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Baby CO Meter

Service Manual

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Micro
Medical

Baby CO Meter

Service Manual

Information in this document is subject to change without notice and does not represent a commitment on the part of Micro Medical Limited. Only the parts supplied by Micro Medical Limited should be used to complete the service operation described in this manual. If in any way you feel unsure about the successful completion of the service operation you should contact Micro Medical Limited or its appointed agent in your country or region and arrange the despatch of the product to a Micro Medical Limited Service Centre.

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Safety Precaution

The servicing of this device is intended to be carried out by a properly trained and competent electronics engineer, or experienced in the maintenance and servicing of medical devices. Read this manual thoroughly before proceeding with the service. If in any doubt please contact the service centre at Micro Medical Limited or their accredited agent in your country or region.

Important Safeguards

- Read all of the instructions.
- Keep the instructions in a safe place for later use.
- Follow all warnings and instructions marked on the product.
- When replacement parts are required, be sure to use replacement parts specified by Micro Medical that have the same characteristics as the original parts. Unauthorised substitutions may result in fire, electric or other hazards.
- Do not place on an unstable table.
- The product should be operated only from the type of power source indicated on the label.

Looking after your Baby CO Meter

- Avoid exposing the Baby CO Meter to solvents including alcohol and disinfectants.
- Avoid operating the Baby CO Meter in dusty conditions or near to heating appliances or radiators.
- Do not keep the Baby CO Meter in a damp place or expose it to extreme temperatures.

Introduction

This service manual provides you with information to carry out the servicing of the Baby CO Meter. It is a process, which is relatively straightforward but must be carried out in a logical sequence. Our advice is to familiarise yourself with the contents of this manual before attempting to carry out the procedure of replacing the parts supplied in the sensor replacement kit for the Baby CO Meter.

