axis from automatically expanding.

The values in the axis can then be changed. To do this, double-click on the value at one end of the axis and adjust using the keypad.



The ‘Alarms’ tab allows setting of alarm thresholds, described in section 9.

The ‘I/O’ tab gives allows monitoring of digital inputs (see section 10) and setting of analog outputs (see section 11).

The ‘Advanced’ tab allows setting of the heater drives (see section 6) and also manual control of the output load resistance for measurement (see section 7).

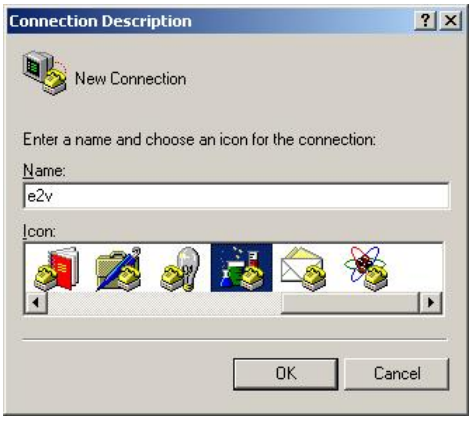
The ‘Hardware’ menu contains an Update Firmware feature which allows software updates to be loaded into the microprocessor without having to return the PCB to e2v for reprogramming. This feature should only be used with direct instructions from e2v.

4 Using HyperTerminal

The e2v Data Logging software provides full control and monitoring of all the operation modes of the Evaluation Kit. However users may wish to communicate using the low level protocol. This can be done manually using a terminal emulation program such as HyperTerminal, or by writing your own PC software using a language such as Visual Basic or Labview. The low level message protocol is given in the appendices to this manual.

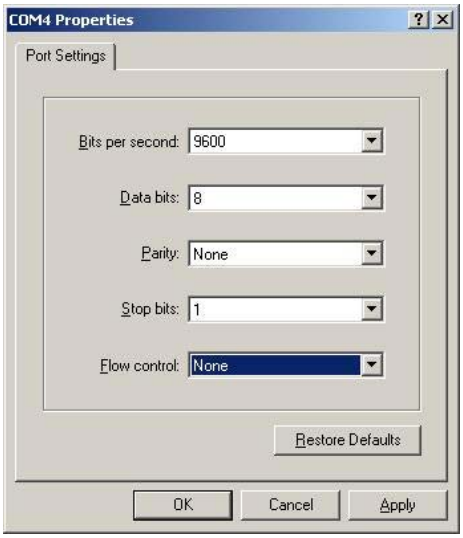
To communicate with the Evaluation Kit using HyperTerminal use the following procedure:
(Note: the USB Drivers must be installed.)

- Run HyperTerminal from the Windows Start button
- Enter a name and choose an icon:

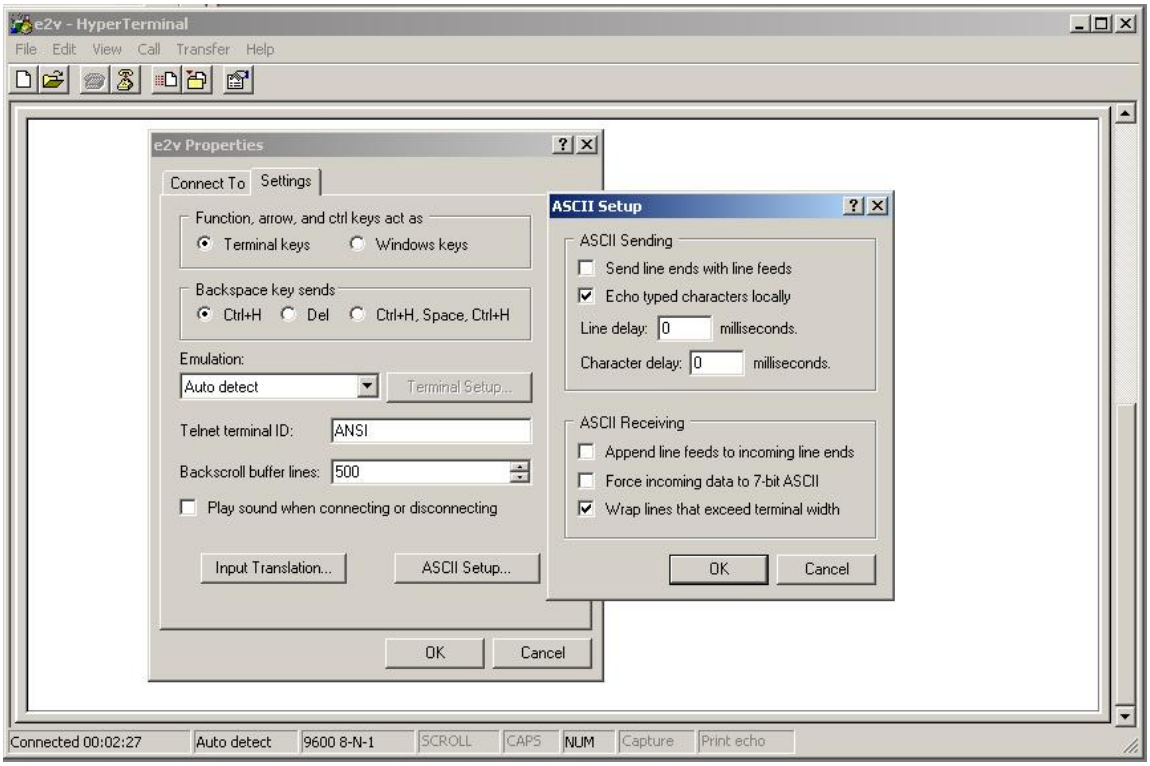


- Select the correct 'COM Port' being used by the USB Driver:

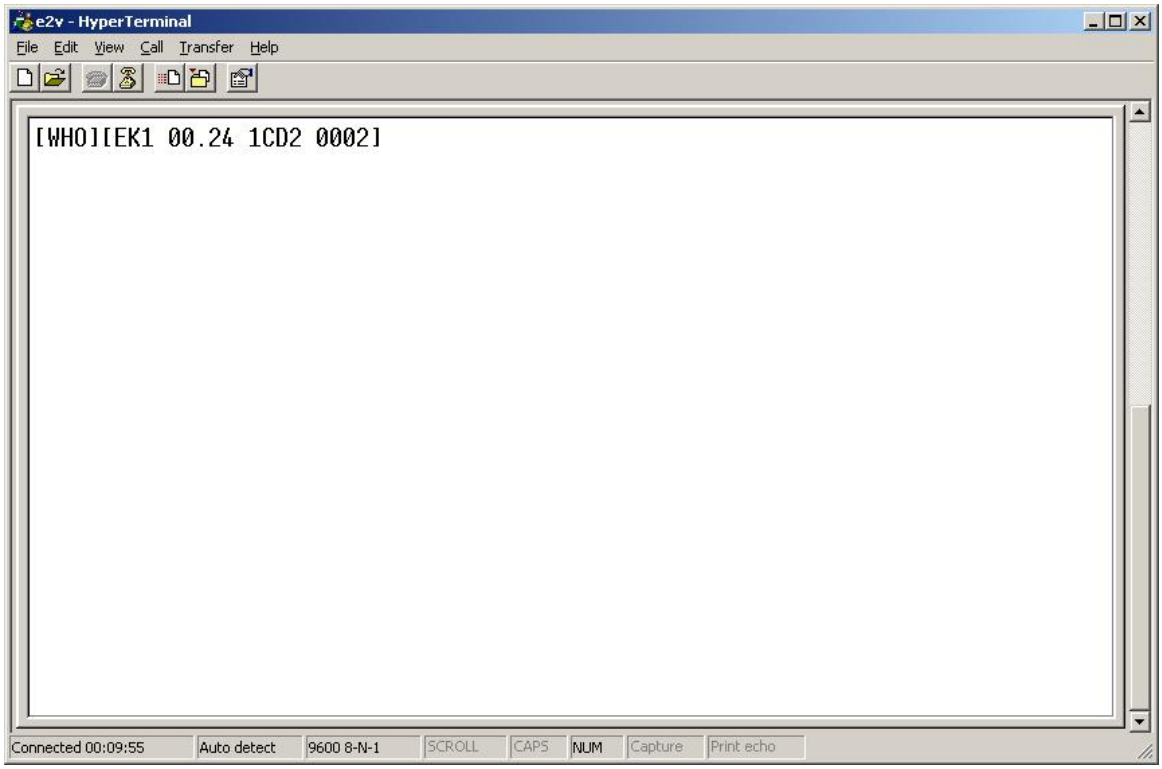
- Select 9600 Bits per second (Baud), 8 data bits, no parity, 1 stop bit, no flow control:



