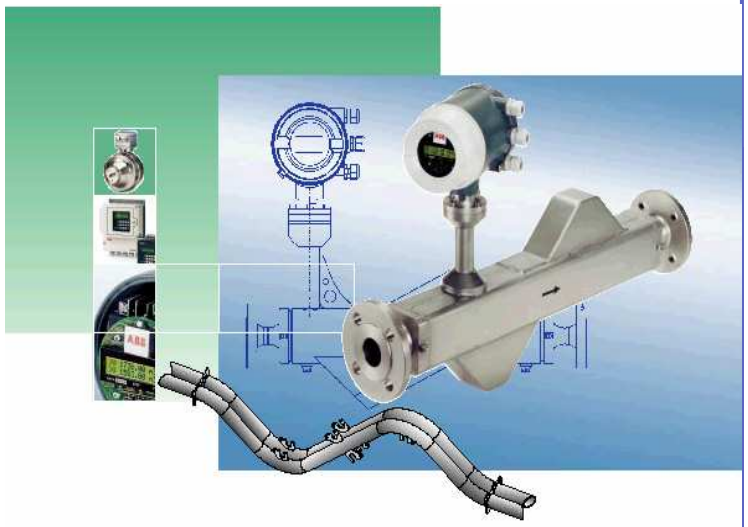

Coriolis Mass - Flowmeter

FCM2000 – MC2 / ME2

Agenda

1. **Startup / Calibration**
2. Technical Details
3. Where can I measure what?
4. Common problems
5. Service Connector
6. Contact

Startup

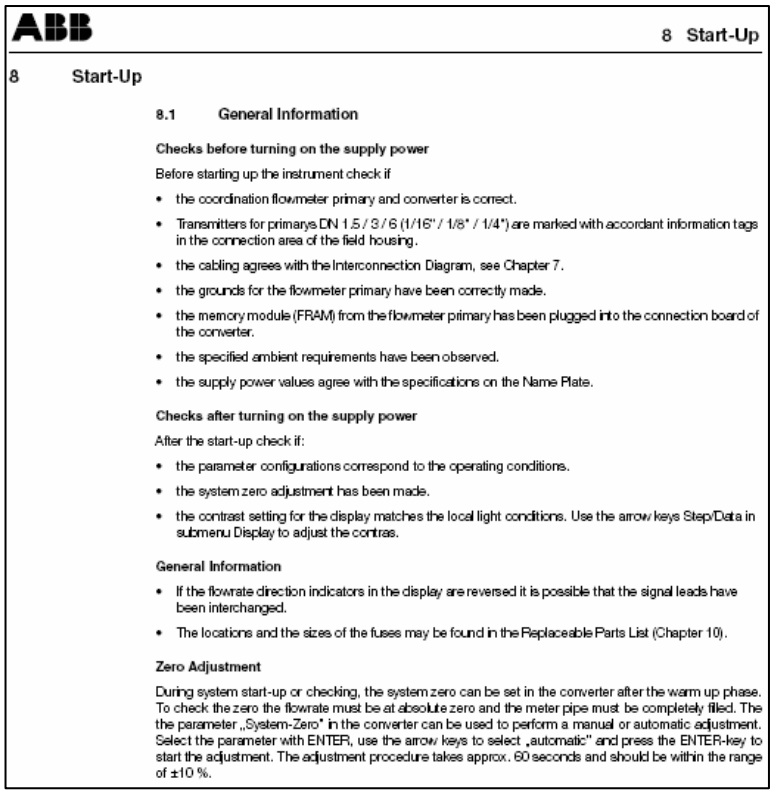

ABB 8 Start-Up

8 Start-Up

8.1 General Information

Checks before turning on the supply power

Before starting up the instrument check if

- the coordination flowmeter primary and converter is correct.
- Transmitters for primarys DN 1.5 / 3 / 6 (1/16" / 1/8" / 1/4") are marked with accordant information tags in the connection area of the field housing.
- the cabling agrees with the Interconnection Diagram, see Chapter 7.
- the grounds for the flowmeter primary have been correctly made.
- the memory module (FRAM) from the flowmeter primary has been plugged into the connection board of the converter.
- the specified ambient requirements have been observed.
- the supply power values agree with the specifications on the Name Plate.

Checks after turning on the supply power

After the start-up check if:

- the parameter configurations correspond to the operating conditions.
- the system zero adjustment has been made.
- the contrast setting for the display matches the local light conditions. Use the arrow keys Step/Data in submenu Display to adjust the contras.

General Information

- If the flowrate direction indicators in the display are reversed it is possible that the signal leads have been interchanged.
- The locations and the sizes of the fuses may be found in the Replaceable Parts List (Chapter 10).