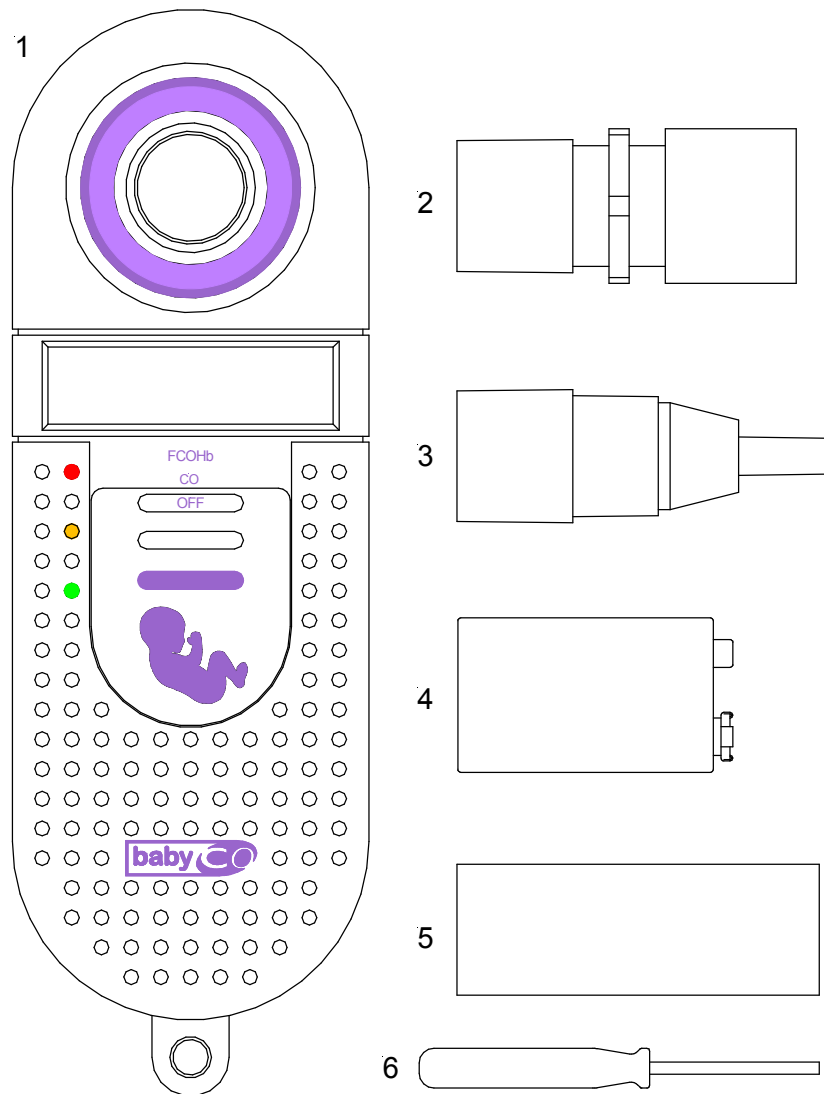
Before You Begin

Before you begin the servicing operation, please read the section on Circuit description very carefully:

Baby CO Meter system overview.

The Micro Medical Baby CO meter consists of a hand held microcomputer unit (1) incorporating a CO sensor and is supplied with a mouthpiece adapter with integral one way valve (2) together with disposable cardboard mouthpieces (5).

The microcomputer unit is powered by a single alkaline PP3 battery (4) and is supplied with a reducing connector for calibration (3).



The CO sensor is an electrochemical fuel cell, and works through the reaction of carbon monoxide at one electrode and oxygen (from ambient air) at the other. This reaction generates an electrical current proportional to the concentration of CO exposed to the sensing surface of the fuel cell.

The current output signal from the sensor is conditioned using a current to voltage converter and is applied to an analogue to digital (A/D) converter.

When the unit is first switched on the microprocessor records the baseline reading on the A/D input and uses this value to auto zero the instrument.

The subject is requested to breathe in maximally, hold the breath for 10 seconds, and then to expire fully through the mouthpiece connected to the microcomputer unit with the mouthpiece adapter. As an aid to timing the breath holding period a countdown from 10 to 0 is displayed after the unit is turned on.

The microprocessor then records the peak value obtained and displays this on a 3½ digit LCD display.

The value can be displayed either as parts per million (ppm) concentration in the expired air or as the equivalent percentage carboxyhaemoglobin (%COHb) using the mathematical relationships described by Jarvis et al, for concentrations below 90ppm and by Stewart et al for higher concentrations.

Jarvis MJ, Belcher M, Vesey C, Hutchison DCS

Low cost carbon monoxide monitors in smoking assessment.

Thorax 1986; 41:886-887

Stewart RD, Stewart RS, Stamm W, Seleen RP

Rapid estimation of carboxyhaemoglobin levels in fire fighters

JAMA 1976; 235:390-392

As a quick guide to the estimated smoking level, red, amber and green indicator lights are provided. The following levels of CO activate these lights:

CO(ppm)	%COHb	Cigarette consumption	Indicator
0 - 5	0 - 0.8	Non smoker	Green
6 - 10	1 - 1.6	Light smoker	Amber
11 - 72	1.8 - 12	Heavy smoker	Red
>72	>12	Suspected poisoning	Red + alarm

CO Sensor

The sensor is an electrochemical micro fuel cell using gaseous diffusion barrier technology resulting in a direct response to volume concentration rather than partial pressure.

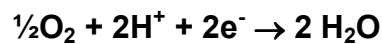
The cell consists of a working electrode and a counter electrode separated by a thin layer of electrolyte. The gaseous diffusion barrier limits the flow of gas to the sensing electrode and ensures the electrochemical activity of the electrode is far in excess of the amount of gas with which it has to deal.

Gas diffusing onto the working electrode reacts at the surface of the electrode by oxidation.