- Select File/Properties. Click the Settings tab, then the ASCII Setup button. Ensure ‘Echo typed characters locally’ is checked:



- Type [WHO] and a response should be received from the Evaluation Kit

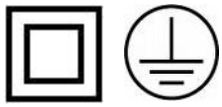


Further HyperTerminal commands are described throughout this manual. A complete list is given in the appendices.

5 User Interfaces, Controls and Indicators

5.1 Power Supply (SK4, TB1)

The Evaluation Kit requires a 9V +/-10% power supply. Either connect the supplied 9 V DC mains adapter to SK4 or a 9 V ± 10% laboratory supply to the terminal block TB1.
The supplied power supply adapter is double insulated, indicated by the double square symbol. If the Evaluation kit is used with a power supply which is not double insulated, connect a Protective Earthing Connection to the Protective Earth terminal on the PCB indicated by the Protective Earth symbol in case of power supply faults.



5.2 Gas Sensors Sockets (SK1, SK2)

Gas sensors should be plugged into SK1 and SK2. Be careful to ensure that the orientation tab on the sensor matches the marking on the circuit board.
A dual surface mount sensor can be testing using an adapter PCB from e2v. The adapter PCB should be plugged into both SK1 and SK2. Be careful to ensure that the PCB is fitted in the correct orientation by observing the corner markings.

5.3 Control Switch (SW1)

SW1 should normally be all off. Other settings allow use of special modes:

SW1	Off	On
1	Normal: SK1 fully controlled by micro	Force high power mode for SK1
2	Normal: SK2 fully controlled by micro	Force high power mode for SK2
3	Normal: SK1 and SK2 independent	Multi-level single sensor mode
4	Normal: Humidity sensor not fitted	Humidity sensor fitted

SW1-1 and SW1-2 may be set ON for CO, VOC and Ozone Sensors to only run these sensors at higher power. This can be useful if the heater drive is set to automatic (see Heater Control).

SW1-3 may be set to ON for multi-level single sensor mode. Only one sensor should be fitted (either SK1 or SK2 but not both) and different heater drive resistors are required. This mode uses the heater drives in parallel on a single sensor to give more levels of heater power for experimental purposes.

SW1-4 may be set to ON when the user has fitted a humidity sensor in position S1. In this case the temperature readings are also taken from the humidity sensor rather than the LM60 IC as this gives slightly improved accuracy.

5.4 JTAG Port (PL1)

The JTAG Port can be used by engineers wishing to develop their own software for the Evaluation Board. The socket will connect to a Texas Instruments MSP430 Debug Interface, e.g. MSP-FET430UIF, for reprogramming and debugging.

TDO	1	2	VCCO
TDI	3	4	VCCI
TMS	5	6	Unused
TCK	7	8	Unused
0V	9	10	Unused
TRST	11	12	Unused
Unused	13	14	Unused

5.5 Expansion Port (PL2)

PL2 is an expansion port allowing connection to additional peripherals. The port provides access to the input and 3.3 V supplies, four open collector outputs, four digital inputs, two analogue outputs and a spare UART connection.

3V3 Regulated Power	1	2	9V Unregulated Power
0V	3	4	0V
Input 1 (3V3 logic)	5	6	Output 1 (Open collector)
Input 2 (3V3 logic)	7	8	Output 2 (Open collector)
Input 3 (3V3 logic)	9	10	Output 3 (Open collector)
Input 4 (3V3 logic)	11	12	Output 4 (Open collector)
0VA	13	14	Analogue Output 1 (0 to 2.048V)
0VA	15	16	Analogue Output 2 (0 to 2.048V)
Serial RXD (3V3)	17	18	Serial TXD (3V3)
0V	19	20	Not used

5.6 LEDS (D1, D2, D3, D4, D5)

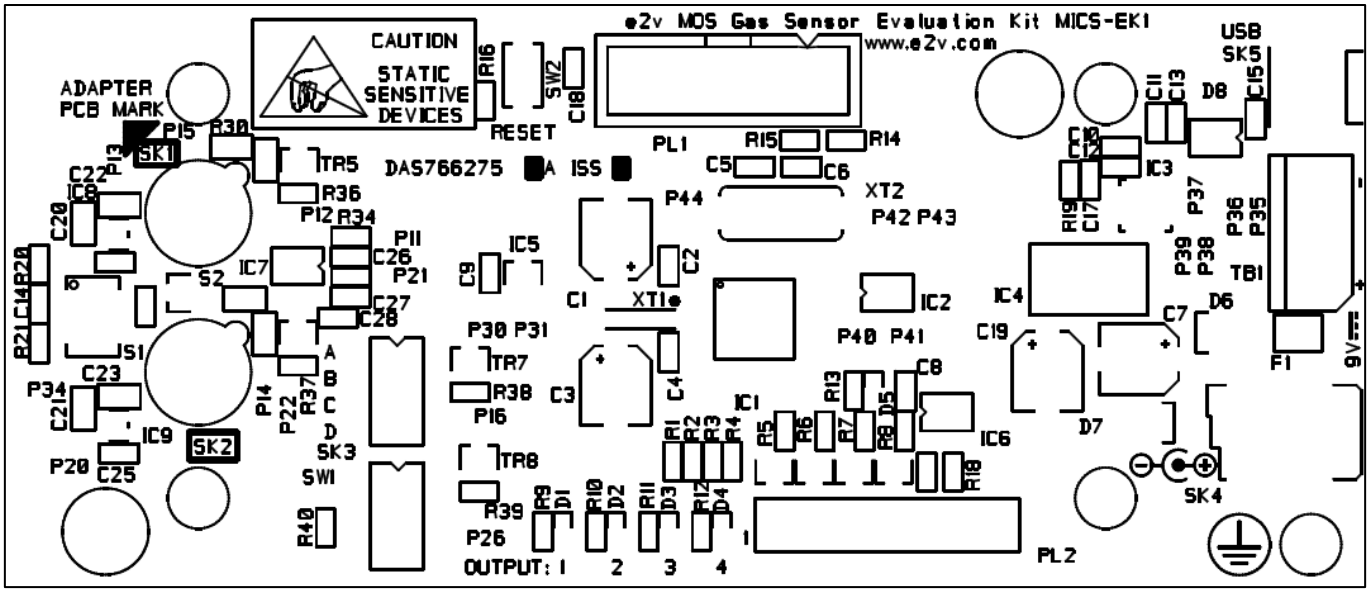
D1, D2, D3 and D4 indicate the state of each open collector output on the Expansion Port.