Zero Adjustment

During system start-up or checking, the system zero can be set in the converter after the warm up phase. To check the zero the flowrate must be at absolute zero and the meter pipe must be completely filled. The the parameter „System-Zero" in the converter can be used to perform a manual or automatic adjustment. Select the parameter with ENTER, use the arrow keys to select „automatic" and press the ENTER-key to start the adjustment. The adjustment procedure takes approx. 60 seconds and should be within the range of ±10 %.

Detailed startup routine:
manual section 8

- Easy Startup:
  - Check correct connection / installation
  - Carry out automatic zero-adjustement in the menu
  - Units and impuls-width selcted according to order

Calibration

- Connect impuls terminals 51 / 52 with 100Ω burden
- Choose Service-level, Code 4000
- Select correct meter size
- Default Option -> destroy calibration
- Submenu Driver
  - Current limit 350mA or 160mA (Eex)
  - Primary gain acc. Table
  - Ktqm = -0.451
  - Ktfreq = 0.24
  - Ki and kp according to table
  - Amplitude acc. table

NW	Amplitude	kp	ki	PrimaryGain
6B	85	400	50	0
10C	85	300	100	0,1
15D	85	200	50	0
20E	120	10	10	0
25F	120	100	50	0
40G	120	400	10	0
50H	120	200	100	0
65I	120	100	50	0
80J	120	200	300	-0,2
100K	120	100	50	0
150L	120	500	30	0,25

- Ensure FRAM – Converter use same data
- Initialize FRAM (data) (in case of empty FRAM: error, restart

Calibration

- Fix density-frequency pair 1 empty pipe (Submenu Density)
- Fix density-frequency pair 2 filled pipe (Submenu Density)
- Set zero AB (internal zero point)
- Submenu Flow
  - Tm calib. Zero -> do not touch
  - Tm calib span -> Temp. During calib.
  - Span Forward -> adjusting through calibration
  - Zero -> internal zero adjustment (min. 3 times)
  - Span Reverse -> add. Calib. Or as Span Forward
- Insert customer specific units etc.

ABB

Agenda

1. Startup / Calibration
2. **Technical Details**
3. Where can I measure what?
4. Common problems
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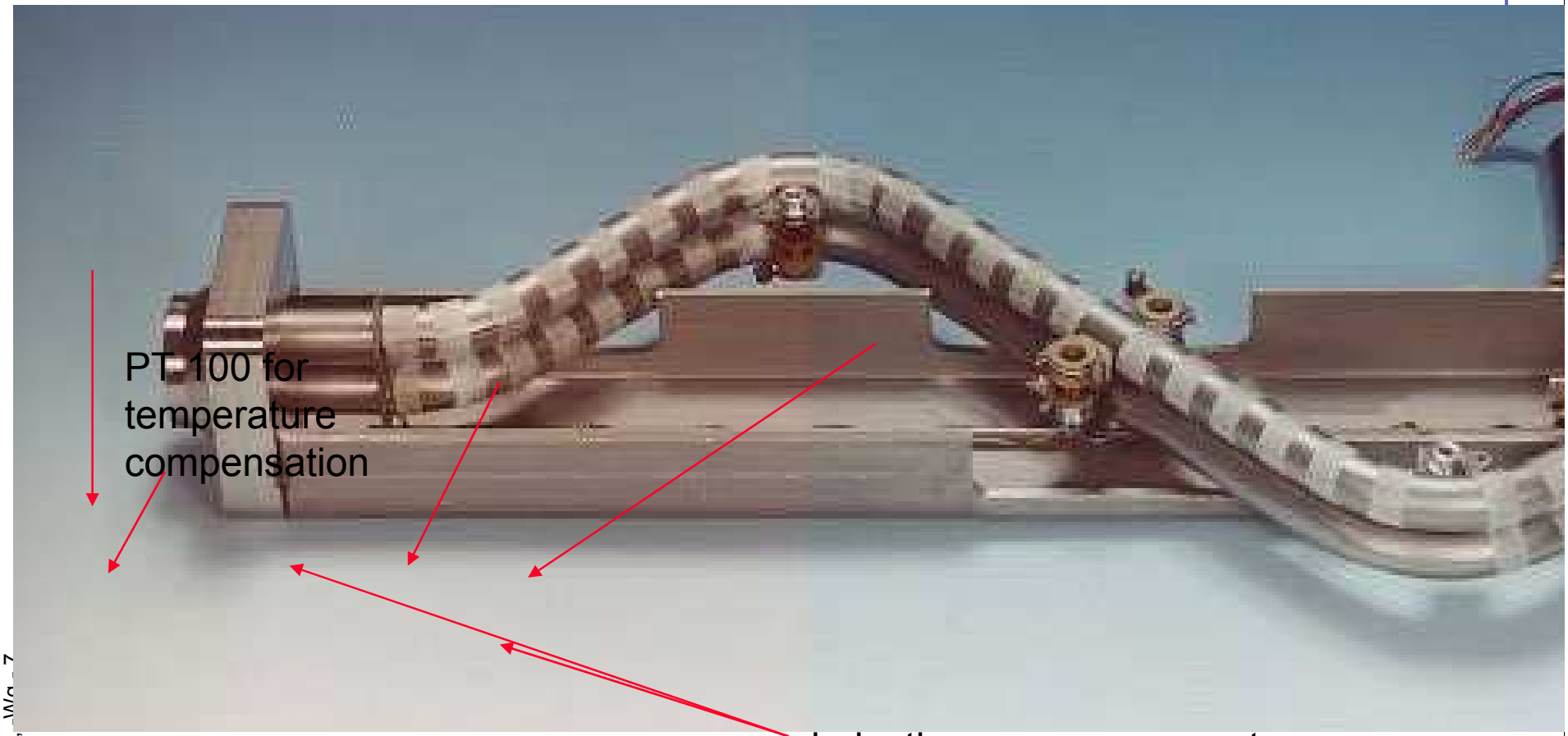
FCM2000 Technology