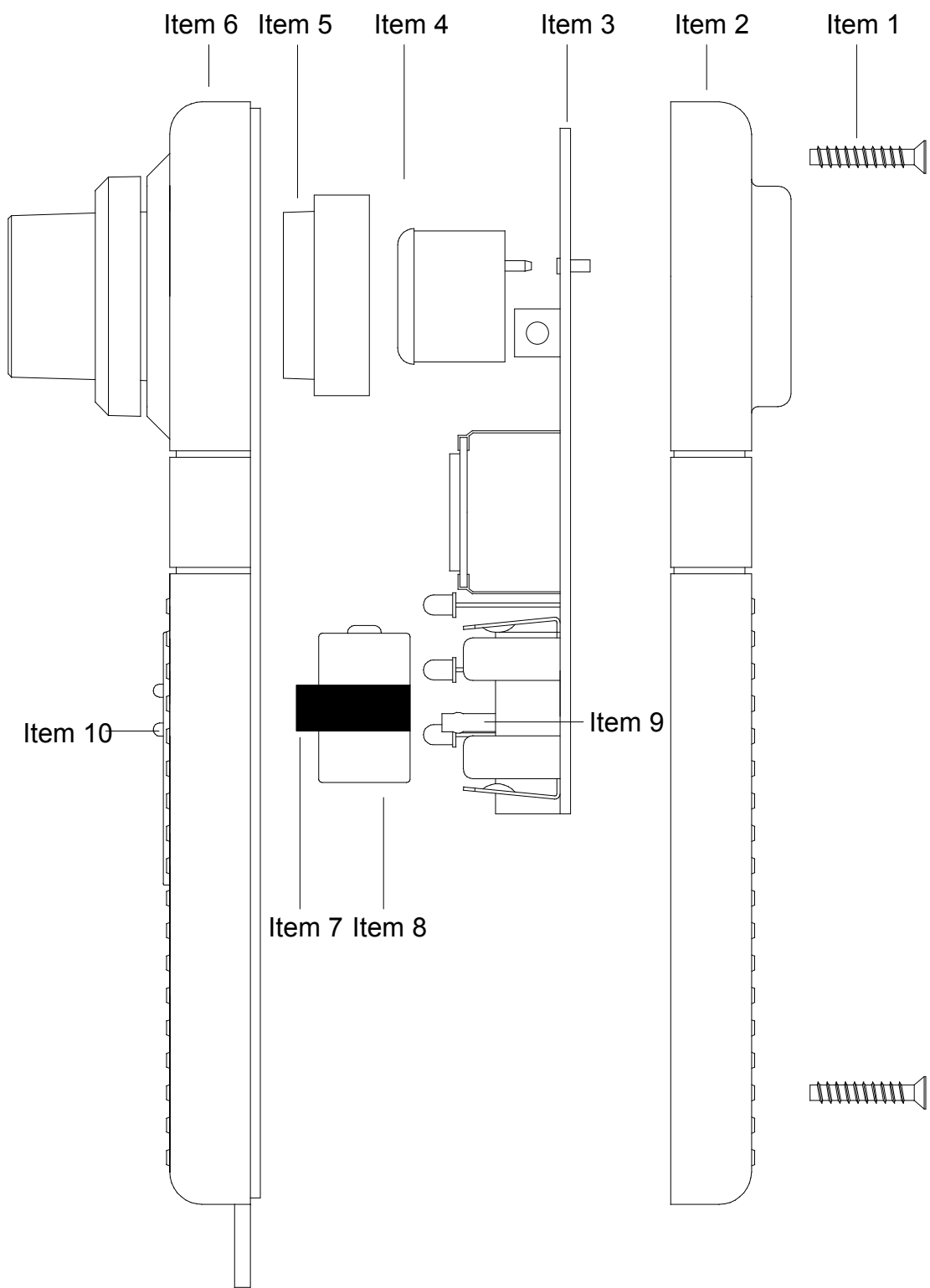
CO reacts at the working electrode according to the equation:



The counter electrode acts to balance out the reaction at the sensing electrode by reducing oxygen in air to water:



Baby CO meter exploded view



Disassembling the Baby CO meter for servicing.

The Baby CO microcontroller unit comprises of a solid state electronic circuit in a robust ABS housing and does not require any preventative maintenance.

Routine maintenance consists of replacing the fuel cell and internal lithium battery when they are exhausted. The 3.6 volt lithium battery is continuously monitored by the microcontroller and the message **bt2** will be displayed when the voltage falls below 3 volts. The fuel cell exhibits a gradual loss of sensitivity with time and has effectively expired when the unit can no longer be calibrated.

