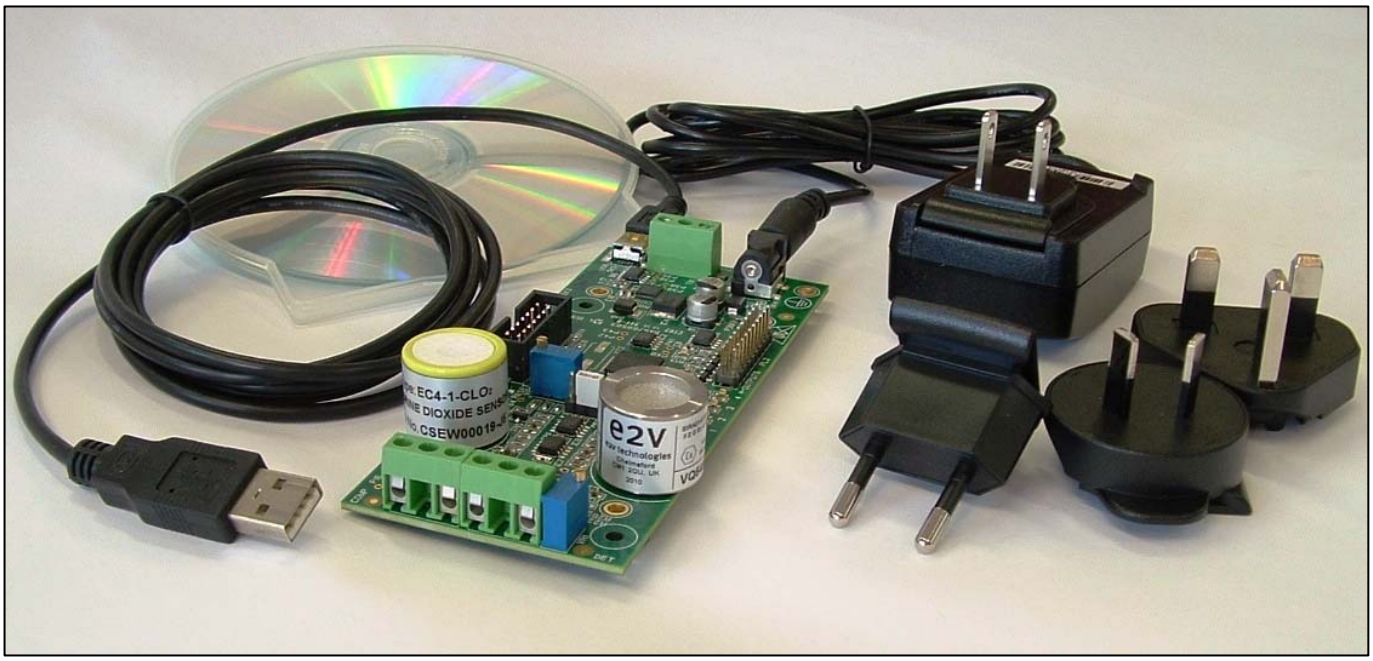
e2v Electrochemical and Pellistor Gas Sensor Evaluation Kit ECVQ-EK3

User Guide



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DAS768835AA Version 2, August 2010

Template: DF764388A-3

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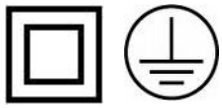
IMPORTANT INFORMATION

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 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 15 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.

Contents

1 Introduction

Thank you for purchasing the e2v Electrochemical and Pellistor Gas Sensors Evaluation Kit.

e2v Electrochemical Gas Sensors are low power devices capable of detecting a range of toxic gases as well as oxygen. e2v Pellistor and Thermal Conductivity Gas Sensors are higher power devices capable of detecting a range of flammable gases. Both of these types of 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 an e2v electrochemical toxic/oxygen sensor
- Test an e2v pellistor/thermal conductivity gas sensors in one of the following forms:
  - Individual bead pairs
  - VQ500 series heads
  - VQ600 series heads
- Control the electrochemical sensor bias voltage
- Control the pellistor bridge supply voltage
- Calibrate sensors based on a linear response and then monitor gas concentration levels
- Set four alarm levels which drive on-board LEDs and open collector outputs.
- Drive two analogue outputs
- Connect additional circuits to an expansion port
- Log sensor outputs, concentrations and temperature readings using the supplied PC Data Logging Program.

Contents of Evaluation Kit

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

Accessories Available

- **JAS767906AA** – Standard Gas Flow Hood for VQ500 series, Infrared mini-sensors and electrochemical (non-reactive gas) sensors

- **JAS769638AA** – Premium Gas Flow Hood recommended for reactive gases e.g. H_2S, NO_2, Cl_2, ClO_2, ETO

2 Quick Start Guide

Warning: Do not connect or plug in any Gas Sensors until instructed!

1. Read the Manual!

a. The supplied CD should auto-run on your PC when inserted into a CD drive.
b. Select 'User Guide' from the CD menu.

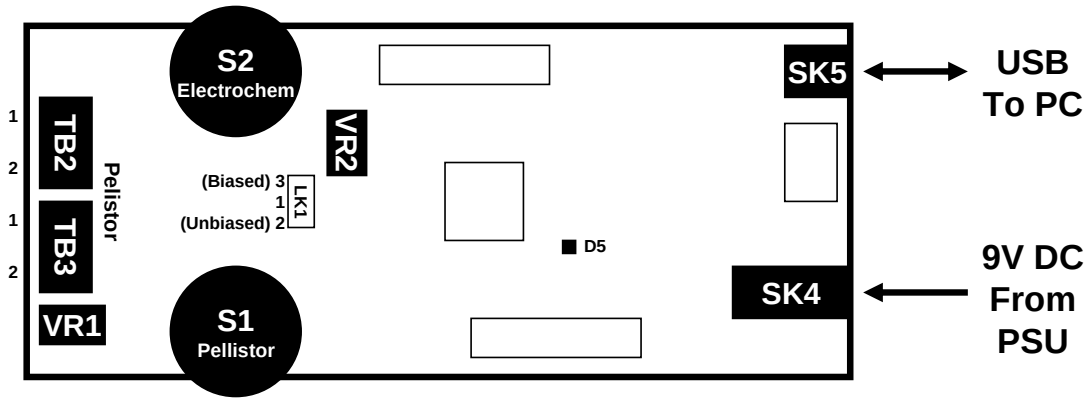
Before using this product, please read and understand all the instructions and warnings. e2v technologies does not accept responsibility for damage or injury resulting from failure to follow the instructions provided!

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

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

3. Connect the USB Interface and 9V Power Supply Unit

a. Connect the supplied USB lead from SK5 to a USB socket on your PC
b. Connect the DC output of the Power Supply Unit to SK4
c. 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.
d. The PC may take a minute to recognise and initialise the new hardware drivers.



4. 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.

5. Set-up for Electrochemical Sensors

a. Check if the electrochemical sensor requires a bias (see table over page).
b. For unbiased sensors (0V) set LK1 to position 1-2, otherwise set to 1-3.
c. For biased sensors set LK1 to position 1-3 and adjust VR2 until the correct bias level is displayed on the PC software (Electrochemical tab).
d. **Turn off the power before plugging the sensor into S2**
e. Turn the power back on and allow time for the sensor to stabilise.
f. Zero the sensor output current in clean air by pressing 'Set Zero' (not required for O_2)
g. The sensor output current (nA) is now being correctly displayed.

