# CareFusion

# SpiroUSB
Service manual

# Spiro USB - System Overview (Fig. 1)

The Spiro USB is a PC connected spirometer dedicated to work with Spirometry PC Software (SPCS).

It consists of a removable digital volume transducer (1) and a housing (2) containing a microprocessor control circuit and USB driver.

When testing a subject the transducer is inserted into the housing, which is plugged into a USB socket of a PC. The digital volume transducer is used to measure the subjects expired flow and volume in accordance with the operating manual.
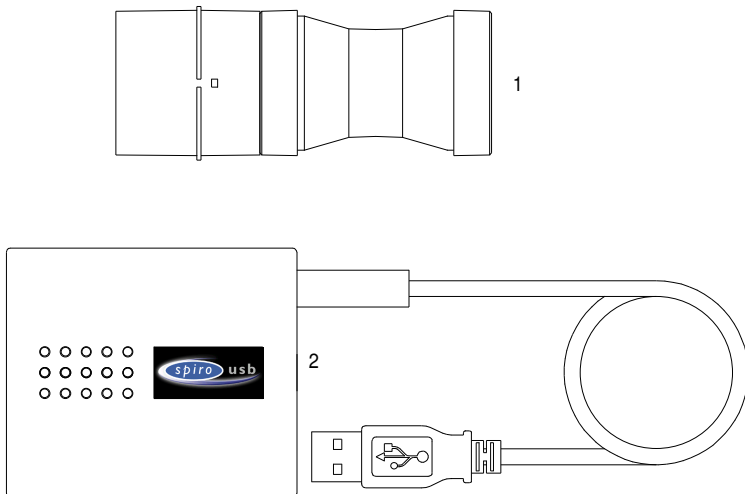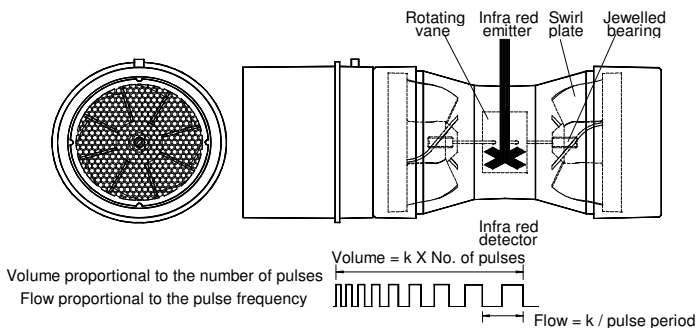
# Transducer (Fig. 2)

The CareFusion digital volume transducer consists of an acrylic tube with a vane positioned between two swirl plates. The low inertia vane is attached to a stainless steel pivot which is free to rotate on two jewelled bearings mounted at the centre of the swirl plates. As air is passed through the transducer a vortex is created by the swirl plates which causes the vane to rotate in a direction dependant upon the direction of air flow. The number of rotations is proportional to the volume of air passed through the transducer and the frequency of rotation is proportional to the flow rate. The transducer housing consists of a main body which contains a pair of light emitting diodes (LED's) and phototransistors. The transducer is fixed to the mouthpiece holder which pushes into the main body and is captured by an "O" ring seal. The LED's produce infra red beams which are interrupted by the vane twice per revolution. This interruption is sensed by the phototransistors. The output from the collector of each phototransistor will be a square wave with a phase difference between the two of + or - 90 degrees depending upon the direction of flow.
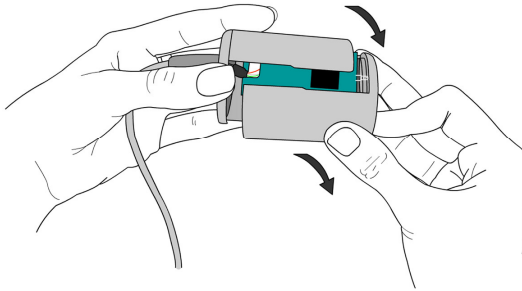
There is no routine maintenance required for the transducer other than cleaning according to the instructions in the operating manual.

**CareFusion Digital Volume Transducer**



3

# Disassembly (Fig. 3)

1. Carefully remove both Spiro USB labels from the transducer housing.

2. Remove the screw under each label.

3. Pull apart the two halves of the housing as shown below:



# Reassembly (Fig. 4)

Please note: Do not use excessive force when reassembling.