When either the fuel cell or the lithium battery has expired, replace by following the procedure below.

1. Turn the unit face down and slide back the battery compartment.
2. Remove the PP3 battery.
3. Remove the 2 self tapping screws (Item 1) and put to one side.
4. Lift the top moulding (Item 6) from the bottom moulding (Item 2).
5. Remove the PCB (Item 3) from the bottom moulding.
6. If the fuel cell (Item 4) is exhausted carefully remove by gently pulling away from the PCB.
7. If the battery (Item 8) has expired, then note the orientation and remove from the PCB-mounted clips by pulling on the battery strap (Item 7) directly away from the PCB. Put the battery strap to one side and discard the battery.

Replacing internal battery of the Baby CO.

- 1 Place the battery strap over the new battery (Cat No: BAT5900) and push into the PCB-mounted clips ensuring the correct orientation. **(Take great care not to short circuit the terminations even momentarily as the low internal impedance of lithium batteries will result in a high current consumption and greatly reduced life).**

Replacing fuel cell of the Baby CO.

- 1 Remove the CO sensor (Cat No: CEL7300) from the plastic container.
- 2 Carefully insert the CO cell into the PCB with the correct orientation.

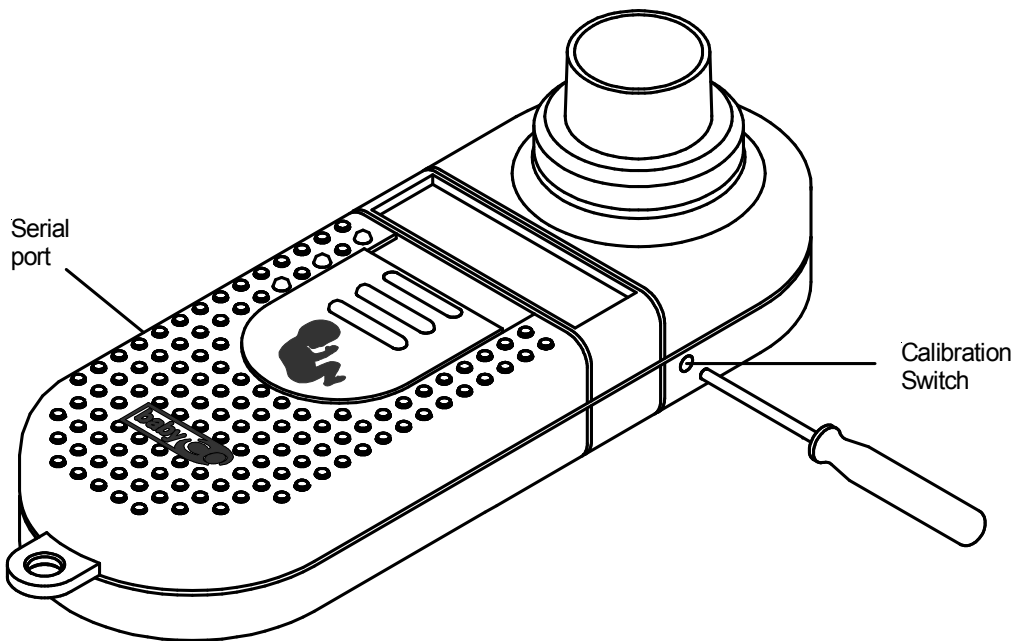
Reassembling the Baby CO meter

1. Place the PCB into the bottom moulding.
2. Tuck the battery strap between the battery and the side wall of the bottom moulding, away from the slide switch.
3. Ensure that the slide switch (Item 9) and the switch plate on the top moulding (item10) are both positioned at the bottom of their travel.
4. Ensure that the rubber gasket (Item 5) is in place in the top moulding.
5. Place the top moulding on top of the bottom moulding ensuring the rubber gasket fits over the cell correctly and secure using the two self-tapping screws.
6. Reconnect the PP3 battery ensuring correct polarity.