6. Set-up for Pellistor/Thermal Conductivity Sensors

a. Check the bridge supply voltage required from the device datasheet.
b. Turn the bridge supply voltage on and adjust VR1 until the correct bridge supply voltage is displayed on the PC software (Pellistor tab).
c. **Turn off the power before connecting a pellistor/TC type device as follows:**
    i. Pairs of beads connect into TB2 (compensator) and TB3 (detector). If a trimming resistor is supplied, connect in parallel with the compensator in TB2.
    ii. VQ500 series devices should be plugged into S2.
    iii. VQ600 devices should be wired into TB2 and TB3:
        - Red lead (compensator) TB2 Pin 1 (top)
        - Yellow lead (common) TB2 Pin 2 (middle)
        - Blue lead (pellistor) TB3 Pin 3 (bottom)
d. Turn the power back on and allow time for the sensor to stabilise.
e. Zero the bridge output in clean air by pressing 'Set Zero'.
f. The bridge output voltage (mV) is now being correctly displayed

7. Further Settings – Span Calibration (Measuring the sensitivity)

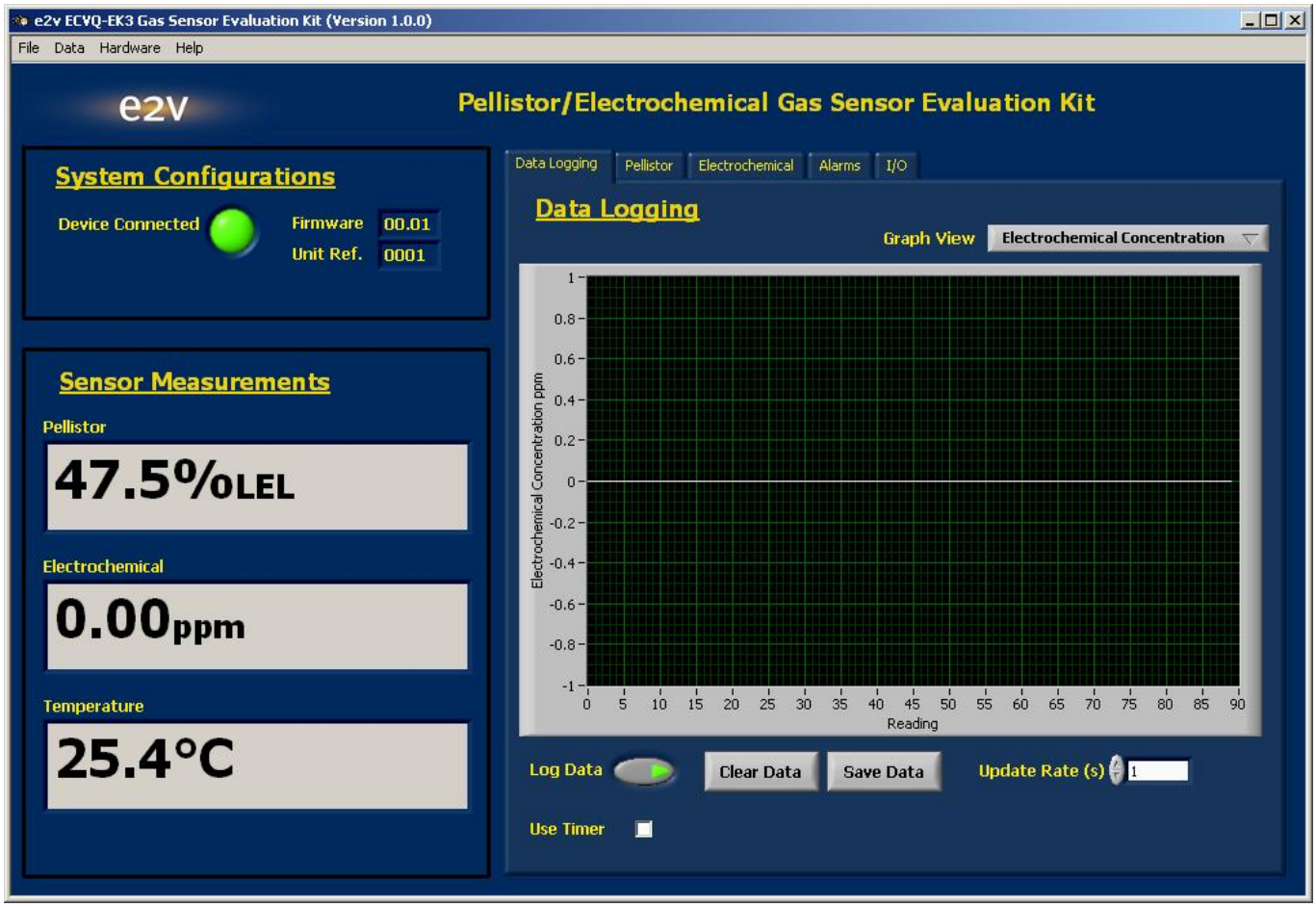
a. At this stage you will not have correct concentration readings – a calibration is required.
b. For electrochemical devices:
    i. Enter the concentration of the calibration gas to be used
    ii. Select 'Measure Sensitivity' when the calibration gas has been applied
c. For pellistors/thermal conductivity devices:
    i. Select the gas type (or manually enter the LEL (Lower Explosive Limit) value)
    ii. Enter the concentration of the calibration gas to be used
    iii. Select 'Measure Sensitivity' when the calibration gas has been applied
d. Note that the calibration assumes a linear response to gas concentration.

Electrochemical Sensor Bias Settings

Sensor	Bias ($V_{SENSE} - V_{REF}$)	LK1 setting	Circuit Output Voltage Polarity
EC4-1-CLO2	0 V	2-1 .	Negative
EC4-50-CLO2	0 V	2-1 .	Negative
EC4-50-CL2	0 V	2-1 .	Negative
EC4-500-CO	0 V	2-1 .	Positive
EC4-2000-CO	0 V	2-1 .	Positive
EC4-100-ETO	+300 mV	. 1-3	Positive
EC4-200-ETO	+300 mV	. 1-3	Positive
EC4-1000-ETO	+300 mV	. 1-3	Positive
EC4-1000-H2	0 V	2-1 .	Positive
EC4-100-H2S	0 V	2-1 .	Positive
EC4-1000-H2S	0 V	2-1 .	Positive
EC4-250-NO	+300 mV	. 1-3	Positive
EC4-2000-NO	+300 mV	. 1-3	Positive
EC4-20-NO2	0 V	2-1 .	Negative
EC4-20-PH3	0 V	2-1 .	Positive
EC4-1000-PH3	0 V	2-1 .	Positive
EC4-20-SO2	0 V	2-1 .	Positive
EC4-2000-SO2	0 V	2-1 .	Positive
EC410 (O2)	-600 mV	. 1-3	Negative

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:

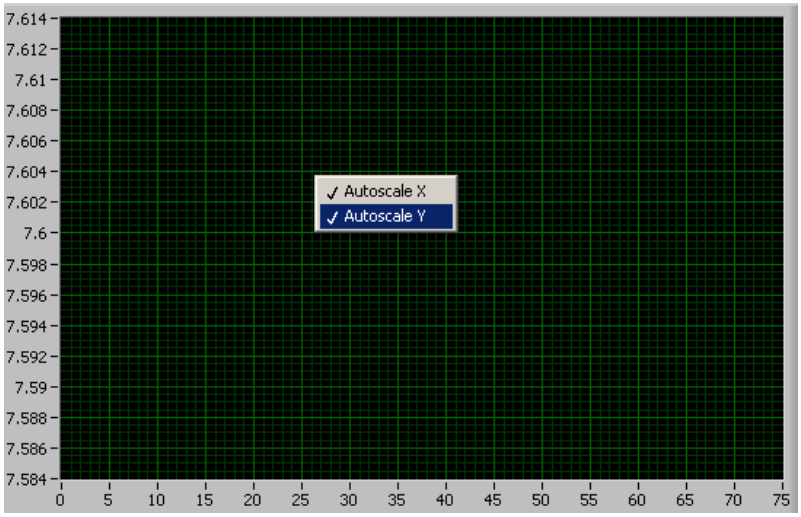


The USB interface to the Evaluation Kit appears as a virtual ‘Com Port’. When the program is started the software will automatically detect which ‘Com Port’ is being used for the USB connection. (If this does not happen, a Com Port can be manually selected by unticking ‘Automatically search for connected 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 concentrations and temperature. The graph view can be changed to display all these parameters and also the raw output voltage (pellistors) and current (electrochemical sensors) 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. Alternatively there is a timer function which can stop data recording after a set period.

