EasyOne™ Technical Manual

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1   Introduction

The EasyOne™ spirometer uses digital ultrasonic flow measurement technology for fast, accurate, reliable operation. The EasyOne™ was designed for full range testing in primary care, specialty physician, industrial and hospital settings. It offers automated comparison to predicted values, pre- and post Broncho Dilator comparisons, interpretation of results and test quality control that automatically assesses patient effort offering helpful suggestions to obtain optimum results. Optional easy to read and interpret color printout with graphic display for instant test review is available. The single-patient-use spirette minimizes risk of cross-infection.

2   Operation Principle

This EasyOne™ flow sensor is equipped with two ultrasonic transducers, mounted at different sides of the flow channel. In order to determine gas flow (and molar mass), ultrasonic pulses are transmitted in up- and downstream direction. Precisely measured transit-times are the basis for determining flow and molar mass. The following figure shows a diagram of the flow sensor including its internal sound transmission path.
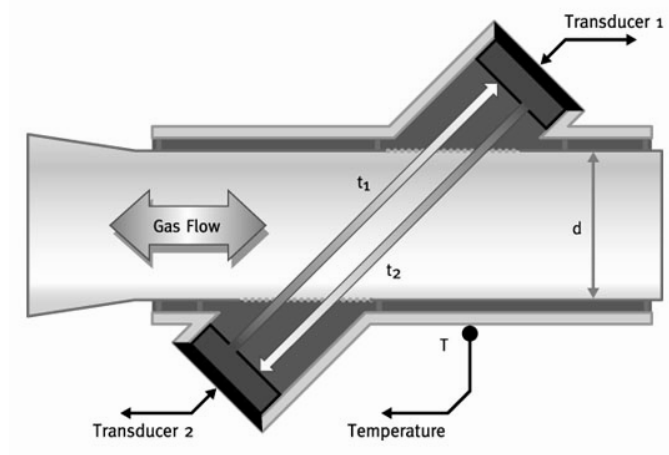

Figure 1: Schematic of EasyOne™ flow sensor

3   Technical Details

3.1 EasyOne™ Spirometer Handheld Unit

The following pictures show the top, rear and bottom views of the EasyOne™.

Figure 2: Top view of EasyOne™

Figure 3: Rear view with empty battery compartment

The two screws on the back side are used to open EasyOne™. With the exception of the lithium battery there are no serviceable parts inside the unit. Therefore do not open the unit!

Figure 4: Bottom view of EasyOne™

The bottom view shows the name plate, the serial number and the EasyOne™-to-Cradle connector.

3.2 Cradle

The following pictures show the top and a rear views of the EasyOne™ cradle.

Figure 5: Cradle top view

The top view shows the EasyOne™-to-Cradle connector. This connector is a non-standard connection between the electronic board inside EasyOne™ and the board inside the cradle.

Figure 6: Cradle rear view

The rear view shows the serial / parallel connector. The function of this connector is automatically determined depending on the cable connected to it. If a standard parallel cable is connected the board inside the cradle switches to 'parallel' mode. If the specialized serial cable is connected the board switches to serial mode.

3.3 Printed Circuit board

All electrical components of EasyOne™ are mounted on a single PCB.
With the exception of the lithium battery no components can be serviced.
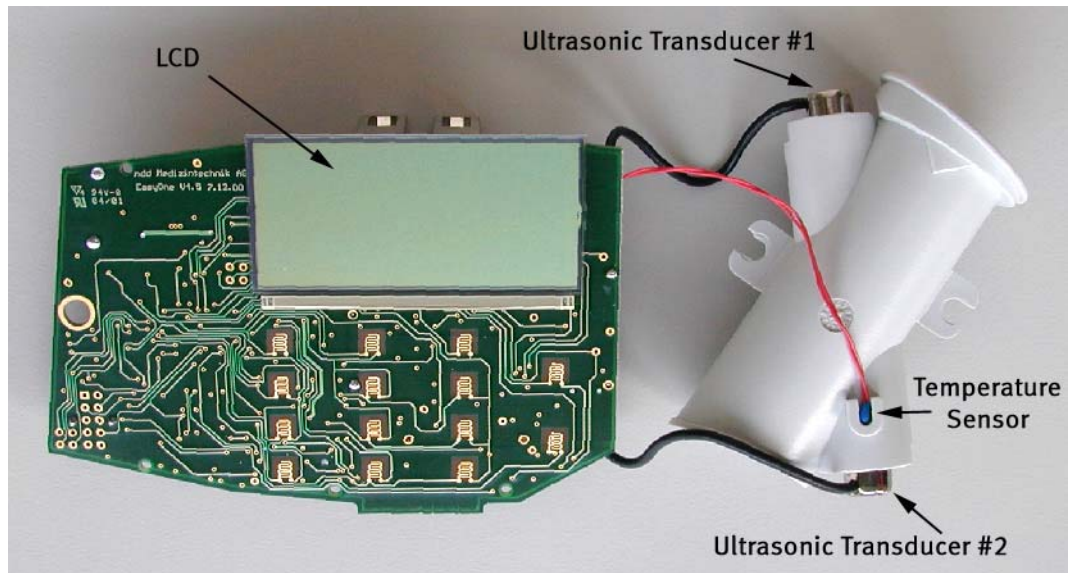The following two pictures show a top and bottom view of the PCB.