Calibrating the CO meter

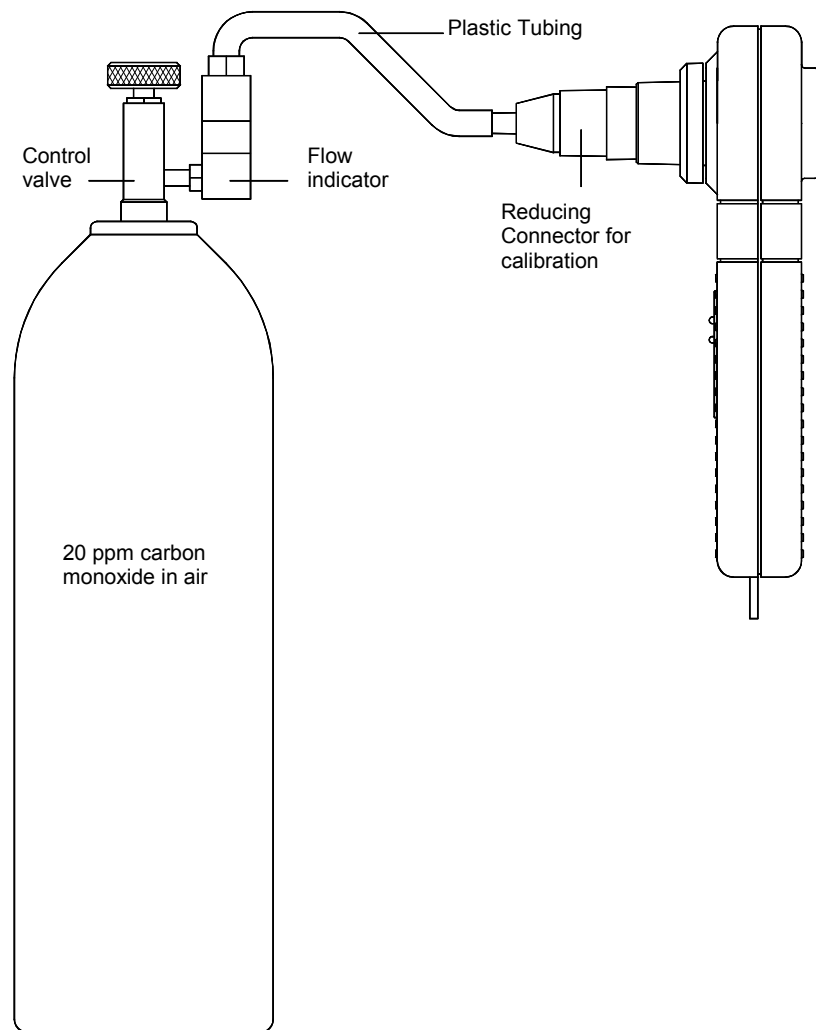
Calibration will remain stable to within 2% over one month and typically to within 10% over 6 months. Micro Medical supplies calibration gas (20ppm CO in air) and recommends that the unit is recalibrated on a 6 monthly basis. See page 13 for calibration accessories.

To carry out the calibration locate the calibration switch on the right hand side of the instrument as shown below.



Push the slide switch to the CO - PPM position and wait for the unit to display zero.

Screw the control valve firmly onto the cylinder and connect the gas supply as shown below:



The plastic tubing supplied with the gas should be pushed firmly over the reducing connector.

Slowly turn the control knob anti-clockwise until the ball in the flow indicator is between the two marks. This will then supply a gas flow of approximately 0.25 l/min. Apply this flow for 25 seconds and if the meter does not read 20ppm use the calibration tool to push the calibration switch.

The unit will then beep 3 times, store the new calibration value, and display the following:



The gas supply should then be turned off.

Circuit description

(Refer to the parts list and circuit diagram)

The circuit is based on the Hitachi one time programmable (OTP) microcontroller HD64F3687FP (U5) operating at a clock frequency of 14.745MHz.