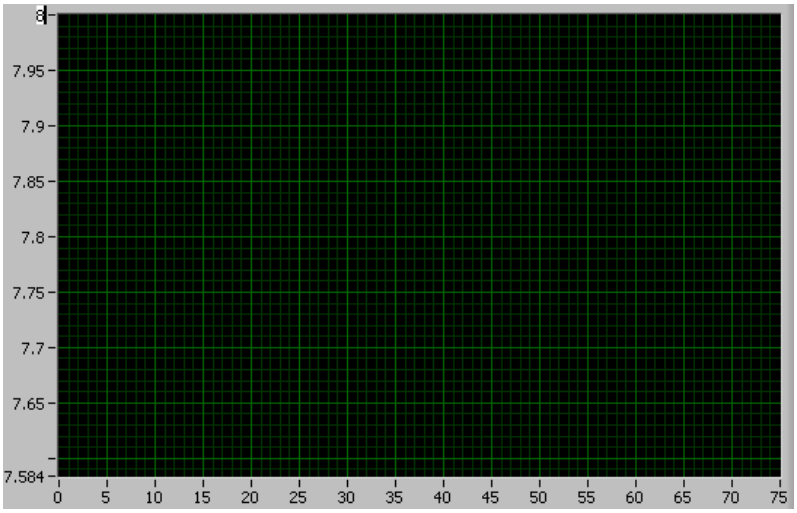
By default, the data logging software autoscales the output readings (i.e. the graph axes expand to show all of the readings on y and x axes). However, it is possible to change these values in order to ‘zoom in’ on certain readings.

In the Data Logging tab, right-click on the graph to be adjusted and untick ‘autoscale’ for the axis 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 ‘Pellistor’ tab allows monitoring, control and calibration of pellistor and thermal conductivity sensors (see section 6). The ‘Electrochemical’ tab allows monitoring, control and calibration of electrochemical sensors (see section 5).

The ‘Alarms’ tab allows control of the open collector alarm output thresholds (see section 9).

The ‘I/O’ tab gives allows monitoring of digital inputs (see section 10) and setting of analog outputs (see section 11). It also allows a serial number to be set, useful if using multiple evaluation kits.

The ‘Data’ menu has options to change the displayed units for concentration and temperature.

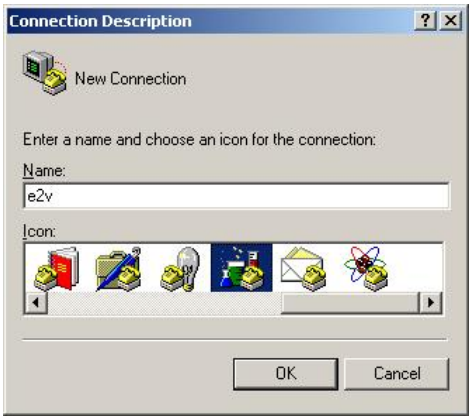
The ‘Hardware’ menu contains an Update Firmware feature which allows software updates to be loaded into the microprocessor without having to return the PCB to e2v for reprogramming (see section 16).

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.

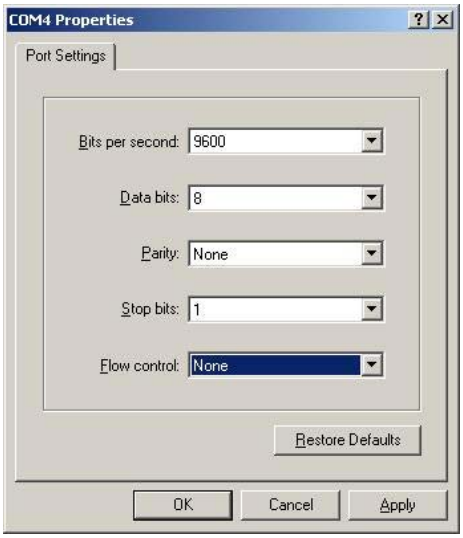
To communicate with the Evaluation Kit using HyperTerminal use the following procedure:
(Note: the USB Drivers must be installed.)

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

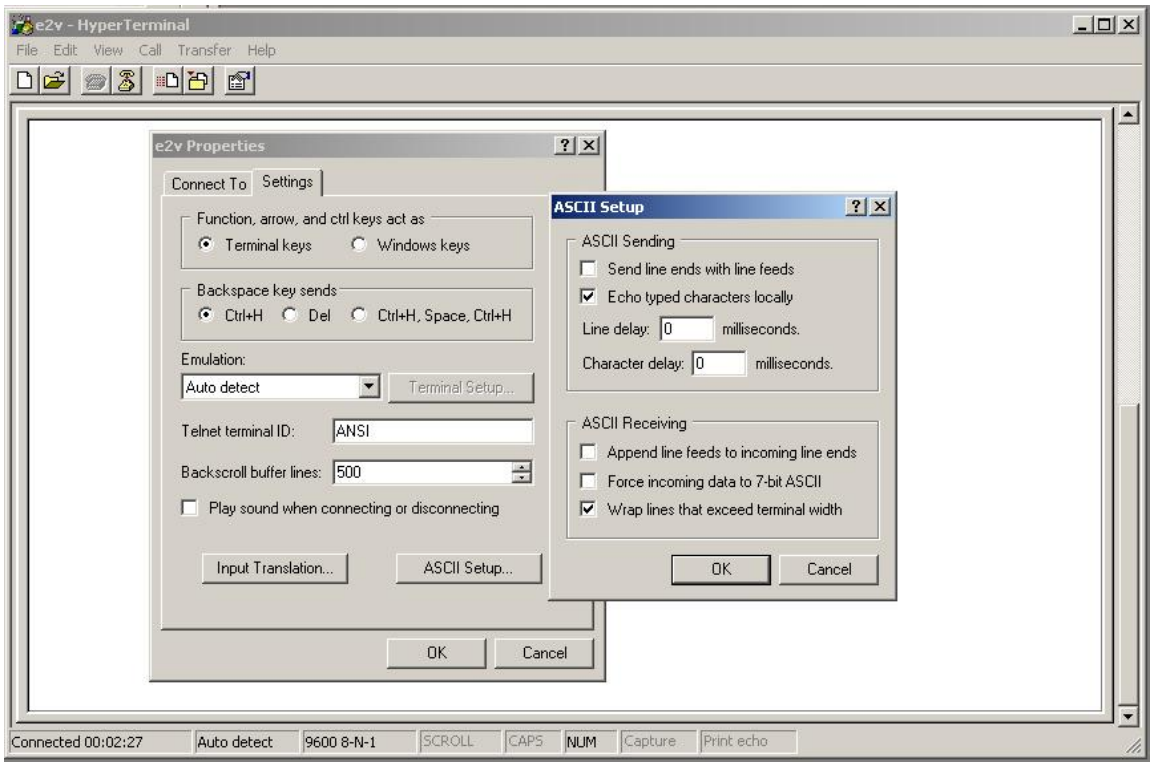


- Select the correct 'COM Port' being used by the USB Driver:

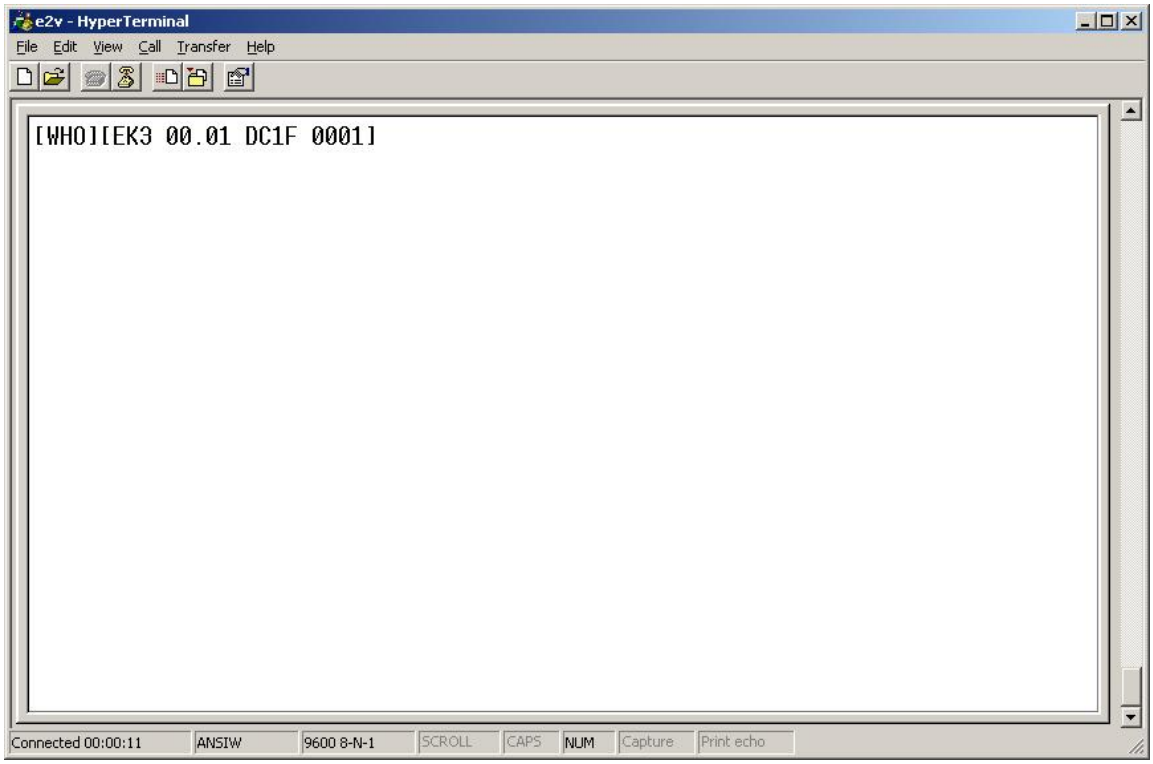
- Select 9600 Bits per second (Baud), 8 data bits, no parity, 1 stop bit, no flow control:



- 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.

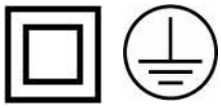


A full list of HyperTerminal commands can be found in Section 14

5 User Interfaces, Controls and Indicators

5.1 Power Supply (SK4, TB1)

The Evaluation Kit requires a 9 V ± 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 USB Interface (SK5)

SK5 is a type B Mini-USB connector for communicating with a PC.

5.3 Electrochemical Sensor Connector (S2)

Electrochemical sensors should be plugged into S2. Before plugging in the sensor, ensure that the correct bias voltage has already been set up and that the power has then been turned off.

5.4 Pellistor/Thermal Conductivity Sensor Connectors (S1, TB2, TB3)

Pellistor sensors should be plugged in as shown belw. Before plugging in the sensor, ensure that the correct bridge supply voltage has already been set up and that the power has then been turned off.

- Pairs of beads connect into TB2 (compensator) and TB3 (detector).
  If a trimming resistor is supplied, connect in parallel with the compensator in TB2.
- VQ500 series devices should be plugged into S2.
- VQ600 devices should be wired into TB2 and TB3:
  - Red lead (compensator) TB2 Pin 1 (top)
  - Yellow lead (common) TB2 Pin 2 (middle)
  - Blue lead (pellistor) TB3 Pin 3 (bottom)

5.5 User Adjustments (VR1, VR2, LK1)

VR1: Pellistor bridge supply voltage adjust (1.6 V to 4.6 V minimum range)
VR2: Electrochemical bias voltage adjust (-700 mV to +350 mV minimum range)
LK1: Electrochemical bias 1-2 Unbiased (0 V); 1-3 Biased

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.

5.8 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.

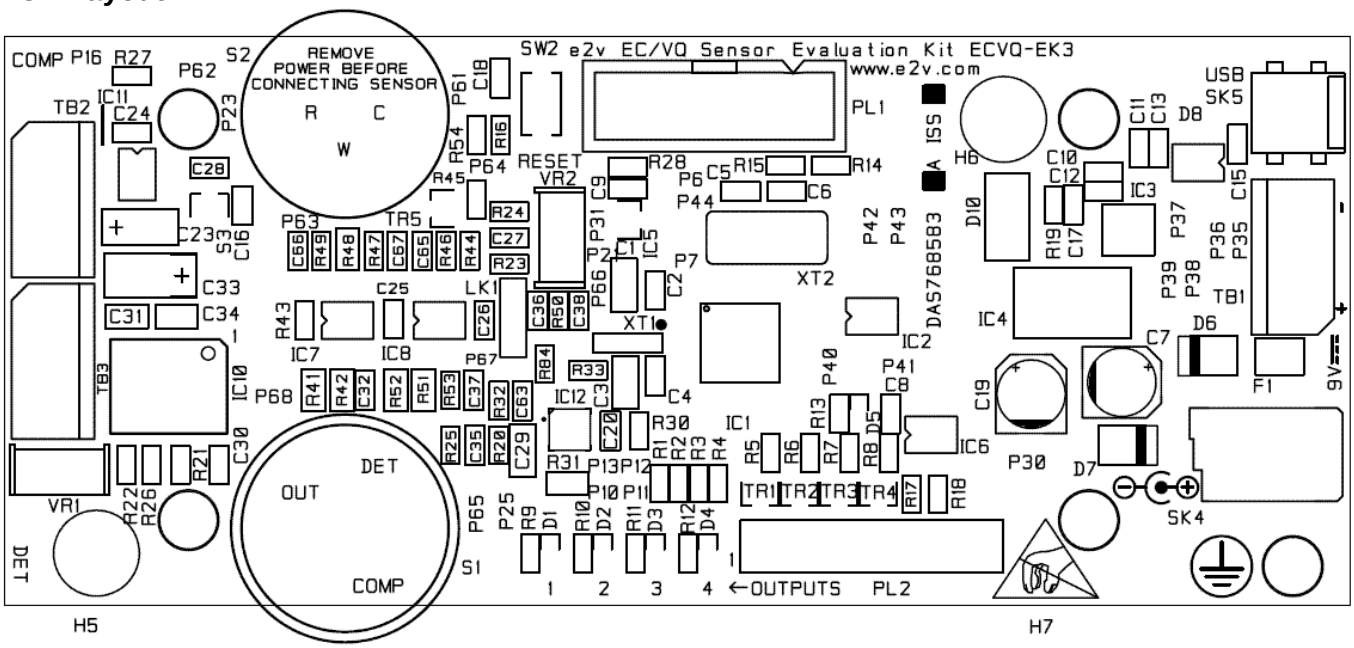
TDO	1	2	VCCO
TDI	3	4	VCCI
TMS	5	6	Unused
TCK	7	8	Unused
0V	9	10	Unused
TRST	11	12	Unused
Unused	13	14	Unused

5.9 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

PCB Layout:



6 Electrochemical Sensors

The user is advised to consult the Electrochemical Sensor Application Notes on the e2v website for information on how an electrochemical sensor operates.