D5 flashes to indicate that the power is on and the software is operating normally.

5.7 Reset Switch (SW2)

Press and release SW2 to reset the microcontroller. This has the same function as removing and reconnecting the power supply.

PCB Layout:



6 Heater Control

6.1 Introduction

Ozone and CO/VOC sensors are normally driven at about 76 mW. NO_2 sensors require only 43 mW, but when first turned on, they will stabilise faster if driven at the higher power for about 90 seconds. It is also useful to overdrive them at the higher power once every 24 hours in order to burn off any build-up of airborne pollutants.

The temperature rise of the heaters is proportional to the applied power. When operated at higher temperatures for extended periods of time, some positive drift of the heater resistance will be experienced. In order to keep the heater power constant as the resistance varies, a simple constant power circuit is used comprising of a 5 V bias with a balance resistor. At lower powers the heater resistance drift is minimal.

The Evaluation Kit allows each heater to be controlled independently. The heater drives can be set to high power, low power, off, or automatic 24 hour cycle. SW1-1 and SW1-2 on the PCB can be used to override low power mode, forcing heaters 1 and 2 respectively to be either high power or off. This can be useful if the Evaluation Kit is set-up for 'automatic' but you want to experiment with different types of sensor.

High power is set at 76 mW and low power at 43 mW using plug-in resistors. Other powers can be set by changing these resistors for different values as shown below. Note that when a dual surface mounted device is used, there will be also be a heating effect due to the power in the adjacent device.

The high power setting is defined by: Heater 1: Rb Heater 2: Rc.
The low power setting is defined by: Heater 1: Ra + Rb Heater 2: Rc + Rd

Total Resistance	Approximate Power
150R	36 mW
133R	43 mW
120R	49 mW
100R	60.5 mW
82R	76 mW
68R	91 mW

Note: For the MICS-5914 ammonia single SMD sensor, change Rb to 93.1R (E96 series resistor, not supplied) to operate at 66mW in high power mode.

Caution! Do not drive the heaters beyond the maximum power rating given in the individual device datasheets.

6.2 Software Control of Heaters

Set heaters to low power (~43 mW with supplied resistors)

- HyperTerminal: Heater 1 Command: `[EK1 GS1 HLO]`
  Heater 2 Command: `[EK1 GS2 HLO]`
  EK1 response: `[ACK]`

- e2v Datalogger: Advanced tab: Heaters Sensor1 manual settings, 'Low Power' button
  Advanced tab: Heaters Sensor2 manual settings, 'Low Power' button

Set heaters to high power (~76 mW with supplied resistors)

Caution: Do not use high power for long periods of time with NO_2 sensors

- HyperTerminal: Heater 1 Command: `[EK1 GS1 HHI]`
  Heater 2 Command: `[EK1 GS2 HHI]`
  EK1 response: `[ACK]`

- e2v Datalogger: Advanced tab: Heaters Sensor1 manual settings, 'High Power' button
  Advanced tab: Heaters Sensor2 manual settings, 'High Power' button

Set heaters to off

- HyperTerminal: Heater 1 Command: `[EK1 GS1 H00]` *(zero zero)*
  Heater 2 Command: `[EK1 GS2 H00]` *(zero zero)*
  EK1 response: `[ACK]`

- e2v Datalogger: Advanced tab: Heaters Sensor1 manual settings, 'Heater Off' button
  Advanced tab: Heaters Sensor2 manual settings, 'Heater Off' button

Set heaters to automatic

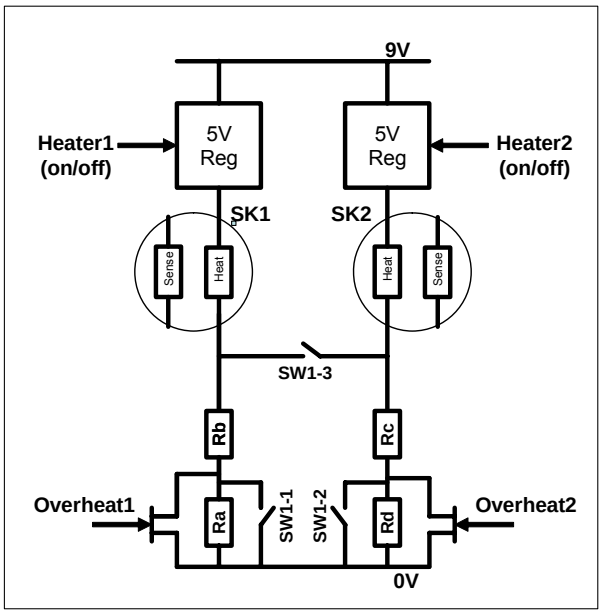
This mode is used for driving low power sensors. It starts a continuous 24-hour cycle of high power for aa seconds followed by low power for the remainder of the 24 hours. If the Evaluation Kit is turned off and on again, the cycle will restart again at turn-on. Overdriving the low power sensors helps to burn off any build-up of airborne pollutants and can also give a quicker initial response.

- HyperTerminal: Heater 1 Command: `[EK1 GS1 Haa]` *(00 < aa ≤ FF)*
  Heater 2 Command: `[EK1 GS2 Haa]` *(00 < aa ≤ FF)*
  EK1 response: `[ACK]`

- e2v Datalogger: Advanced tab: Heaters Sensor1 manual settings, 'Auto Heaters' button
  Advanced tab: Heaters Sensor2 manual settings, 'Auto Heaters' button
  (The high period in seconds should be entered as 'Auto Period')

6.3 Multiple Power Levels

A simplified diagram of the heater control circuit is shown below.



Ra, Rb, Rc and Rd are plug-in leaded resistors. The high power setting is defined by:

Heater 1: Rb
Heater 2: Rc.

The low power setting is defined by:

Heater 1: Ra + Rb
Heater 2: Rc + Rd

As supplied, Ra = Rd = 51R and Rb = Rc = 82R.

With these resistors, high power is set at about 76mW and low power at 43mW.

The heater drive resistors can be switched in parallel to drive a single sensor at four different levels in position SK1 only. Position SK2 should be left empty and switch SW1-3 should be closed in order to force the four plug-in resistors into a parallel formation.

The four combinations of 'Overheat1' and 'Overheat2' control lines can be used to give four different resistance values which should be calculated for the particular application. The following table shows the power outputs for a particular set of resistance values:

Ra=27R, Rb=100R, Rc=220R, Rd=not fitted (infinity)

Overheat1	Overheat2	Resulting Resistance		Approx. Power
Off	Off	(Ra + Rb) // (Rc + Rd)	127R	45mW
On	Off	Rb // (Rc + Rd)	100R	60.5mW
Off	On	(Ra + Rb) // Rc	80.5R	77mW
On	On	Rb // Rc	68.75R	89mW

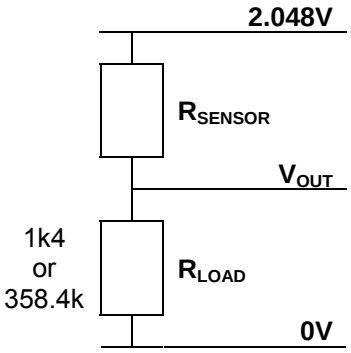
To control 'Overheat1' and 'Overheat2' set the heaters to 'High Power' for 'on' or 'Low Power' for 'off'. This can be done using the e2v Datalogger software or via a terminal emulation program such as HyperTerminal.