1. Ensure the PCB is aligned correctly as shown in Fig. 4.

2. Pull the cable gland through the hole in housing A (already on the cable) and locate the centre moulding into the housing.

3. Line up the channel on the centre moulding with the screw hole of housing A.

4. When refitting housing B, locate the moulded bracket (with the nut) between the end of the channel and housing A and carefully pivot housing B around until the two housings meet (ensuring the blue LED fits into it's hole).

5. Replace the screws.

6. Carefully reposition the Spiro USB labels.

The PCB, LED'S and phototransistors will be accessible as shown below:

Fig. 4.

Centre moulding

Channel
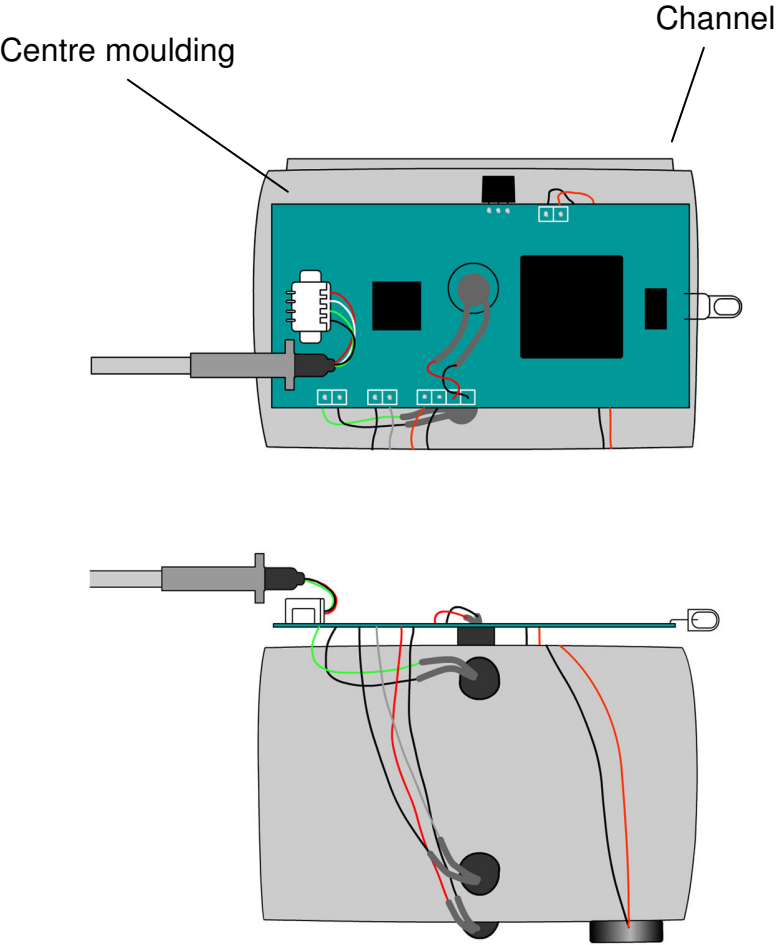
# Microprocessor control circuit,
# See drawing 075-01 and 075-02

The microprocessor control circuit monitors the transducer pulses, carries out the spirometry routines, and communicates with the PC via a USB driver under the control of it's internal program.

Power for the processor circuit is derived from the 5 volt USB power line.  The power line is filtered by C12, L1 and C13.  The filtered 5 volt is regulated down to 3.3 volts by the linear regulator, U7.  U7 also provides a reset signal for the microprocessor.

The microprocessor, U3, is a Hitachi HD64F2318 16 bit microprocessor with 256K of flash memory and 8K of Ram. The system clock is supplied by 12MHz crystal, X1.  There is also 512 Kbytes of external RAM, U8, used for storing pulses during a spirometry manoeuvre.  The internal flash memory is used to store the microprocessor firmware.

Calibration data and system data is stored in an EEPROM, U2. Communication to the EEPROM is carried out using a two wire serial connection to pins 54 and 55 of the microprocessor.  If the device is ever replaced, the unit will have to undergo factory recalibration.

Ambient temperature is monitored by a solid-state temperature sensor, U9.  It communicates with the microprocessor via a one wire serial interface on pin 90.

The ambient temperature reading is used for adjusting inspiratory volume at ambient temperature to volume at body temperature.