6.1 Biasing

Electrochemical sensors are normally operated in a 'potentiostat' circuit which is designed to maintain a constant bias between the sensing electrode (sometimes call the working electrode) and the reference electrode. The bias voltage is given is device datasheets as the 'applied potential' and is also summarised in the quick start guide, section 2.

For unbiased sensors, set LK1 to position 1-2.
For biased sensors, set LK1 to position 1-3. VR2 should then be adjusted to set the bias voltage.

Note that the potentiostat circuit (IC8-B) is effectively floating at 2.5 V due to the sensing electrode connection. The bias voltage on VR2 and LK1 must be considered reference to 2.5 V. Also, the way that electrochemical sensor bias is defined ($V_{SENSE} – V_{REF}$) means that the polarity is opposite to that at VR2 and LK1. For example:

For unbiased sensors: LK1 voltage = 2.5 V (equal to 2.5 V reference)
For +300 mV biased sensors LK1 voltage = 2.2 V (equal to 2.5 V – 300 mV)
For -600 mV biased sensors LK1 voltage = 3.1 V (equal to 2.5 V + 600 mV)

The PC software program displays the actual sensor bias setting, i.e. $V_{SENSE} – V_{REF}$

The bias voltage should be set-up before the sensor is plugged in.
Turn the power off when plugging in a sensor.

Note that TR5 will clamp the bias to 0 V when the power is turned off. This is useful to keep unbiased sensors at 0 V so that they will stabilise very quickly when power is re-applied. Biased sensors may require several hours to stabilise after switch-on. In a gas sensor instrument it is common to maintain power to the bias circuit via a battery, even when the rest of the instrument is turned off, to achieve a rapid stabilisation.

6.2 Output Amplifiers

The output of an electrochemical sensor is a current proportional to gas concentration. The range of this current can be calculated from the sensitivity values given in individual device data sheets.

IC7B is configured as a current to voltage converter with a gain set by R48 + R49 = 3.051k
Therefore the output signal of IC7B (EC_hi_range_out) has the following voltage:

- EC_hi_range_out = 3051 V/A = 3.051 μV/nA

The ADC converter (IC12) is a 16-bit device (65536 steps) using a 5 V reference. Therefore each ADC step corresponds to 76.29 μV. In terms of sensor output current this is as follows:

- EC_hi_range_out = 0.00007629/3051 = **25 nA per ADC step**

This is the basic resolution of the Evaluation Kit when using the high range. This range is primarily intended for operating oxygen sensors which have a very high output. For most other sensors, IC8A provides a gain of 5 so that its output has the following voltage:

- EC_lo_range_out = 15255 V/A = 15.255 μV/nA

This can be expressed in terms of ADC steps as follows:

- EC_lo_range_out = 0.00007629/15255 = **5 nA per ADC step**

Using the PC software, the Evaluation Kit can be set to either of the two ranges, or to automatically switch between them according to the signal level.

Note that the output current is described as positive for most gases (electrons flowing out of the sensing electrode, although conventional current is actually negative). However for gases which undergo a reduction in the cell (CLO2, CL2, NO2, O2) the output current is described as negative (electrons flowing into the sensing electrode, positive conventional current) as shown below. This will correspond to positive and negative voltage readings accordingly.

Sensor	Output Current Direction
EC4-1-CLO2	Negative
EC4-50-CLO2	Negative
EC4-50-CL2	Negative
EC4-500-CO	Positive
EC4-2000-CO	Positive
EC4-100-ETO	Positive
EC4-200-ETO	Positive
EC4-1000-ETO	Positive
EC4-1000-H2	Positive
EC4-100-H2S	Positive
EC4-1000-H2S	Positive
EC4-250-NO	Positive
EC4-2000-NO	Positive
EC4-20-NO2	Negative
EC4-20-PH3	Positive
EC4-1000-PH3	Positive
EC4-20-SO2	Positive
EC4-2000-SO2	Positive
EC410 (O2)	Negative

6.3 Setting Zero

To remove any zero offsets, apply clean air to the sensor and press ‘Set Zero’.
For oxygen sensors this is not necessary; in fact it as advisable to press ‘unset zero’ to remove any previously stored zero settings. If a supply of nitrogen is available, this can be used to set an accurate zero.

The sensor output current (nA) is now being correctly displayed with the zero offset removed.

6.4 Setting Span/Sensitivity

At this stage you will not have correct concentration readings. The Evaluation Kit allows a simple calibration to be performed based on a linear response to gas.

Enter the concentration of the calibration gas to be used, then select ‘Measure Sensitivity’ when the calibration gas has been applied.

On the ‘Data’ menu the concentration units can be changed between %Volume and ppm.

6.5 Minimising Noise on the Electrochemical Sensor Output

Electrochemical cells have very low output signal levels and can be susceptible to noise pickup. The ECVQ-EK3 has very short track lengths for the sensitive signal to minimise this effect, but the user can take further steps to improve the output.

- Turn the pellistor supply off when measuring electrochemical cells.
  The pellistor supply uses a switched mode power supply which can cause a small but measurable level of interference to the electrochemical cell.

- Use averaging of the output.
  The PC software will default to a 10 second rolling average. This can be increased or reduced as required.

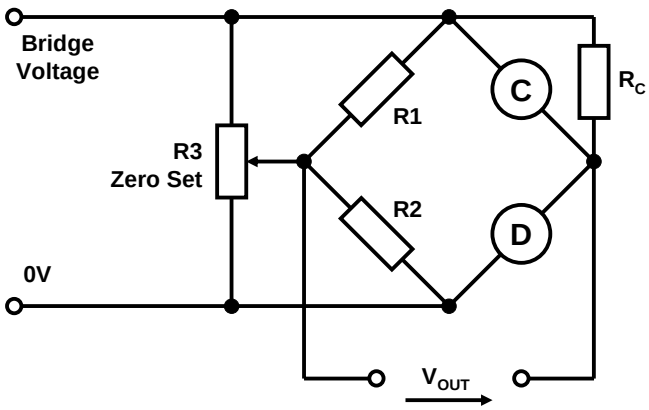
- Do not operate RF transmitters (e.g. mobile phones) close to the ECVQ-EK3
  Bursts of RF energy may cause disturbance of the signal. This effect can also me minimised by operating the ECVQ-EK3 in a screened enclosure.

7 Pellistors and Thermal Conductivity Sensors

The user is advised to consult the Pellistor Application Notes on the e2v website for information on how Pellistors and Thermal Conductivity Devices operate.