The method of multi-heater drive described above can also be automated by writing a small PC application (in a language such as Visual Basic or Labview) to send the appropriate serial commands.

7 Sensor Resistance Measurement

7.1 Introduction

Metal Oxide Semiconductor Gas Sensors contain a sensitive layer whose resistance changes with gas concentration when heated to an appropriate temperature. Different types of sensor have different ranges of resistance - see individual data sheets for details. However, the Evaluation Kit has been designed to operate with all MOS sensors. A switched load resistance is used to provide two ranges giving a good accuracy over a very wide range of resistances.



Sensitive Layer Maximum Power

The low range has a load resistor of 1k4 which keeps the sensitive layer power below the maximum permitted value from the datasheet, 1 mW for some sensors. The Maximum Power Transfer Theorem states that the highest power will be present when R_{SENSOR} = R_{LOAD} (1k4). Using a 2.048 V supply, the maximum sensitive layer power is given by:

$$P_{MAX} = \frac{1.024^2}{1k4} = 0.75 \text{ mW}$$

Voltage to Resistance Conversion

For a particular Sensor and Load resistance, the output voltage can be calculated from:

$$V_{OUT} = \frac{R_{LOAD} \times 2.048V}{R_{LOAD} + R_{SENSOR}}$$

From a measurement of the Output Voltage, the sensor resistance can be calculated from:

$$R_{SENSOR} = R_{LOAD} \times \left\{ \frac{2.048}{V_{OUT}} - 1 \right\}$$

The high range has a load resistor of 1k4 + 357k = 358.4k. Note that this is 256 times 1.4k which allows a common software routine to be used for both ranges to convert from voltage to resistance. For example an output voltage of 1.19466 V corresponds to a sensor resistance of:

- 1k0 on the low resistance range
- 256k on the high resistance range

Range Selection

The optimum value for switching between ranges is when R_{SENSOR} = 22.4k (16 x 1k4). R_{LOAD} can be programmed in software to be always low (1k4), always high (358.4k) or to switch automatically.

Accuracy

The Evaluation Kit has a 12 bit ADC for highly accurate resistance readings during experimentation. The accuracy of the resistance measurement is related to the number of ADC bits and also the difference between R_{SENSOR} and $R_{LOAD.}$ Accuracy is highest when R_{SENSOR} is close to R_{LOAD}.
The Evaluation Kit also contains an operational amplifier buffer to prevent the ADC input impedance loading the sensor circuit at very high values of R_{SENSOR} (> 1M).

The nature of MOS Gas Sensors means that they are often used in cost sensitive applications where high measurement accuracy is not always required. In such cases a 10-bit ADC may be sufficient and the operational amplifier buffer may not be necessary.

7.2 Software Control of Sensors

Set load resistor range to low (1.4k load resistance)

- HyperTerminal: Sensor 1 Command: `[EK1 GS1 RLO]`
  Sensor 2 Command: `[EK1 GS2 RLO]`
  EK1 response: `[ACK]`

- e2v Datalogger: Advanced tab: Resistance Sensor1 manual settings, 'Low Range' button
  Advanced tab: Resistance Sensor2 manual settings, 'Low Range' button

Set load resistor range to high (358.4k load resistance, 357k + 1.4k)

- HyperTerminal: Sensor 1 Command: `[EK1 GS1 RHI]`
  Sensor 2 Command: `[EK1 GS2 RHI]`
  EK1 response: `[ACK]`

- e2v Datalogger: Advanced tab: Resistance Sensor1 manual settings, 'High Range' button
  Advanced tab: Resistance Sensor2 manual settings, 'High Range' button

Set load resistor range to automatic (recommended setting)

- HyperTerminal: Sensor 1 Command: `[EK1 GS1 RAU]`
  Sensor 2 Command: `[EK1 GS2 RAU]`
  EK1 response: `[ACK]`

- e2v Datalogger: Advanced tab: Resistance Sensor1 manual settings, 'Auto Range' button
  Advanced tab: Resistance Sensor2 manual settings, 'Auto Range' button

Read the Sensor Resistance (Enquire Status)

- HyperTerminal: Sensor 1 Command: `[EK1 GS1 ENQ]`
  Sensor 2 Command: `[EK1 GS2 ENQ]`
  EK1 response (GS1): `[EK1 GS1 aaa bbb ccc ddd eee fffffff ggg hhh]`
  EK1 response (GS2): `[EK1 GS2 aaa bbb ccc ddd eee fffffff ggg hhh]`

aaa	*Heater setting*	*HLO, HHI, H00, Hxx*
bbb	*Heater present condition*	*HLO, HHI, H00*
ccc	*Range setting*	*RLO, RHI, RAU*
ddd	*Range present condition*	*RLO, RHI*
eee	*Raw ADC reading*	*000 to FFF (hex)*
fffffff	*Resistance reading, ohms (four significant digits)*	*00000000-99999999 (dec)*
ggg	*Temperature reading, degrees celcius*	*-99 to +99* *ERR (if error)*
hhh	*Relative humidity reading, percent*	*000 to 100 (dec)* *XXX (if not fitted)* *ERR (if error)*

- e2v Datalogger: The full status of both sensors is continually displayed.

8 Temperature and Humidity Measurement

8.1 Temperature Measurement

The Evaluation Kit PCB is fitted with an LM60 temperature sensor IC mounted close to the sensor sockets. This gives a voltage output proportional to the ambient temperature and is measured with the Analog to Digital Converter (ADC) in the microcontroller.

Ensure that SW1-4 is set to OFF to use the LM60 temperature sensor.

- HyperTerminal: Temperature can be read with the Enquire Status command described in the previous section:
  `[EK1 GS1 ENQ] or [EK1 GS2 ENQ]`
- e2v Datalogger: The measured temperature is continually displayed.

8.2 Humidity Measurement

The PCB can also be fitted with a Sensirion SHT10 or SHT11 combined temperature and humidity sensor by the user in position S1. SHT11 devices are widely available through electronic catalogues.

Set SW1-4 to ON to use the SHT10/11. (the temperature readings will also be taken from this device which has a slightly better accuracy compared with the LM60).

- HyperTerminal: Humidity can be read with the Enquire Status command described in the previous section:
  `[EK1 GS1 ENQ] or [EK1 GS2 ENQ]`
- e2v Datalogger: The measured humidity is continually displayed.

If SW1-4 is set to OFF, ‘XXX’ is returned for the humidity value.

If SW1-4 is set to ON but the combined temperature and humidity sensor is not fitted or cannot be read, ‘ERR’ is returned for both temperature and humidity.

9 Alarm Outputs and LEDs

9.1 Introduction

Four open collector alarm outputs are provided on the expansion port PL2. Each alarm has an associated LED (D1-D4) to indicate the status of the alarm output.