Figure 7: Bottom view of EasyOne™ PCB

The lithium battery located on the top right of the PCB has an approximate life time of 5 to 10 years. In early revisions of the hardware the lithium battery is soldered on the board.
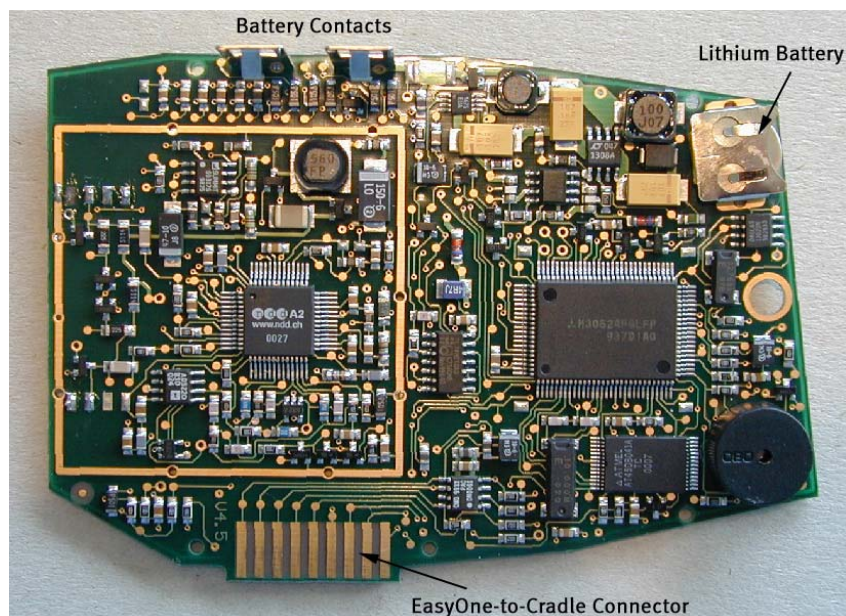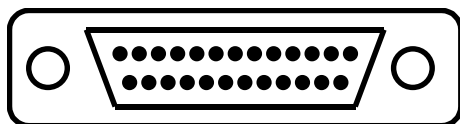

Figure 8: Top view of EasyOne™ PCB (without EMI shielding)

4   Parallel Cradle to Printer Pin-Out

The following table lists the pin-out of the printer connector.

Pin	Description	Pin	Description
1	Strobe	14	nc
2	Data 0	15	Fault
3	Data 1	16	nc
4	Data 2	17	nc
5	Data 3	18	Ground
6	Data 4	19	Ground
7	Data 5	20	Ground
8	Data 6	21	Ground
9	Data 7	22	Ground
10	Acknowledge	23	Ground
11	Busy	24	Ground
12	nc	25	nc
13	nc		

nc = not connected

5   RS232 Cradle to PC Cable Pin-Out

The RS232 cradle to PC cable has a standard 9 pin DSUB connector at the PC side. The following table lists the pin-out of that connector.
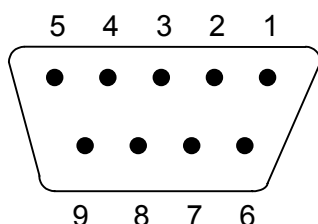
Pin	Description
1	not connected
2	RXD (receive data)
3	TXD (transmit data)
4	not connected
5	GND (ground)
6	not connected
7	RTS (ready to send)
8	CTS (clear to send)
9	not connected

6   Replacement Parts List

The following parts are available for replacement:

Part description	Part number
Case front half "diagnostic"	2001 − 1.12
Case front half "frontline"	2000 − 1.12
Case rear half	2001 − 1.13
Battery door	2001 − 1.14
Lithium battery (BR 1225, 3V)	2001 − 1.15
Cradle housing	2010 − 1.6

7   Operation Verification

In order to check correct operation of EasyOne™ please perform the following steps:

• Perform a calibration check as explained in the EasyGuide manual.
• Make a printout of the calibration report.