7.1 Bridge Circuit

Pellistors and Thermal Conductivity Devices are normally operated in a Wheatstone bridge arrangement as shown below. The compensator and detector beads are balanced using R1 and R2 with some zero adjustment using R3. Many pellistors are supplied with a separate trimming resistor which is connected across the compensator bead.



In the evaluation kit the bridge voltage is set using VR1 covering a range of at least 1.6 V to 4.6 V. The value of the bridge supply is monitored by the Analog to Digital Converter (ADC) and displayed by the PC Software.

The bridge voltage should be set up before connecting the pellistor device. Once a correct voltage has been set, the power should be turned off, then the device plugged in as follows:

- Pairs of beads connect into TB2 (compensator) and TB3 (detector). If a trimming resistor is supplied, connect in parallel with the compensator in TB2.
- VQ500 series devices should be plugged into S2.
- VQ600 devices should be wired into TB2 and TB3:
  - Red lead (compensator) TB2 Pin 1 (top)
  - Yellow lead (common) TB2 Pin 2 (middle)
  - Blue lead (pellistor) TB3 Pin 3 (bottom)

7.2 Setting Zero

The evaluation kit does not need resistors R1 and R2 to determine a reference point. This is calculated as exactly half the bridge voltage. R3 is also not required. To remove any zero offsets, apply clean air to the sensor and press ‘Set Zero’. This will automatically calculate the zero point.

The zero adjustment can also be removed by pressing ‘Unset Zero’

When the zero has been set, the bridge output (mV) will be correctly displayed by the PC software.

7.3 Setting Span/Sensitivity

At this stage you will not have correct concentration readings. The Evaluation Kit allows a simple calibration to be performed based on a linear response to gas.

- First select the gas type or manually enter the LEL (Lower Explosive Limit) value.
- Enter the concentration of the calibration gas to be used.
- Select ‘Measure Sensitivity’ when the calibration gas has been applied.

On the ‘Data’ menu the concentration units can be changed between %LEL, %Volume and ppm.

Enter the concentration of the calibration gas to be used, then select ‘Measure Sensitivity’ when the calibration gas has been applied

8 Temperature Measurement

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

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 9 V 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 of the four alarm outputs can be set to one of the options shown below.
Click 'Refresh Settings' to read the current settings from the PCB.
Click 'Write All Alarm Settings' to write new alarm settings to the PCB.
The status of the alarms is continually displayed in the 'Alarms' tab of the PC Software

Monitor Gas: Each alarm can be set to monitor either the Electrochemical or the Pellistor channel

- **Electrochemical channel**: the alarm can be set to come on above or below a threshold of current (nA) or concentration (ppm or %Volume).
- **Pellistor channel:** the alarm can be set to come on above or below a threshold of voltage (mV) or concentration (ppm, %LEL or %Volume).

Force ON: This forces the selected alarm line ON

Force OFF: This forces the selected alarm line OFF

Follow Input: This forces the selected alarm to track the associated digital input

10 Digital Inputs

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 viewed on the 'I/O' tab on the PC Software.

11 Analog Outputs

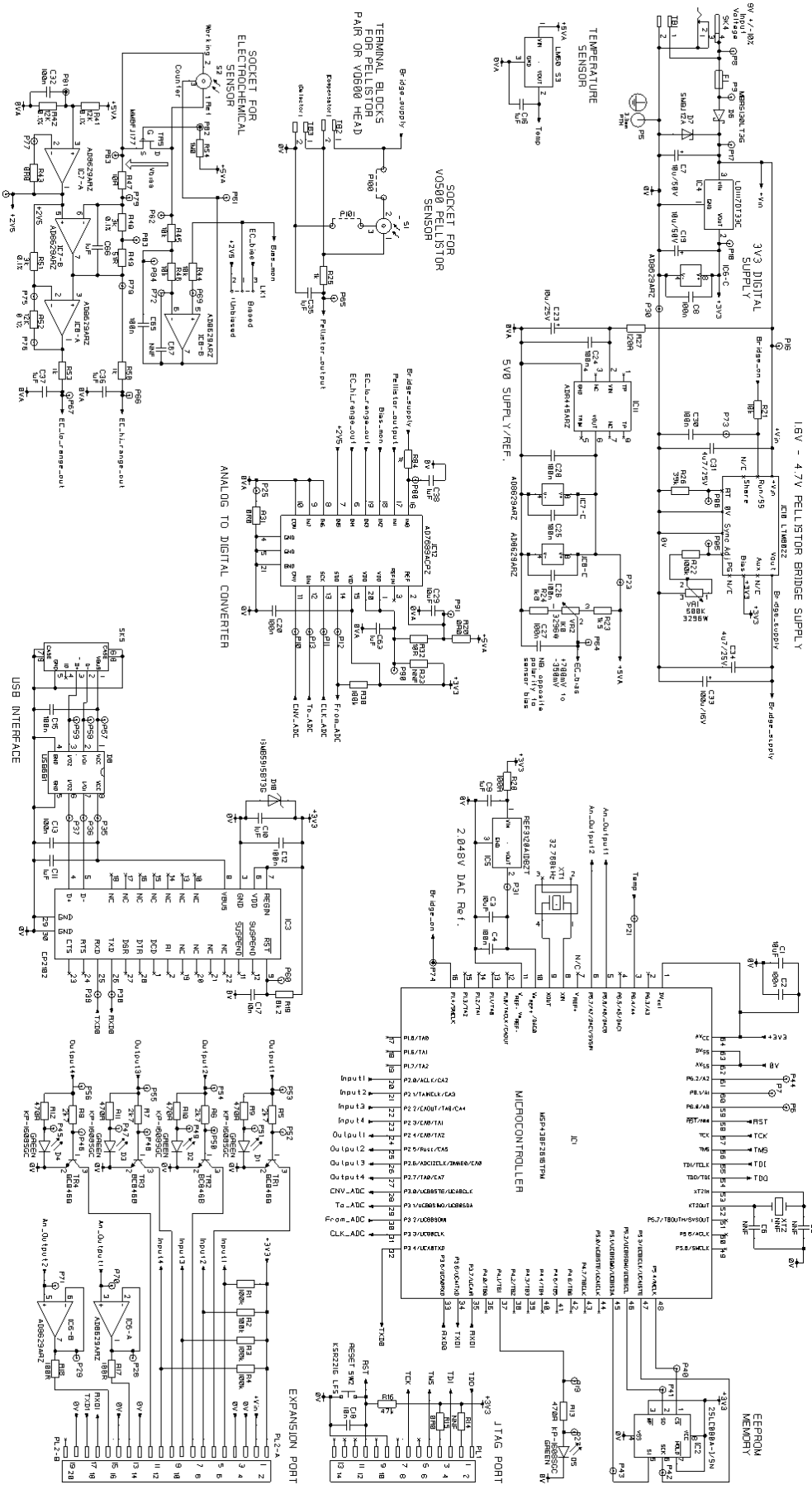
The outputs of two 12-bit digital to analog converters (DACs) are provided on the expansion port PL2. Each analogue output is buffered by an operational amplifier and can give outputs in the range 0 V (000 hex) to 2.048 V (FFF hex). The analog outputs can be configured on the 'I/O' tab as follows:

Write Value: Fixes the DAC output at a fixed voltage level set on the PC Software

Follow Pellistor: tracks the value of the Pellistor channel output in mV (adjustable scale)
Note: that a bridge voltage of 0mV corresponds to 1.024V on the output