Cut-away model



The name DSP-ELCO FCM2000

It is the name of the Electronic Converter

- **DSP:**
  - A Digital Signal Processor for excitation and data acquisition is implemented

- **ELCO:**
  - Electronic Converter

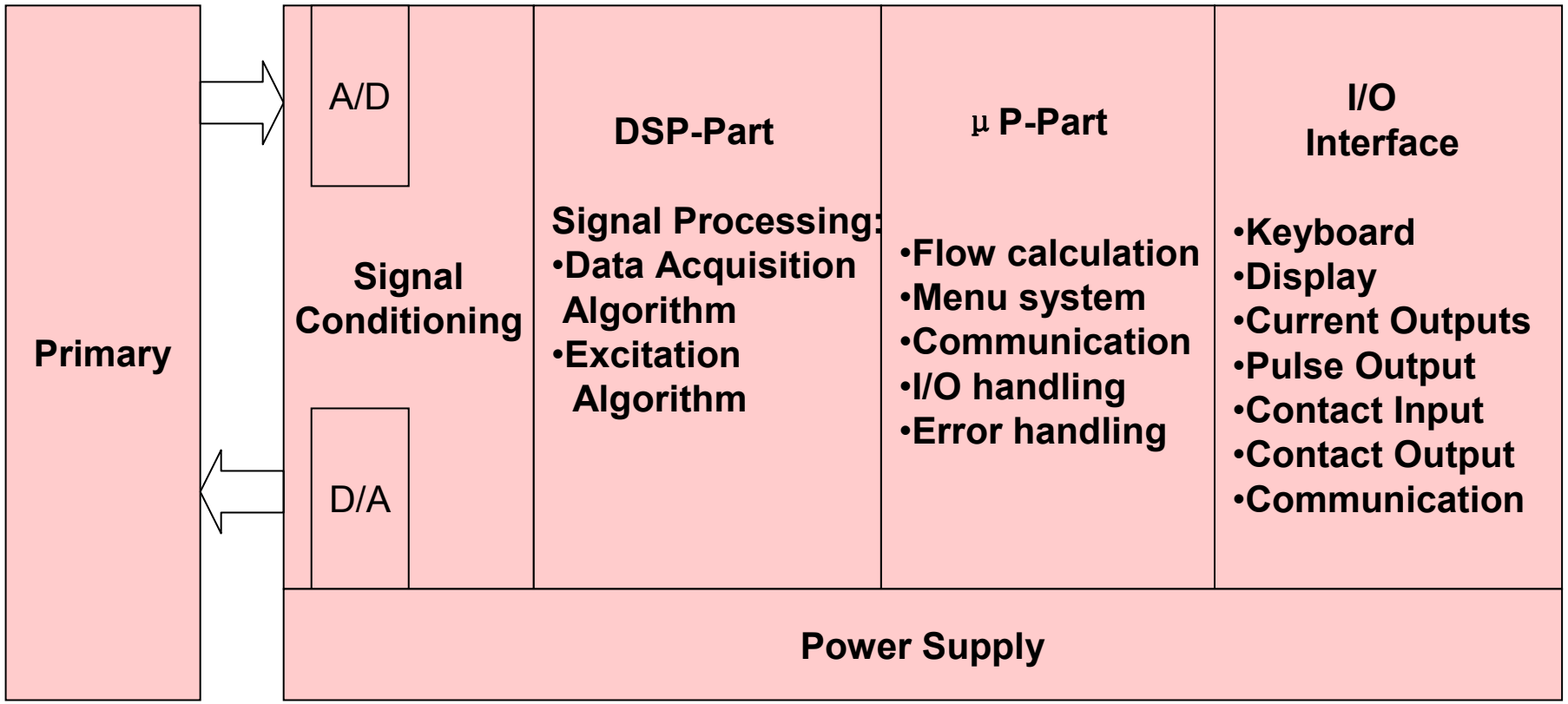
ABB

What is measured?