The supply to the two series LED's, mounted inside the transducer housing, is provided through TR1, which is switched on by pin 4 of the microprocessor during a spirometry manoeuvre.  Inside the transducer housing the two phototransistors used to detect the

interrupted infra-red beam are in open collector configuration. The pull up resistor for the two phototransistors is provided by R7 and R8.

Pulses from the phototransistor, TR2, are applied to the pulse timing input of the processor, pin 5, after being squared up by the action of the Schmitt inverter, U4. Pulses from the second phototransistor, TR3, after conditionings, U5, are applied to pin 6 of the microprocessor and are used to determine the direction of flow. The pulse count is used to determine the volume passed through the transducer since the start of the test and the pulse period is used to determine the flow at each volume increment.

The microprocessor communicates with the host PC via a USB interface, U6. U6 is connected to the microprocessor data bus and one address line, A0.

The 512k x 8 static RAM, U8, is located on the underside of the PCB and communicates with the processor on the 19-bit address bus and 8-bit data bus.
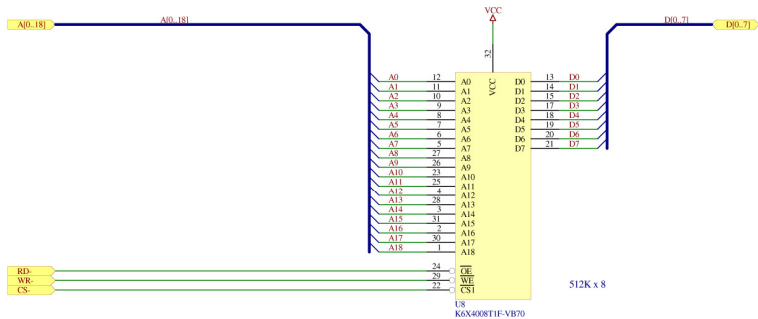
The speaker, J1, is directly connected to ports on pins 91 and 92 that are toggled at 1 KHz to generate the sound.

Parts List For: Spiro USB

| | | | |
|---|---|---|---|
| Drawing No. 075-00 | | Date: 21/8/2006 | |
| Revision No. 1.11 | | Page: 1 OF 2 | |