If these two steps can be executed successfully the device operates normally.

8   Hidden Keys

The "hidden key" sequences access special features that are not available in the standard menu structure of EasyOne™. The following table shows what key sequences are available. The column labeled 'Location' indicates in what menu / screen the described key sequence has to be used.

Caution: The key sequences should not be used in conjunction with patient testing.

Location	Key sequence	Description
Main Menu	1-3-5	Factory defaults (same as in Configuration Menu).
Configuration Menu	1-3-5	Manual adjustment of flow gain factors (FlowGainIn/Ex). Attention: Changing these values will influence the calibration of the unit.
Device self test error screen	1-3-5	Ignore error an go on.
Device info screen (from Configuration Menu).	1-2-4	Show additional device information.
Device info screen	1-2-5	Hard factory reset (database is also deleted).
Device info screen	1-2-6	FVC filter disable temporarily (until next power cycle).
Device info screen	1-2-7	Switch off BTPS correction temporarily (until next power cycle).
Device info screen	1-2-8	Switch off flow linearity correction temporarily (until next power cycle).
Device info screen	1-2-9	Switch on "*predicted/print all*" feature temporarily (until next power cycle). All (internal) parameters are printed, the predicted values are printed with 4 digit resolution, the Lower limits of normal (LLN) are also printed with 4 digit resolution.
Device info screen	1-3-9	Restore corrupt database: Caution use only for inconsistent databases.

9   Device Error Codes

Internal errors are reported using the following screen:

```
           ERROR
      Device Selftest
        Failure #xx
      Please contact
           service
```

The number xx indicates the type of error that is detected. The following list shows all error numbers and a description of the internal error.

No.	Description
1	internal software error (wrong argument)
2	internal software error (unsupported)
3	internal software error (timeout)
4	internal software error (data inconsistent)
5	internal software error (write error)
6	internal software error (read error)
7	internal software error (not found error)
13	internal software error (WD timeout)
14	the ultrasonic receive amplitude is too low (check spirette insertion)
15	the ultrasonic receive amplitude is too high (check spirette insertion)
16	Bootloader software inconsistent (CRC failure)
17	User software inconsistent (CRC failure). Update EasyOne™ software.
18	Calibration data inconsistent.
19	Failure of flash memory.
20	Flow sensor transit time range check error. Possible reasons: a) Blocked sound path, e.g. caused by wrongly inserted spirette, b) almost empty batteries.
21	ndd ASIC serial transmission error (STX expected)
22	ndd ASIC serial transmission error (sequence error)
23	ndd ASIC serial transmission error (unknown character)
24	Real time clock RAM error
25	Configuration data inconsistent (lithium battery failure possible)
49	internal software error (overrun error)
50	internal software error (timeout error)
51	internal software error (storage error)
52	internal software error (record structure error)
53	internal software error (address error)
54	Serial data flash or serial communication data inconsistent (CRC failure)
55	internal software error (flash command sequence error)
56	internal software error (flash block erase error)
57	internal software error (flash program error)
65	internal software error (flash block program error)
66	internal software error (flash busy)
70	internal software error (unknown error)
144	Sensor serial communication error

10 EasyOne™ Software Update

10.1 Introduction

The internal software of EasyOne™ is stored in a Flash EPROM. It is therefore possible to update the internal software. The following procedure describes how this update is executed.

10.2 Preparation

The following items are required:

- ndd RS232 cable 2060-1 (please note that this is a non-standard RS232 cable)
- PC program EzFlash.exe, V01.07 or higher.
- EasyOne™ device software for the download. This file is named EasyOne™_Vaabbccdd.hex, where aabbccdd is the software version e.g. V01110000
- PC with Windows 95, 98, 2000, NT or ME.

The following installation description presumes that you have basic knowledge of your PC operating system.