To use the open collector outputs, a resistor or other load should be connected to the desired external voltage. The 9V input and 3V3 microcontroller supply are also available on the expansion connector for this purpose.

LED ON = alarm enabled (open collector driven - low)
LED OFF = alarm disabled (open collector released – high)

Each alarm can be programmed in software to be enabled above or below a specified resistance

9.2 Software Control of Alarm outputs

Force alarm output ON, OFF or FOLLOW digital inputs (examples of each command)

- HyperTerminal:
  Alarm 1 Command: `[EK1 AL1 MAN ONX]`
  …or: `[EK1 AL1 MAN OFF]`
  …or: `[EK1 AL1 FOL]`
  EK1 response: `[ACK]`
- e2v Datalogger: Alarms Tab: Use buttons in 'New Settings'

Set automatic alarm threshold (examples showing threshold settings)

- HyperTerminal:
  Alarm 1 Command: `[EK1 AL1 aaa bbbbbbbb]`
  EK1 response: `[ACK]`

aaa	***Sensor association and function***
1GT	*Alarm when Sensor 1 resistance ≥ bbbbbbbb*
1LT	*Alarm when Sensor 1 resistance ≤ bbbbbbbb*
2GT	*Alarm when Sensor 2 resistance ≥ bbbbbbbb*
2LT	*Alarm when Sensor 2 resistance ≤ bbbbbbbb*

- e2v Datalogger: Alarms Tab: Use buttons in 'New Settings'

Read individual alarm conditions (Enquire Status)

- HyperTerminal:
  Alarm 1 Command: `[EK1 AL1 ENQ]`
  EK1 response: `[EK1 AL1 aaa bbb cccccccc]`

aaa	*Alarm status*	*ONX, OFF*
bbb	*Alarm setting*	*MAN, FOL, 1GT, 1LT, 2GT, 2LT*
cccccccc	*Alarm threshold*	*00000000-99999999 (dec)*

- e2v Datalogger: The status of the alarms is continually displayed in the Alarms tab.

Quick read of all alarms (Enquire Status)

- HyperTerminal: Alarm 1-4 Command: `[EK1 AL0 ENQ]`
  EK1 response: `[EK1 AL0 aaa bbb ccc ddd]`

aaa	*Alarm 1 output*	*ONX, OFF*
bbb	*Alarm 2 output*	*ONX, OFF*
ccc	*Alarm 3 output*	*ONX, OFF*
ddd	*Alarm 4 output*	*ONX, OFF*

- e2v Datalogger: The status of the alarms is continually displayed in the Alarms tab.

9.3 Additional Alarm Function

The following functions are added in version 1.0.1 of the PC Software and version 01.02 of the firmware (PCB software), available from e2v:

Set 'rate of change' alarm (examples of each command)

- HyperTerminal: Alarm 1 Command: `[EK1 AL1 abb cc d]`
  EK1 response: `[ACK]`

abb	***Sensor association and function***
1UP	*Alarm when Sensor 1 resistance increases by cc% in d seconds*
1DN	*Alarm when Sensor 1 resistance decreases by cc% in d seconds*
2UP	*Alarm when Sensor 2 resistance increases by cc% in d seconds*
2DN	*Alarm when Sensor 2 resistance decreases by cc% in d seconds*
cc	*Percentage 01-99*
d	*Seconds 1-8*

- e2v Datalogger: Alarms Tab: Use 'Monitor Gas' buttons in 'New Settings'
  Tick 'Rate of Change'

Note that the rate of change alarm is triggered for 5 seconds whenever the condition is detected. If the rate of change is maintained for 10 seconds, the alarm will stay enabled for 15 seconds.

Read individual alarm conditions (Enquire Status response when in 'Rate of Change' condition)

- HyperTerminal: Alarm 1 Command: `[EK1 AL1 ENQ]`
  EK1 response: `[EK1 AL1 aaa bcc dd e]`

aaa	*Alarm status*	*ONX, OFF*
bcc	*Alarm setting*	*1UP, 1DN, 2UP, 2DN*
dd	*Percentage*	*01-99 (dec)*
e	*Time*	*1-8 (dec)*

- e2v Datalogger: The status of the alarms is continually displayed in the Alarms tab.

10 Digital Inputs

10.1 Introduction

Four digital inputs are provided on the expansion port PL2. They can be used by engineers writing their own application software to run on the Evaluation Kit. The status of each digital input can be read in software.

10.2 Software Reading of Digital Inputs

Read digital inputs (Enquire Status)

- HyperTerminal: Din Command: `[EK1 DIN ENQ]`
  EK1 response: `[EK1 DIN abcd]`

a	*Digital Input 1 status*	*0, 1*
b	*Digital Input 2 status*	*0, 1*
c	*Digital Input 3 status*	*0, 1*
d	*Digital Input 4 status*	*0, 1*

- e2v Datalogger: The status of the inputs is continually displayed on the I/O tab.

11 Analog Outputs

11.1 Introduction

Two analog outputs are provided on the expansion port PL2. Each analogue output is buffered by an operational amplifier and can be set in the range 0V (000 hex) to 2.048V (FFF hex).

11.2 Software Control of Analog Outputs

Set Analog Outputs

- HyperTerminal:

DAC1 Command: `[EK1 DA1 aaa]`
DAC2 Command: `[EK1 DA2 aaa]`
EK1 response: `[ACK]`

aaa	***Sensor association and function***
`000-FFF`	*Set 12-bit DAC output to aaa (hex)*
`M00`	*Special mode 00:* *Track voltage reading of corresponding DAC*
`M01 etc.`	*Future options*

- e2v Datalogger: The status of the outputs is continually displayed on the I/O tab.