Follow EC: tracks the magnitude of the Electrochem channel output in nA (adjustable scale)

12 Appendix: Evaluation Kit PCB Schematic Diagram



13 Appendix: Evaluation Kit PCB Parts List

Item	Description	Manufacturer	Part No.	Qty	Reference
1	Blank PCB, DPP768583AA	Any manufacturer		1	HW1
2	Feet, stick on, black, 11.1mm dia.	3M	SJ5003BLACK	4*	HW2, HW3, HW4, HW5
3	Resistor 0603 0.063W 1% 0R0	Any manufacturer		3	R15, R20, R43
4	Resistor 0603 0.063W 1% 10R	Any manufacturer		2	R32, R47
5	Resistor 0603 0.063W 1% 51R	Any manufacturer		1	R49
6	Resistor 0603 0.063W 1% 100R	Any manufacturer		3	R17, R18, R28
7	Resistor 0603 0.063W 1% 470R	Any manufacturer		5	R9, R10, R11, R12, R13
8	Resistor 0603 0.063W 1% 1k5	Any manufacturer		1	R23
9	Resistor 0603 0.063W 1% 1k8	Any manufacturer		1	R24
10	Resistor 0603 0.063W 1% 2k7	Any manufacturer		4	R5, R6, R7, R8
11	Resistor 0603 0.063W 1% 8k2	Any manufacturer		1	R19
12	Resistor 0603 0.063W 1% 10k	Any manufacturer		4	R21, R44, R45, R46
13	Resistor 0603 0.063W 1% 39k	Any manufacturer		1	R26
14	Resistor 0603 0.063W 1% 47k	Any manufacturer		1	R16
15	Resistor 0603 0.063W 1% 100k	Any manufacturer		6	R1, R2, R3, R4, R22, R30
16	Resistor 0603 0.063W 1% 1M	Any manufacturer		1	R54
17	Resistor 0805 0.1W 1% 0R0	Any manufacturer		1	R31
18	Resistor 0803 0.1W 0.1% 25ppm 3k	Any manufacturer		2	R48, R51
19	Resistor 0803 0.1W 0.1% 25ppm 12k	Any manufacturer		3	R41, R42, R52
20	Resistor Variable 1k 0.5W Multiturn	Bourns	3296W-1-102LF	1	VR2
21	Resistor Variable 500k 0.5W Multiturn	Bourns	3296W-1-504LF	1	VR1
22	Capacitor Cer. 0603 X7R 50V 10% 10nF	Any manufacturer		2	C17, C18
23	Capacitor Cer. 0603 X7R 50V 10% 100nF	Any manufacturer		15	C2, C4, C8, C12, C13, C15, C20, C24, C25, C26, C27, C28, C30, C32, C65
24	Capacitor Cer. 0603 X7R 16V 10% 1uF	Any manufacturer		10	C9, C10, C11, C16, C35, C36, C37, C38, C63, C66
25	Capacitor Cer. 0805 X5R 25V 10% 4u7	Any manufacturer		2	C31, C34
26	Capacitor Cer. 1206 X7R 6.3V 10% 10uF	Any manufacturer		3	C1, C3, C29
27	Capacitor Tant. TPSC 25V 10% 10uF	AVX	TPSC106K025R0500	1	C23
28	Capacitor Tant. TPSE 16V 10% 100uF	AVX	TPSE107K15R0100	1	C33
29	Capacitor Alum. Elec 50V 20% 10uF	Panasonic	EEE1HA100SP	2	C7, C19
30	Diode LED Green SMD	Kingbright	KP-1608SGC	5	D1, D2, D3, D4, D5
31	Diode Schottky 1A 30V SMB	On-Semi	MBRS130LT3G	1	D6
32	Diode TVS 12V 600W	Any manufacturer	SMBJ12A	1	D7
33	Diode Pack TVS 6V 500W	ST-Micro	USB6B1	1	D8
34	Diode Zener 3V9 3W	OnSemiconductor	1SMB5915BT3G	1	D10
35	Transistor NPN SOT23	NXP	BC846B	4	TR1, TR2, TR3, TR4
36	Transistor JFET P-Chan. SOT23	Fairchild	MMBFJ177	1	TR5
37	IC Micro 16 bit 64LQFP	Texas **	MSP430F2616TPM	1	IC1
38	IC Serial Eeprom SO8	Microchip	25LC80A-I/SN	1	IC2
39	IC USB to UART Bridge MLP-28	Silicon Labs	CP2102	1	IC3
40	IC Regulator 3V3 DPAK	ST	LD1117DT33C	1	IC4
41	IC Reference 2.048V SOT23	Texas	REF3120AIDBZT	1	IC5
42	IC Op-amp Rail-to-rail I/O SO8	Analog	AD8629ARZ	3	IC6, IC7, IC8
43	IC Regulator DC/DC LGA50	Linear	LTM8022EV#PBF	1	IC10
44	IC Reference 5.0V SO8	Analog	ADR445ARZ	1	IC11
45	IC ADC 8x16bit 20QFN	Analog	AD7689ACPZ	1	IC12
46	IC Temp. Sensor SOT23	National	LM60BIM3	1	S3
47	Connector Press Mount Socket	Wearnes Cambion	450-1804-01-03-00	6	S1 (3 off), S2 (3 off)
48	Connector SKT DC Power 2.5mm	Lumberg	1613 14	1	SK4
49	Connector SKT USB Mini Type B	Molex	675031020	1	SK5
50	Connector PLG 14 Way Box Header	Amp	1-1634688-4	1	PL1
51	Connector PLG 2x10 Way 2.54mm	Harwin	M20-9981045	1	PL2
52	Connector PLG 1x3 Way 2.54mm	Harwin	M20-9990345	1	LK1
53	Fuse Polyswitch 500mA Hold	Tyco	MICROSMD050F	1	F1
54	Terminal Block 2 Way	Elkay	15001/2	3	TB1, TB2, TB3
55	Switch Push button SMD	C&K	KSR221G LFS	1	SW2
56	Crystal SMD 32.768kHz	Epson Toyocom	MC-146 32.768kHz +/-20ppm 7.0pF	1	XT1
57	Link, 0.1” Jumper	Any manufacturer		1***	LK1
58	Resistor 0603 0.063W 1% 1k0	Any manufacturer		4	R25, R50, R53, R84
59	Resistor 0603 0.063W 1% 120R	Any manufacturer		1	R27
	Components not fitted:				
	Capacitor Ceramic 0603			3	C5, C6, C67
	Resistor SMD 0603			1	R14, R33
	Crystal HC49/4H			1	XT2