| Designation | Dwg/Manufacturers Part no. | JDE Part no. | Description. |
|---|---|---|---|
| | | 36-ASS1041 | **PCB ASSEMBLY** |
| U1 | BU4S11 | 36-IC1042 | Single Schmitt NAND gate, SOT23-5 package |
| U2 | 24LC00-OT | 36-IC1025 | 128 bit serial EEPROM SOT23-5 package |
| U3 | HD64F2318VTE25 | 36-IC1057 | Hitachi microcontroller |
| U4 | INC-BU4S584 | 36-IC1043 | Single Schmitt inverter, SOT23-5 package |
| U5 | BU4S584 | 36-IC1043 | Single Schmitt inverter, SOT23-5 package |
| U6 | INC-SL811HST-AXC | 36-IC1123 | Cypress USB controller TQFP48 package |
| U7 | MAX6349TL | 36-IC1103 | 3V3 regulator with integrated RESET control SOT23-5 package |
| U8 | K6X4008T1F-VF70 | 36-IC1065 | Samsung 512k X 8 bit CMOS static RAM, SOL32/525 package |
| U9 | DS18S20 | 36-IC1049 | Dallas semiconductor digital thermometer, TO-92B package |
| U10 | BU4S11 | 36-IC1042 | Single Schmitt NAND gate, SOT23-5 package |
| TR1 | TRA-DTD113EK | 36-TRA1045 | Rohm NPN digital transistor SOT 23 package |
| TR2 | BSS138 | 36-TRA1044 | FET transistor, SOT-23 package |
| R1 | 100K0603 | 36-RES1044 | 100K surface mount 0.06 watt 1% resistor 0603 package |
| R2 | 100K0603 | 36-RES1044 | 100K surface mount 0.06 watt 1% resistor 0603 package |
| R3 | 1K0603 | 36-RES1086 | 1K surface mount 0.06 watt 1% resistor 0603 package |
| R4 | 10K0603 | 36-RES1051 | 10K surface mount 0.06 watt 1% resistor 0603 package |
| R5 | 10K0603 | 36-RES1051 | 10K surface mount 0.06 watt 1% resistor 0603 package |
| R6 | 1K0603 | 36-RES1086 | 1K surface mount 0.06 watt 1% resistor 0603 package |
| R7 | 15K0603 | 36-RES1212 | 15K surface mount 0.06 watt 1% resistor 0603 package |
| R8 | 15K0603 | 36-RES1212 | 15K surface mount 0.06 watt 1% resistor 0603 package |
| R9 | 22R0603 | 36-RES1210 | 22 Ohm surface mount 0.06 watt 1% resistor 0603 package |
| R10 | 22R0603 | 36-RES1210 | 22 Ohm surface mount 0.06 watt 1% resistor 0603 package |
| R11 | 1500R0603 | 36-RES1071 | 1.5K surface mount 0.06 watt 1% resistor 0603 package |
| R12 | 120R0805 | 36-RES1064 | 120 Ohm surface mount 0.1 watt 1% resistor 0805 package |
| R13 | 100K0603 | 36-RES1044 | 100K surface mount 0.06 watt 1% resistor 0603 package |
| R14 | 100K0603 | 36-RES1044 | 100K surface mount 0.06 watt 1% resistor 0603 package |
| R15 | 100K0603 | 36-RES1044 | 100K surface mount 0.06 watt 1% resistor 0603 package |
| R16 | 100K0603 | 36-RES1044 | 100K surface mount 0.06 watt 1% resistor 0603 package |
| C1 | 33P0603 | 36-CAP1040 | 33pF 0603 package |
| C2 | 33P0603 | 36-CAP1040 | 33pF 0603 package |
| C3 | 100N0603 | 36-CAP1009 | 100nF 0603 package |
| C4 | 100N0603 | 36-CAP1009 | 100nF 0603 package |
| C5 | 100N0603 | 36-CAP1009 | 100nF 0603 package |
| C6 | 100N0603 | 36-CAP1009 | 100nF 0603 package |
| C7 | 1N0603 | 36-CAP1029 | 1nF ceramic 0603 package |
| C8 | 1N0603 | 36-CAP1029 | 1nF ceramic 0603 package |
| C9 | 100N0603 | 36-CAP1009 | 100nF ceramic 0603 package |
| C10 | 100N0603 | 36-CAP1009 | 100nF ceramic 0603 package |
| C11 | 4700N1206 | 36-CAP1047 | 4.7uF Ceramic 1206 package |
| C12 | 100N0603 | 36-CAP1009 | 100nF ceramic 0603 package |
| C13 | 1M0805 | 36-CAP1026 | 1uF AVX or Philips capacitor size 0805 X7R dialectric |
| L1 | LQW18ANR22G00D | 36-IND1023 | Murata 220nH inductor, 0603 package |
| X1 | CS1012.000MABJTR | 36-XTL1002 | Citizen 12MHz surface mount crystal. Digi-Key 300-8089-1-ND |
| CON1 | IL-Z-5P-S125T3-E | 36-CON1033 | JAE 5 way pin header. Farnell 388-7170 |
| CON2 | 53261-0490 | 36-CON1026 | Molex 4 way pin header, 90 degree mount. Farnell 889-430 |
| J1 | PT-1550W | 36-MEC1275 | Dau Components piezo ceramic sounder |
| J2 | 05FKZ-SM1-1-TB | 36-CON1067 | JST ZIF FFC connector 5 way |
| LED2 | SFH487-2-lead free | 36-DIO1036 | Osram Infrared LED 3MM/T1 |
| LED3 | L934MBC | 36-DIO1042 | Kingbright 3mm blue LED. RS 247-1628 |
| | 075-03 | 36-PCB1014 | PCB 075-03 ISS 3 |
| | | | |
| | | | **FLEXI CIRCUIT ASSEMBLY** |
| | 075-20 | 36-PCB1015 | PCB 075-20 ISS 1.1 |
| D1 | SFH487-2-lead free | 36-DIO1036 | Osram Infrared LED 3MM/T1 |
| TR1 | SFH309FA-6-lead free | 36-TRA1006 | Osram Photo transistor |
| TR2 | SFH309FA-6-lead free | 36-TRA1006 | Osram Photo transistor |