Read Analog Output Values

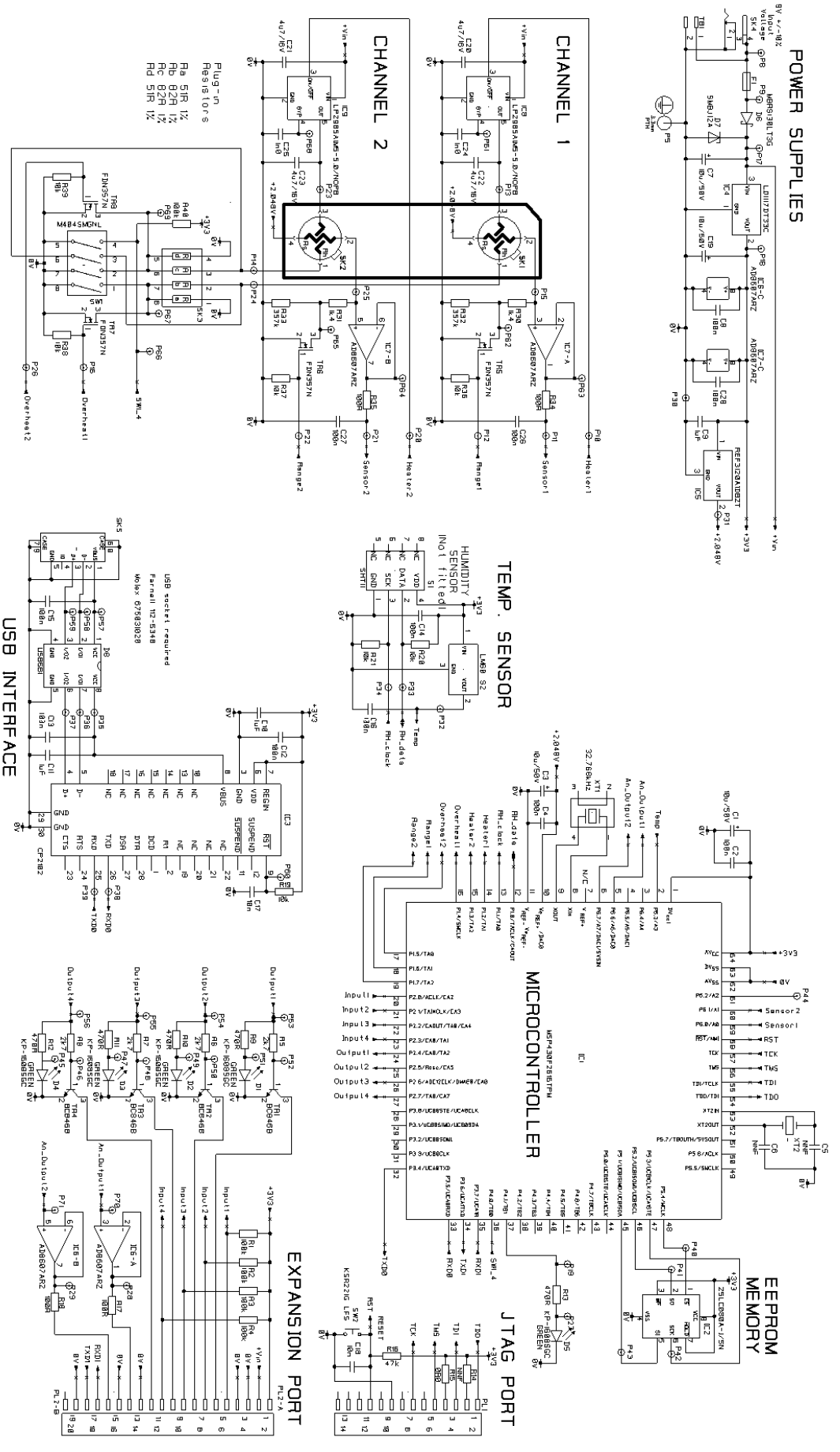
- HyperTerminal:

DAC1 Command: `[EK1 DA1 ENQ]`
DAC2 Command: `[EK1 DA2 ENQ]`
EK1 response: `[EK1 DA1 aaa bbb]`
EK1 response: `[EK1 DA2 aaa bbb]`

`aaa`	*DAC setting*	*000-FFF, M00, M01 etc.*
`bbb`	*DAC output*	*000-FFF*

- e2v Datalogger: The status of the outputs is continually displayed on the I/O tab.

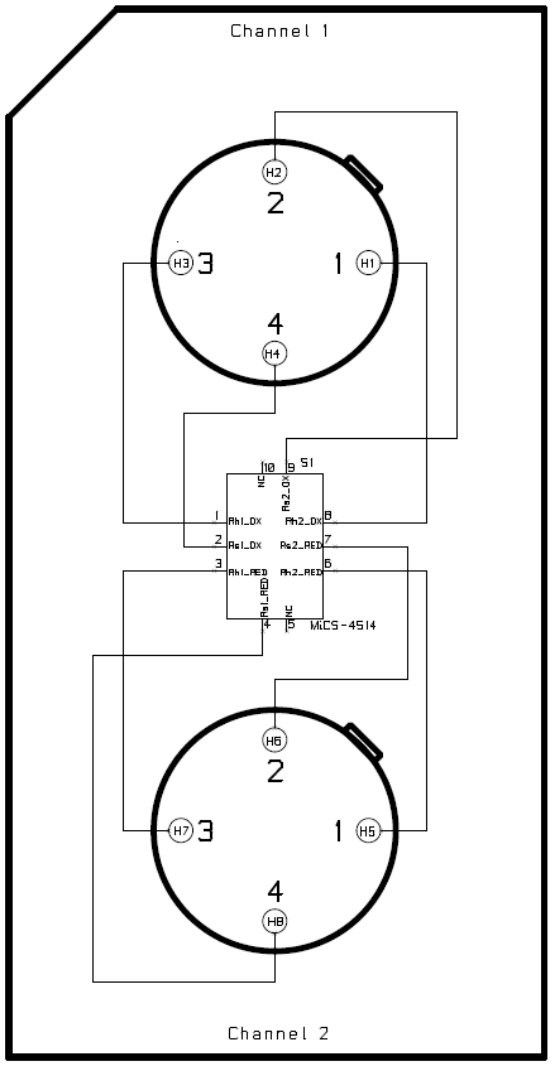
12 Appendix: Evaluation Kit PCB Schematic Diagram