10.3 Software Update Procedure

In order to update the software in EasyOne™ follow this procedure:

1. Connect the EasyOne™ cradle with the ndd RS232 cable (2060-1) with an unused serial port of your PC.
2. The PC Software for the programming of EasyOne™ does not need special settings and can be copied directly to a folder of your choice e.g. to C:\nddmed.
3. The device software can also be copied to a folder of your choice, e.g. to C:\nddmed.
4. Turn the power of EasyOne™ on and put it in the cradle. Press the "1" key to activate the PC interface mode. The EasyOne™ display shows: „PC interface active".
5. Start the PC software EzFlash (e.g. Start button, then Run, Open c:\nddmed\Ezflash.exe)
6. Set the appropriate serial port using the Options menu, Settings e.g. COM1.
7. The device software can be selected through selecting the Open icon or under File, Open (e.g. EasyOne™_V01110000.hex).
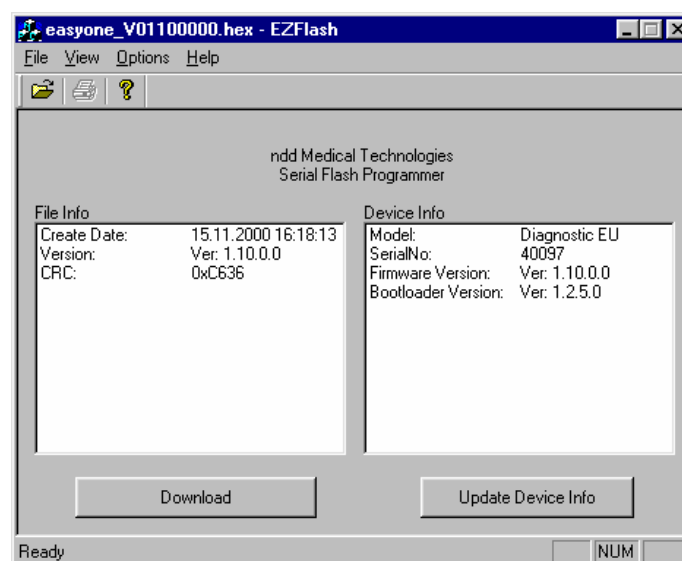
8. The programming is started by pressing the Download button. You are requested to enter your company and user name.
9. During the programming of EasyOne™ a progress bar is shown. The programming takes approx. 3 to 5 minutes. Please do not interrupt the programming process.
10. EasyOne™ shows the successful programming on the device screen. The device has to be restarted using the ON/OFF key. The correct programming can be checked under Configuration, See Device Info under FirmVer (firmware software version).

Troubleshooting:
- If the programming of the software is interrupted: Turn the power of EasyOne™ off and turn it on again. Retry the programming procedure.
- If EasyOne™ shows device self test error #17 please proceed as follows: Do not press the "1" key and start the software download procedure directly.

11 Printer Compatibility List

In general, a large number of printers are supported by EasyOne™. Due to the extremely large number of printers available on the market, ndd cannot test every single printer on its compatibility. EasyOne™ supports three different principal driver types:

- Hewlett-Packard (HP) PCL,
- Epson ESC/P2, and
- Canon Extended Mode (CEM) commands.

Many laser printer manufactures like Brother, Canon, Kyocera etc. have PCL compatible models and work therefore with the HP b&w setting.

Matrix Printers: Many matrix printer manufactures like Epson, Panasonic etc. have ESC/P2 compatible models and work therefore with the EPSON b&w setting. Please check the specifications of the model for the ESC/P2 mode.

List of tested printers that work using direct connection to EasyOne™ cradle:

Manfct.	Model	Type	Driver	EasyOne Setting	Note
Apollo	1000	Inkjet	PCL3	HP b&w	
Canon	BJC-85, 620, 2000, 2100, 4100, 7000, 7100	Inkjet	CEM	Canon b&w / color	
Canon	S400, S450	Inkjet	CEM	Canon b&w / color	3
Epson	Stylus Color 600, 680, 900	Inkjet	ESC/P2	Epson b&w / color	
Epson	C60, C70, C80	Inkjet	ESC/P2	Epson b&w / color	
Epson	Stylus Photo	Inkjet	ESC/P2	Epson b&w / color	
Epson	LQ 570	Matrix	ESC/P2	Epson b&w	4
HP	LaserJet 4M, 4MP, 6L, 4050	Laser	PCL5	HP b&w	
HP	LaserJet 1100, 1200, 2100, 2200	Laser	PCL6	HP b&w	1
HP	DeskJet 350C	Inkjet	PCL 3e	HP b&w	2
HP	DeskJet 340, 350, 500, 510, 520, 540	Inkjet	PCL3	HP b&w	only b&w
HP	DeskJet 550C, 610C, 640C, 840C, 850C, 895C, 940C, 948C, 1120C, 3820	Inkjet	PCL3e	HP b&w / color	
HP	OfficeJet G55	Inkjet	PCL3e	HP b&w / color	1
Samsung	ML-7000	Laser	PCL5	HP b&w	

Notes:
1. These HP models only work correctly with a modified cradle. Either use EasyWare PC software or exchange the cradle.
2. The HP DeskJet 350C works only in b&w mode, color mode is not supported.
3. If EasyOne firmware smaller 1.15 is used, the page size is reduced to a ¼ page.
4. Matrix printers in general are very slow.