| Parts List For: Spiro USB | | | |
|---|---|---|---|
| Drawing No. 075-00 | | Date: 21/8/2006 | |
| Revision No. 1.11 | | Page: 2 OF 2 | |
| Designation | Manufacturers Part No. (F=Farnell) | JDE Part no. | Description. |
| | 039-18 | 36-TDX1043 | **TURBINE ASSEMBLY** |
| | 031-17 | 36-MLD1388 | 2 off moulded turbine inner swirl plate |
| | 031-18 | 36-MLD1389 | 2 off moulded turbine outer swirl plate |
| | 039-12 | 36-MLD1431 | Transducer Body - Reduced Cone Diameter |
| | 039-02 | 36-MLD1344 | Mouthpiece holder Grey |
| | 039-14 | 36-MEC1166 | Jewelled fixed bearing M3 thread |
| | 039-16 | 36-MEC1168 | Jewelled sprung bearing M3 thread |
| | 039-17 | 36-ASS1152 | 27mm offset vane assembly |
| | 039-15 | 36-MEC1228 | 27mm Pivot |
| | 039-08 | 36-MEC1160 | Flow deflector plate (039-08 iss 1.3) |
| | | | |
| | 075-14 | 36-CAB1016 | **CABLE ASSEMBLY** |
| | 039-00 | 36-MLD1088 | Transducer holder - body |
| | GUC-AO-1.8M | 36-CAB1046 | Glory Mark USB A Male to open Cable Assembly Grey |
| | 075-05 | 36-MEC1186 | Moulded cable gromett |
| | 51021-0400 | 36-CON1020 | Molex 4 way receptacle housing, Farnell 889-489 |
| | 50079-8100 | 36-CON1005 | 4 off Molex crimp terminal, 26/28 AWG female. |
| | CB01654 | 36-MEC1141 | CPC 4.8mm black heatshrink sleeving as required |
| | 150-152 | 36-FIX1073 | Farnell tie wrap. |
| | | | |
| | | | **CASE COMPONENTS** |
| | 039-00 | 36-MLD1088 | Transducer holder - body |
| | 075-04 | 36-MLD1294 | Transducer body machining |
| | 039-01 | 36-MLD1093 | 2 off transducer holder - LED housing |
| | BS028NI70 | 36-MEC1394 | BSL O ring 1.78 x ID 34.65mm Nitrile 70 Shore |
| | SCW-M2X4CSK | 36-FIX1043 | 2 off M2 X 4mm countersunk posidrive screw |
| | NUT-M2 | 36-FIX1007 | 2 off M2 nut |
| | 075-07 | 36-LAB1103 | 2 off Spiro USB logo label |
| | 075-08 | 36-LAB1104 | USB cable label |
| | PAD-2198232 | 36-ADH1017 | 3 off Sellotape double-sided self adhesive pad 12x25x1.5mm |
| | | | |
| | | | **SUNDRY ITEMS** |
| | GUC-AAF-3M | 36-CAB1047 | Glory Mark USB2.0 A Male to Female Cable Assembly Grey |
| | 44B8008 | 36-LAB1179 | CILS Wheelie bin self adhesive label 12.5 x 9.5mm |

USB SPIROMETER

| Size | Number | | Revision |
|---|---|---|---|
| A3 | 075-01 | | 1.3 |

Date: 9-Nov-2009

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Sheet of

A[0..18]

A[0..18]

D[0..7]

D[0..7]

VCC

| | | | | | | |
|---|---|---|---|---|---|---|
| A0 | 12 | A0 | | D0 | 13 | D0 |
| A1 | 11 | A1 | | D1 | 14 | D1 |
| A2 | 10 | A2 | | D2 | 15 | D2 |
| A3 | 9 | A3 | | D3 | 17 | D3 |
| A4 | 8 | A4 | | D4 | 18 | D4 |
| A5 | 7 | A5 | | D5 | 19 | D5 |
| A6 | 6 | A6 | | D6 | 20 | D6 |
| A7 | 5 | A7 | | D7 | 21 | D7 |
| A8 | 27 | A8 | | | | |
| A9 | 26 | A9 | | | | |
| A10 | 23 | A10 | | | | |
| A11 | 25 | A11 | | | | |
| A12 | 4 | A12 | | | | |
| A13 | 28 | A13 | | | | |
| A14 | 3 | A14 | | | | |
| A15 | 31 | A15 | | | | |
| A16 | 2 | A16 | | | | |
| A17 | 30 | A17 | | | | |
| A18 | 1 | A18 | | | | |

VCC 32

RD- 24 OE
WR- 29 WE
CS- 22 CS1

512K x 8

U8
K6X4008T1F-VB70

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