14 Appendix: Serial Message Protocol

Enquire Status	Command	Response	Notes	
PCB	[WHO]	[EK3 **aa.bb cccc dddd**]	**aa.bb**	Software version
			cccc	Software checksum
			dddd	Serial number
Pellistor Sensor	[EK3 PEL ENQ]	[EK3 PEL **aaaa ±bbbbbbbb ±cccc ±dddd ±eeee ffffffff gggggggg ±hh.h iii**]	**aaaa**	Bridge Supply, mV: (hex)
			±bbbb	Measured Concentration (ppm*100)(hex)
			±cccc	Bridge Reading (mV *100)(hex)
			±dddd	Sensitivity Reading (span voltage)(mV *100)(hex)
			±eeee	Measured Sensitivity mV/%LEL *100)(hex)
			ffffffff	Pellistor LEL Conc (ppm*100)(hex)
			gggggggg	Pellistor Span Conc (ppm*100)(hex)
			±hh.h	Temperature (C)(decimal to 1dp)
			iii	Bridge Supply (ONX, OFF)
Electrochem Sensor	[EK3 ECM ENQ]	[EK3 ECM **±aaaa ±bbbbbbbb ±cccccccc ddddddd ±eeeeeeee ±ff.f ggg hhh**]	**aaaa**	Bias Voltage (mV)(hex)
			±bbbbbbbb	Measured Concentration (ppm*100)(hex)
			±cccccccc	Sensor Output Current (nA)(hex)
			ddddddd	Electrochem Span Concentration (ppm*100)(hex)
			±eeeeeeee	Span Current (nA)(hex)
			±ff.f	Temperature (C) (decimal to 1dp)
			ggg	Current Range (RLO = 5nA, RHI = 25nA)
			hhh	Selected Range (RLO, RHI, RAU)
Analog Out (DAC)	[EK3 DA1 ENQ]	[EK3 DA1 **aaa bbb ±cccccccc**]	**aaa**	DAC Setting: MAN, ECM, PEL
			bbb	DAC output: 000-FFF
	[EK3 DA2 ENQ]	[EK3 DA2 **aaa bbb ±cccccccc**]	**±cccccccc**	Range Maximum (nA if ECM or mV*100 if PEL)(hex)
Alarms (individual)	[EK3 AL1 ENQ]	[EK3 AL**a bbb ccc ±ddddddd eee**]	**a**	Alarm Number (1-4)
	[EK3 AL2 ENQ]		**bbb**	Alarm status ONX, OFF
	[EK3 AL3 ENQ]		**ccc**	Alarm setting: MAN, FOL, PGT, PLT, EGT, ELT
	[EK3 AL4 ENQ]		**±ddddddd**	Alarm threshold: Depends on units (below) (hex)
			eee	Threshold Units: LEL, VOL, RAW • LEL, Threshold in %LEL*1000000 • VOL, Threshold in ppm*100 • RAW (Electrochem) Threshold in nA • RAW (Pellistor) Threshold in mV*100
Alarms (all)	[EK3 AL0 ENQ]	[EK3 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	[EK3 DIN ENQ]	[EK3 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
Calibration				
Pellistor	[EK3 CAP ZERO]	[ACK]		Set Pellistor Zero
	[EK3 CAP UZER]	[ACK]		Unset Pellistor Zero
	[EK3 CAP SPAN]	[ACK]		Set Pellistor Span
Electrochem	[EK3 CAE ZERO]	[ACK]		Set Electrochem Zero
	[EK3 CAE UZER]	[ACK]		Unset Electrochem Zero
	[EK3 CAE SPAN]	[ACK]		Set Electrochem Span
Span Gas	[EK3 CAP SCG **aaaaaaaa**]	[ACK]	**aaaaaaaa**	Set Pellistor Span Concentration (ppm*100)(hex)
	[EK3 CAE SCG **aaaaaaa**]	[ACK]	**aaaaaaaa**	Set Electrochem Span Concentration (ppm*100)(hex)
LEL	[EK3 CAP LEL **aaaaaaaa**]	[ACK]	**aaaaaaaa**	Set LEL Concentration (ppm*100)(hex)
	No LEL for Electrochem			
Sensors			**Notes**	
Pellistor Bridge	[EK3 PEL ONX]	[ACK]		Turn Pellistor Bridge Supply On
	[EK3 PEL OFF]	[ACK]		Turn Pellistor Bridge Supply Off
Electrochemical Range	[EK3 ECM R**aa**]	[ACK]	**aa**	LO (use 5nA range), HI (use 25nA range), AU (Automatically select range)
Set DAC	**Command**	**Response**	**Notes**	
Fixed value	[EK3 DA1 **aaa**]	[ACK]	**aaa**	000-FFF
	[EK3 DA2 **aaa**]	[ACK]		
Automatic mode	[EK3 DA1 **aaa bbbbbbbb**]	[ACK]	**aaa**	Sensor to follow (PEL or ECM)
			bbbbbbbb	Scale Maximum (mV*100 (PEL) or nA(ECM))(hex)
	[EK3 DA2 **aaa bbbbbbbb**]	[ACK]		

Set Alarms	Command	Response	Notes
Manual On (individual: 1-4) (all together: 0)	[EK3 AL1 MAN ONX]	[ACK]	
	[EK3 AL2 MAN ONX]	[ACK]	
	[EK3 AL3 MAN ONX]	[ACK]	
	[EK3 AL4 MAN ONX]	[ACK]	
	[EK3 AL0 MAN ONX]	[ACK]	
Manual Off (individual: 1-4) (all together: 0)	[EK3 AL1 MAN OFF]	[ACK]	
	[EK3 AL2 MAN OFF]	[ACK]	
	[EK3 AL3 MAN OFF]	[ACK]	
	[EK3 AL4 MAN OFF]	[ACK]	
	[EK3 AL0 MAN OFF]	[ACK]	
Follow digital inputs (individual: 1-4) (all together: 0)	[EK3 AL1 FOL]	[ACK]	
	[EK3 AL2 FOL]	[ACK]	
	[EK3 AL3 FOL]	[ACK]	
	[EK3 AL4 FOL]	[ACK]	
	[EK3 AL0 FOL]	[ACK]	
On if Sensor **a** value is Greater Than threshold (individual: 1-4) (all together: 0)	[EK3 AL1 **a**GT **±bbbbbbbb ccc**]	[ACK]	**a** P (Pellistor) or E (Electrochem) **±bbbbbbbb** Threshold Value **ccc** Threshold Units (LEL, VOL, RAW)
	[EK3 AL2 **a**GT **±bbbbbbbb ccc**]	[ACK]	
	[EK3 AL3 **a**GT **±bbbbbbbb ccc**]	[ACK]	
	[EK3 AL4 **a**GT **±bbbbbbbb ccc**]	[ACK]	
	[EK3 AL0 **a**GT **±bbbbbbbb ccc**]	[ACK]	
On if Sensor **a** value is Less Than threshold (individual: 1-4) (all together: 0)	[EK3 AL1 **a**LT **±bbbbbbbb ccc**]	[ACK]	**a** P (Pellistor) or E (Electrochem) **±bbbbbbbb** Threshold Value **ccc** Threshold Units (LEL, VOL, RAW)
	[EK3 AL2 **a**LT **±bbbbbbbb ccc**]	[ACK]	
	[EK3 AL3 **a**LT **±bbbbbbbb ccc**]	[ACK]	
	[EK3 AL4 **a**LT **±bbbbbbbb ccc**]	[ACK]	
	[EK3 AL0 **a**LT **±bbbbbbbb ccc**]	[ACK]	
System	**Command**	**Response**	**Notes**
Serial Number	[EK3 SER aaaa]	[ACK]	**aaaa** Serial Number (decimal)
Invalid command	Invalid command	[NAK]	

15 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) **ECVQ-EK3 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) DAS768583AA 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) DF769485A Quick Start Guide	O	O	O	O	O	O
5	光盘说明书 (CD Manual) DAS768879AA CD-ROM Manual/Software	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

16 Appendix: Updating the ECVQ-EK3 Embedded Software

From time to time e2v may release updates to the PC datalogging software or the embedded software (firmware) which runs on the ECVQ-EK3 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 ECVQ-EK3, follow these instructions very carefully:

1. Download the firmware zip file. Unzip and save the text file (ecvq_ek3_.....txt) to the computer hard drive.
2. Connect up the ECVQ-EK3 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 (ecvq_ek3_.....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.