Additional Notes:

- All printers are supported if the printing is done 'via PC' using the EasyWare PC software.
- Many low cost laser printers use the GDI language which is not supported by EasyOne™.
- Some matrix printers can be supported but the printout is extremely slow.

12 Predicted Values Overview

The following table lists the predicted values and lower limits of normal implemented in EasyOne.

Reference	NHANES III	Knudson 83	Knudson 76	Crapo	Morris	Hsu	Dockery (Harvard)	ERS, EGKS (Quanjer)	Zapletal	Austria	Roca (Spain)	Cherniak (add. Reference)	Hedenström	Gulsvik	Berglund
Publ. Year	1999	1983 (1976)	1976	1981	1971	1979	1993	1993	1977	1988	1982	172	1985 1986	1985	1963
Abbrev.	NH	KN	KN	CR	MO	HS	DO	ER	ZA	FO	BA	CH	HE	GU	BE
Age Range [yr]	8-80 (6-90)	6-85	8-85	15-91	20-90	7-20 (4-20)	6..18	18-70 (18-90)	6-17 (4-17)	7-76 (7-90)	6-70 (6-90)	15-79	20-70 (18-90)	20-70 (18-90)	20-70 (18-90)
Min Height [cm]	110	107	110	146	142	110 (93)	115	145	115 (93)	110	110	100	150 (148)	150	154
Max Height [cm]	195 (210)	196 (210)	200 (210)	194 (210)	203 (210)	195 (210)	185 (210)	195 (210)	180 (210)	200 (210)	200 (210)	200	195 (210)	190 (210)	191 (210)
Weight [kg]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	>0	n/a	f:45-94 m: n/a	n/a	n/a
Caucasian	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
African	X						X								
Mexican, Hispanic	X					X									
Asian															
Parameter															
FVC	X	X	X	X	X	X	X	X	VC	X	X		X	VC	VC
FIVC	FVC	FVC	FVC	FVC	FVC	FVC	FVC	FVC	VC	FVC	FVC		FVC	VC	VC
IVC								X							
VC	FVC	FVC	FVC	FVC	FVC	FVC	FVC	IVC	X	FVC	FVC	X	X	X	X
FEV1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FEV1 / FVC %	X	X	X	X	FEV1/FVC	FEV1/FVC	X	X	X	X	FEV1/FVC		FEV1/VC	X	X
FEV1 / VC %													X		
FEV3		X$_{76}$	X	X											
FEV6	X														
FEV3 / FVC %				X											
FEV1 / FEV6 %	X														
FEF25								X	X	ER		X	X		
FEF50		X						X	X	ER	X	X	X		
FEF75		X						X	X	ER	X	X	X		
FEF25-75	X	X	X	X	X	X	X	X	X	ER	X	X		X	
PEF	X	X$_{76}$	X			X		X	X	ER	X	X	X		
MVV	CH	CH	CH	CH	CH	CH	CH	CH	CH	X	CH	X			
LLN Parameter															
FVC	X	X	X	X		X	X			X			X	VC	VC
FIVC	FVC	FVC	FVC	FVC		FVC	FVC			FVC			FVC	VC	VC
IVC															
VC													X	X	X
FEV1	X	X	X	X		X	X			X			X	X	X
FEV1 / FVC %	X	X	X	X			X			X			FEV1/VC	X	X
FEV1 / VC %													X		
FEV3				X											
FEV6	X														
FEV3 / FVC %				X											
FEV1 / FEV6 %	X														
FEF25													X		
FEF50		X											X		
FEF75		X											X		
FEF25-75	X	X		X		X	X							X	
PEF	X					X							X		
MVV										X					

Legend of symbols used in the Matrix:

1. X (grey)   an X indicates that the parameter is directly available in the source. However only the grey marked fields are available in EasyOne.
2. FVC, IVC   the value of the parameter is copied from the listed parameter of the same source.
3. FEV/FVC   FEV1 / FVC % is computed from the predicted FEV1 and FVC.
4. Abbreviation   the value of the parameter is copied from the listed source.
5. Height range   the published height range is listed, the extended (extrapolated) height range used in EasyOne is listed in parentheses.
6. Age range   the published age range is listed, the extended (extrapolated) age range used in EasyOne is listed in parentheses.
7. Scandinavian   Scandinavian reference values (only available with the Scandinavian firmware) are combined with Zapletal reference values.