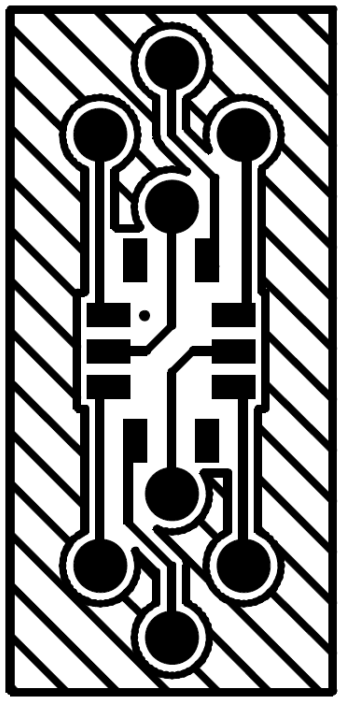


13 Appendix: Evaluation Kit PCB Parts List

Item	Description	Manufacturer	Part No.	Qty	Reference
1	Blank PCB, DPP766275AA Issue 2	Any manufacturer		1	HW1
2	Resistor 0603 0.063W 1% 0R0	Any manufacturer		1	R15
3	Resistor 0603 0.063W 1% 100R	Any manufacturer		4	R17, R18, R34, R35
4	Resistor 0603 0.063W 1% 470R	Any manufacturer		5	R9, R10, R11, R12, R13
5	Resistor 0603 0.063W 1% 2k7	Any manufacturer		4	R5, R6, R7, R8
6	Resistor 0603 0.063W 1% 10k	Any manufacturer		7	R19, R20, R21, R36, R37, R38, R39
7	Resistor 0603 0.063W 1% 47k	Any manufacturer		1	R16
8	Resistor 0603 0.063W 1% 100k	Any manufacturer		5	R1, R2, R3, R4, R40
9	Resistor 0805 0.1W 0.1% 10ppm 1k4	Tyco	RN73C2A1K4BTG	2	R30, R31
10	Resistor 0805 0.1W 0.1% 10ppm 357k	Tyco	RN73C2A357KB	2	R32, R33
11	Capacitor Cer. 0603 NPO 50V 5% 1nF	Any manufacturer		2	C24, C25
12	Capacitor Cer. 0603 X7R 50V 10% 10nF	Any manufacturer		2	C17, C18
13	Capacitor Cer. 0603 X7R 50V 10% 100nF	Any manufacturer		11	C2, C4, C8, C12, C13, C14,C15, C16, C26, C27, C28
14	Capacitor Cer. 0603 X7R 16V 10% 1uF	Any manufacturer		3	C9, C10, C11
15	Capacitor Cer. 0805 X7R 16V 10% 4.7uF	Any manufacturer		4	C20, C21, C22, C23
16	Capacitor Alum. Elec 10uF 50V 20%	Panasonic	EEE1HA100SP	4	C1, C3, C7, C19
17	Diode LED Green SMD	Kingbright	KP-1608SGC	5	D1, D2, D3, D4, D5
18	Diode Schottky 1A 30V SMB	On-Semi	MBRS130LT3G	1	D6
19	Diode TVS 12V 600W	Any manufacturer	SMBJ12A	1	D7
20	Diode Pack TVS 6V 500W	ST-Micro	USB6B1	1	D8
21	Transistor NPN SOT23	NXP	BC846B	4	TR1, TR2, TR3, TR4
22	Transistor N-Channel MOSFET SOT23	Fairchild	FDN357	4	TR5, TR6, TR7, TR8
23	IC Micro 16 bit 64LQFP	Texas	MSP430F2616TPM	1	IC1
24	IC Serial Eeprom SO8	Microchip	25LC80A-I/SN	1	IC2
25	IC USB to UART Bridge MLP-28	Silicon Labs	CP2102	1	IC3
26	IC Regulator 3V3 DPAK	ST	LD1117DT33C	1	IC4
27	IC Reference 2.048V SOT23	Texas	REF3120AIDBZT	1	IC5
28	IC Op-amp Rail-to-rail I/O SO8	Analog	AD8607ARZ	2	IC6, IC7
29	IC Regulator 5V0 SOT23-5	National	LP2985AIM5-5.0	2	IC8, IC9
30	IC Temp. Sensor SOT23	National	LM60BIM3	1	S2
31	Connector SKT TO-5	Mill-Max	917-43-104-41-005000	2	SK1, SK2
32	Connector SKT DIL8	Tyco	808-AG11D-LF	1	SK3
33	Connector SKT DC Power 2.5mm	Lumberg	1613 14	1	SK4
34	Connector SKT USB Mini Type B	Molex	675031020	1	SK5
35	Connector PLG 14 Way Box Header	Amp	1-1634688-4	1	PL1
36	Connector 2x10 Way 2.54mm	Harwin	M20-9981045	1	PL2
37	Fuse Polyswitch 500mA Hold	Tyco	MICROSMD050F	1	F1
38	Terminal Block 2 Way	Elkay	15001/2	1	TB1
39	Switch DIP 4 Way	APEM	M404SMGNL	1	SW1
40	Switch Push button SMD	C&K	KSR221G LFS	1	SW2
41	Crystal SMD 32.768kHz	Epson Toyocom	MC-146 32.768kHz +/-20ppm 7.0pF	1	XT1
	Components fitted manually into SK3:				
51	Resistor Metal Film Axial 1% 0.125W 51R	Any manufacturer		2	RA, RD
52	Resistor Metal Film Axial 1% 0.125W 82R	Any manufacturer		2	RB, RC
53	Feet, stick on, black, 11.1mm dia.	3M	SJ5003BLACK	4	53
	Components not fitted:				
	Capacitor Ceramic 0603			2	C5, C6
	Resistor SMD 0603			1	R14
	Humidity/Temp. Sensor Sensirion SHT11			1	S1
	Crystal HC49/4H			1	XT2

14 Appendix: SMD Adapter PCB Schematic and Legend





8 x Pins: Wearnes Cambion 460-3231-02-03-00

15 Appendix: Serial Message Protocol

Enquire Status	**Command**	**Response**	**Notes**	
PCB	[WHO]	[EK1 **aa.bb cccc dddd**]	**aa.bb**	Software version
			cccc	Spftware checksum
			dddd	Serial number
Sensors	[EK1 GS1 ENQ]	[EK1 GS1 **aaa bbb ccc ddd eee fffffff ggg hhh**]	**aaa**	Heater setting: HLO, HHI, H00, Hxx
			bbb	Heater present condition: HLO, HHI, H00
	[EK1 GS2 ENQ]	[EK1 GS2 **aaa bbb ccc ddd eee fffffff ggg hhh**]	**ccc**	Range setting: RLO, RHI, RAU
			ddd	Range present condition: RLO, RHI
			eee	Raw ADC reading 000 to FFF (hex)
			fffffff	Resistance reading, ohms (four sig. digits) 00000000-99999999 (dec)
			ggg	Temperature reading °C: -99 to +99 or ERR
			hhh	RH reading %: 000 to 100 (dec) or ERR or XXX (not fitted)
Analog Out (DAC)	[EK1 DA1 ENQ]	[EK1 DA1 **aaa bbb**]	**aaa**	DAC setting: 000-FFF, M00, M01 etc.
	[EK1 DA2 ENQ]	[EK1 DA2 **aaa bbb**]	**bbb**	DAC output: 000-FFF
Alarms (individual)	[EK1 AL1 ENQ]	[EK1 AL1 **aaa bbb cccccccc**]	**aaa**	Alarm status ONX, OFF
	[EK1 AL2 ENQ]	[EK1 AL2 **aaa bbb cccccccc**]	**bbb**	Alarm setting: MAN, FOL, 1GT, 1LT, 2GT, 2LT
	[EK1 AL3 ENQ]	[EK1 AL3 **aaa bbb cccccccc**]	**cccccccc**	Alarm threshold 00000000-99999999 (dec)
	[EK1 AL4 ENQ]	[EK1 AL4 **aaa bbb cccccccc**]		
*Response when in Rate Alarm mode**	[EK1 AL1 ENQ]	[EK1 AL1 **aaa bcc dd e**]	**aaa**	Alarm status ONX, OFF
	[EK1 AL2 ENQ]	[EK1 AL2 **aaa bcc dd e**]	**b**	Sensor: 1 or 2
	[EK1 AL3 ENQ]	[EK1 AL3 **aaa bcc dd e**]	**cc**	UP (increasing resistance), DN (decreasing resistance)
	[EK1 AL4 ENQ]	[EK1 AL4 **aaa bcc dd e**]	**dd**	Percentage change to activate alarm 01-99 (decimal)
			e	Time (seconds) in which this occurs 1-8 (decimal)
Alarms (all)	[EK1 AL0 ENQ]	[EK1 AL0 **aaa bbb ccc ddd**]	**aaa**	Alarm 1 output ONX, OFF
			bbb	Alarm 2 output ONX, OFF
			ccc	Alarm 3 output ONX, OFF
			ddd	Alarm 4 output ONX, OFF
Digital Inputs	[EK1 DIN ENQ]	[EK1 DIN **abcd**]	**a**	Digital Input 1 status: 0, 1
			b	Digital Input 2 status: 0, 1
			c	Digital Input 3 status: 0, 1
			d	Digital Input 4 status: 0, 1
Set Heaters	**Command**	**Response**	**Notes**	
High Power	[EK1 GS1 HLO]	[ACK]		
	[EK1 GS2 HLO]	[ACK]		
Low Power	[EK1 GS1 HHI]	[ACK]		
	[EK1 GS2 HHI]	[ACK]		
Off	[EK1 GS1 H00]	[ACK]		
	[EK1 GS2 H00]	[ACK]		
Automatic 24 hour cycle	[EK1 GS1 H**aa**]	[ACK]	**aa**	Start continuous 24 hour cycle of high power for **aa** seconds followed by low power. (00 < **aa** ≤ FF)
	[EK1 GS2 H**aa**]	[ACK]		
Set Resistance	**Command**	**Response**	**Notes**	
Low Range (1k4 Load)	[EK1 GS1 RLO]	[ACK]		
	[EK1 GS2 RLO]	[ACK]		
High Range (358k4 Load)	[EK1 GS1 RHI]	[ACK]		
	[EK1 GS2 RHI]	[ACK]		
Automatic load switching	[EK1 GS1 RAU]	[ACK]		
	[EK1 GS2 RAU]	[ACK]		
Set DAC	**Command**	**Response**	**Notes**	
Fixed value	[EK1 DA1 **aaa**]	[ACK]	**aaa**	000-FFF
	[EK1 DA2 **aaa**]	[ACK]		
Automatic mode	[EK1 DA1 M**aa**]	[ACK]	**aa**	00: Track voltage reading of corresponding DAC 01 etc.: Future options
	[EK1 DA2 M**aa**]	[ACK]		