This processor contains EPROM, RAM, and eight 10-bit analogue to digital (A/D) converters. The current output signal from the sensor is conditioned using a current to voltage converter and is applied to an A/D input of the microcontroller. Voltages derived from the external PP3 battery and the internal lithium battery are also connected to the A/D converter inputs. When the unit is first switched on the microprocessor records the baseline reading from the A/D and uses this value to auto-zero the instrument. The signal from the CO sensor is continuously monitored and the peak of the calculated carbon monoxide concentration is displayed and transmitted through the RS232 driver (U7).

Power Supply

The unit has two separate supplies. The externally accessible alkaline 9 volt PP3 battery (BAT 1) provides the main supply. The instrument may be switched on and off with the slide switch and may also be switched off by a signal from the processor. This is done if the unit is left on, without use, for a period of 4 minutes in order to conserve battery power. The supply is controlled by gates U2 and U3 arranged in a bi-stable configuration, and powered continuously from BAT1. When the slide switch is moved to the 'CO-PPM' position one end of R7 is pulled low. This transition is differentiated by the action of C15 and R6 so that a momentary pulse appears on pin 2 of U3. This pulse will toggle the bi-stable circuit so that pin 4 of U2 will go low, turning transistor TR2 on, and supplying 9 volts to the low drop-out regulator, U4. When the slide switch is returned to the 'off' position pin 1 of U2 is pulled low, the bi-stable action is reversed, and TR2 will be turned off. If the unit is left on without use for approximately 4 minutes then pin 44 of U5 is driven high, under software control, turning on TR1 which will also turn the unit off via the bi-stable circuit. When this happens the slide switch must be pushed to the 'off' position and then to the 'CO-PPM' position in order to initiate another pulse through C15 to turn the unit back on again. The output of the 5 volt regulator supplies the processor and associated circuitry. C13 and C14 smooth the input and output of U4.

BAT1 is monitored by an A/D input of the microcontroller, pin 62 through the potential divider, R13 and R14. When this battery falls below 6.6 volts a battery low warning is temporarily indicated on the display upon switch on. When the battery falls below 6.1 volts the message is displayed permanently and the unit cannot be used.

The secondary power supply is provided by a single 3.6 volt lithium cell, BAT2, used to permanently power the fuel cell amplifier circuit consisting of the op-amp U1 and associated passive circuitry. The amplifier circuit draws less than 11uA from the 1000mA-Hr lithium battery giving a nominal operational life of greater than 10 years.

BAT2 is buffered by U8B and monitored by an A/D input of the microcontroller, pin 63. R27, between BAT2 and the inverting amplifier, prevents the battery from discharging through the op-amp when the supply is switched off. The battery has an end point of 3 volts and when this level is reached the message bt2 will be displayed. When this happens follow the procedure outlined in Servicing.

Fuel cell amplifier circuit.

The fuel cell provides an output current, from the counter electrode, proportional to the concentration of target gas at the sensing surface. This current is converted to a voltage by the action of U1 and the associated passive components at a nominal transfer factor of 387mV/ μ A. This signal is further amplified by U8A with a gain of 2.08 and applied the A/D input of the microcontroller, pin 44, after being filtered by the action of R8 and C4. The sensitivity of the CO fuel cell is 0.045 +/- 0.015 μ A giving a nominal amplified output of 36mV/ppm CO.

Reset Circuit

This microcontroller has internal reset circuitry that requires C12 and D5 for proper operation.

Display

The display is a custom 3½ digit low power LCD. The segments and backplane are driven directly by microcontroller. The backplane is driven by a square wave of nominally 60Hz. The individual segments are driven by a similar square wave that is in phase with the backplane when the segment is off and 180 degrees out of phase when the segment is on.

Sounder

The sounder is operated by a 1kHz square wave generated by pins 24 and 25 of U5.

Indicator lights

The three indicator LED's are driven from pins 51, 52 and 53 of the microcontroller through transistors TR3, TR4 and TR5.

RS232 interface

The transmit and receive ports for RS232 transmission are on pins 46 and 45 respectively of the microcontroller. The transmission is converted from logic to RS232 levels by the U7.

Specifications

Type	Electro - chemical fuel cell
Range	0 - 100ppm
Resolution	1ppm
Green indicator light	0 to 6ppm (0 to 1% COHb)
Amber indicator light	7 to 10ppm (1.1 to 1.6% COHb)
Red indicator light	11 to 72ppm (1.8 to 12% COHb)
Flashing red light + alarm	>72ppm (>12% COHb)
Accuracy	+/-5% of full scale of 1ppm whichever is the greater
Sensitivity drift	0.5%/°C
Sensor Life	>2 to 5 years
Response time	<15 sec (to 90% of reading)
Hydrogen cross sensitivity	<15%
Operating temperature	15 to 25°C
Operating pressure	Atmospheric +/-10%
Pressure coefficient	0.02% signal per mBar
Relative humidity	15 – 90% continuous
(Non condensing)	(0 – 99% intermittent)
Baseline drift	0ppm (auto zero)
Long term drift	<2% signal loss per month
Power source	Single Alkaline 9 volt PP3
Main battery life	>30 hours of continuous use
Internal battery life	10 years
Weight	180g (Including battery)
Dimensions	170 x 60 x 26mm
Display	3½ digit LCD
Storage temperature	-20 to +70 deg Celsius
Storage humidity	30% to 90%

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Parts List

Designation	Description
U1	OP90GS. Precision micro power surface mount
U2	BU4S11. Single NAND gate
U3	BU4S11. Single NAND gate
U4	LM2931M5.0. Low drop-out 5 volt regulator
U5	HD64F3687FP. Hitachi microcontroller
U6	24LC00. 16 Byte surface mount serial EEPROM
U7	MAX3221CAE. Maxim RS232 transceiver
U8	MCP602-I/SN. Microchip dual rail-to-rail OP-AMP
D1	ZHCS750 Schottky diode
D2	3mm green LED
D3	3mm red LED
D4	3mm yellow LED
D5	BAS21. Small signal diode
DISPLAY	(LCD 016-03) 3½ Digit custom display
TR1	DTC114EKA NPN transistor
TR2	FMMT591 PNP transistor
TR3	DTC114EKA NPN transistor
TR4	DTC114EKA NPN transistor
TR5	DTC114EKA NPN transistor
R1	330K Resistor
R2	12K Resistor
R3	1M Resistor
R4	10K Resistor
R5	10K Resistor
R6	1M Resistor
R7	1M Resistor
R8	100K Resistor
R9	10K Resistor
R10	560R Resistor
R11	560R Resistor
R12	820R Resistor
R13	100K Resistor
R14	100K Resistor
R15	100K Resistor
R16	10K Resistor
R17	1M Resistor
R18	10K Resistor
R19	10K Resistor
R20	10K Resistor
R21	27R Resistor
R22	1K Resistor
R23	10K Resistor
R24	180K Resistor
R25	360K Resistor
R26	390K Resistor
R27	1M Resistor
C1	10µF Tantalum capacitor
C2	22pF Ceramic capacitor
C3	0.1µF Ceramic capacitor
C4	1µF Ceramic capacitor

C5	22pF Ceramic capacitor
C6	0.1μF Ceramic capacitor
C7	0.1μF Ceramic capacitor
C8	0.1μF Ceramic capacitor
C9	0.1μF Ceramic capacitor
C10	1μF Ceramic capacitor
C11	0.1μF Ceramic capacitor
C12	10nF Ceramic capacitor
C13	0.1μF Ceramic capacitor
C14	47μF Electrolytic capacitor
C15	0.1μF Ceramic capacitor
C16	33pF Ceramic capacitor
C17	33pF Ceramic capacitor
C18	1μF Ceramic capacitor
C19	1μF Ceramic capacitor
C20	0.1μF Ceramic capacitor
C21	0.1μF Ceramic capacitor
TH1	NTC 47K thermistor
SW1	SLF2300. Double pole 3 position slide switch
SW2	Push switch
BAT2	SL235 CVHZ Sonnenschein 1A-Hr ½ AA Lithium cell
X1	14.745 MHz crystal
CO CELL	1000 ppm CO fuel cell