** Implemented on Version 1.0.1 of the PC Software and Version 01.02 of the firmware (PCB software)*

Set Alarms	Command	Response	Notes
Manual On (individual: 1-4) (all together: 0)	[EK1 AL1 MAN ONX]	[ACK]	
	[EK1 AL2 MAN ONX]	[ACK]	
	[EK1 AL3 MAN ONX]	[ACK]	
	[EK1 AL4 MAN ONX]	[ACK]	
	[EK1 AL0 MAN ONX]	[ACK]	
Manual Off (individual: 1-4) (all together: 0)	[EK1 AL1 MAN OFF]	[ACK]	
	[EK1 AL2 MAN OFF]	[ACK]	
	[EK1 AL3 MAN OFF]	[ACK]	
	[EK1 AL4 MAN OFF]	[ACK]	
	[EK1 AL0 MAN OFF]	[ACK]	
Follow digital inputs (individual: 1-4) (all together: 0)	[EK1 AL1 FOL]	[ACK]	
	[EK1 AL2 FOL]	[ACK]	
	[EK1 AL3 FOL]	[ACK]	
	[EK1 AL4 FOL]	[ACK]	
	[EK1 AL0 FOL]	[ACK]	
On if Sensor **a** resistance is Greater Than **bbbbbbbb** (individual: 1-4) (all together: 0)	[EK1 AL1 **a**GT **bbbbbbbb**]	[ACK]	**a** Sensor: 1 or 2 **bbbbbbbb** Resistance (Ohms) 00000000-99999999 (decimal)
	[EK1 AL2 **a**GT **bbbbbbbb**]	[ACK]	
	[EK1 AL3 **a**GT **bbbbbbbb**]	[ACK]	
	[EK1 AL4 **a**GT **bbbbbbbb**]	[ACK]	
	[EK1 AL0 **a**GT **bbbbbbbb**]	[ACK]	
On if Sensor **a** resistance is Less Than **bbbbbbbb** (individual: 1-4) (all together: 0)	[EK1 AL1 **a**LT **bbbbbbbb**]	[ACK]	
	[EK1 AL2 **a**LT **bbbbbbbb**]	[ACK]	
	[EK1 AL3 **a**LT **bbbbbbbb**]	[ACK]	
	[EK1 AL4 **a**LT **bbbbbbbb**]	[ACK]	
	[EK1 AL0 **a**LT **bbbbbbbb**]	[ACK]	
Rate Alarm* Increasing resistance (individual: 1-4) (all together: 0)	[EK1 AL1 **a**UP **cc d**]	[ACK]	**a** Sensor: 1 or 2 **cc** Percentage change to activate alarm 01-99 (decimal) **d** Time (seconds) in which this occurs 1-8 (decimal)
	[EK1 AL2 **a**UP **cc d**]	[ACK]	
	[EK1 AL3 **a**UP **cc d**]	[ACK]	
	[EK1 AL4 **a**UP **cc d**]	[ACK]	
	[EK1 AL5 **a**UP **cc d**]	[ACK]	
Rate Alarm* Decreasing resistance (individual: 1-4) (all together: 0)	[EK1 AL1 **a**DN **cc d**]	[ACK]	**a** Sensor: 1 or 2 **cc** Percentage change to activate alarm 01-99 (decimal) **d** Time (seconds) in which this occurs 1-8 (decimal)
	[EK1 AL2 **a**DN **cc d**]	[ACK]	
	[EK1 AL3 **a**DN **cc d**]	[ACK]	
	[EK1 AL4 **a**DN **cc d**]	[ACK]	
	[EK1 AL5 **a**DN **cc d**]	[ACK]	
System	**Command**	**Response**	**Notes**
Enter bootloader	[EK1 BLO DER]		
Invalid command	Invalid command	[NAK]	

** Implemented on Version 1.0.1 of the PC Software and Version 01.02 of the firmware (PCB software)*

16 Appendix: China RoHS Declaration

		有毒有害物质或元素 (Hazardous Substances or Elements)					
	零件项目(名称) (Component Name) **MICS-EK1 Evaluation Kit**	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Chromium VI Compounds (Cr6+)	多溴联苯 Poly- brominated Biphenyls (PBB)	多溴二苯醚 Poly- brominated Diphenyl Ethers (PBDE)
1	印制电路配件 (Printed Circuit Assemblies) DAS766275AA Evaluation Kit PCB	O	O	O	O	O	O
2	外接电(线)缆 (External Cables) E100918 USB Lead	O	O	O	O	O	O
3	电源供应器 (Power Supply Unit) DAS766693AA Power Supply Unit	O	O	O	O	O	O
4	文件说明书 (Paper Manuals) DF766764A Quick Start Guide	O	O	O	O	O	O
5	光盘说明书 (CD Manual) DAS766762AA CD-ROM Manual/Software	O	O	O	O	O	O
	零件项目(名称) (Component Name) **MICS-SMD-PCB5 SMD Adapter Kit**						
1	印制电路配件 (Printed Circuit Assemblies) DAS766276AA SMD Adapter PCB x5	O	O	O	O	O	O
2	塑胶外壳 (Plastic Enclosure) PC3863 Anti-static Box	O	O	O	O	O	O

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006标准规定的限量要求以下.
O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

X: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006标准规定的限量要求.
X: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006

17 Appendix: Updating the MICS-EK1 Embedded Software

From time to time e2v may release updates to the PC datalogging software or the embedded software (firmware) which runs on the MICS-EK1 microprocessor. These will normally be available for download from the e2v website www.e2v.com. To install a new version of embedded software on the MICS-EK1, follow these instructions very carefully:

1. Download the firmware zip file. Unzip and save the text file (mics_ek1_.....txt) to the computer hard drive.
2. Connect up the MICS-EK1 evaluation kit to the PC via the USB lead and connect the power.
3. Run the PC software (installed from the supplied CD)
4. Make sure the device is shown as connected.
5. Change the mode to 'Device Setup Mode'
6. Select the 'Hardware' menu, then 'Update Firmware'
7. Click 'Start Update'
8. Select the firmware file (mics_ek1_.....txt) on the computer hard drive
9. Click OK

   ****** Warning: Do not disconnect device during update ******

10. When the progress bar has completed, the installation is complete. The new version number will be shown on the PC screen.

Please read any compatibility notes provided in the readme.txt file supplied in the zip file. It may be necessary to upgrade to a later version of PC software at the same time.