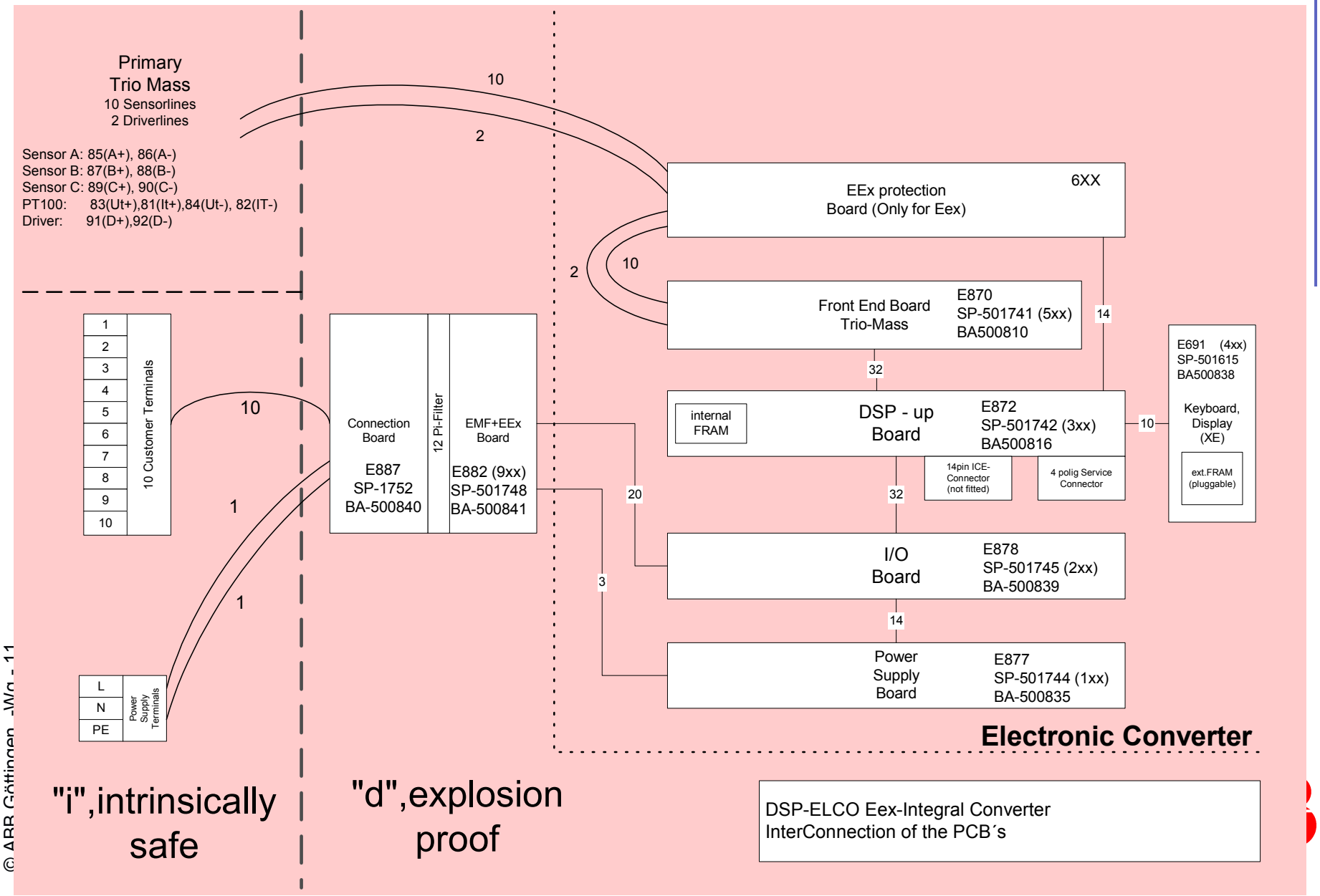
- **Directly measured values:**
  - Phase shift between the motion sensors
  - Pipe frequency
  - Temperature
  - Driver current
- **Calculated Values:**
  - Mass flow
    - calculated by help of phase shift and temperature
  - Density
    - calculated by help of pipe frequency and temperature
  - Volume flow
    - calculated by help of mass flow and density
  - Concentration (only Densi-Mass)
    - calculated by help of density and temperature

ABB

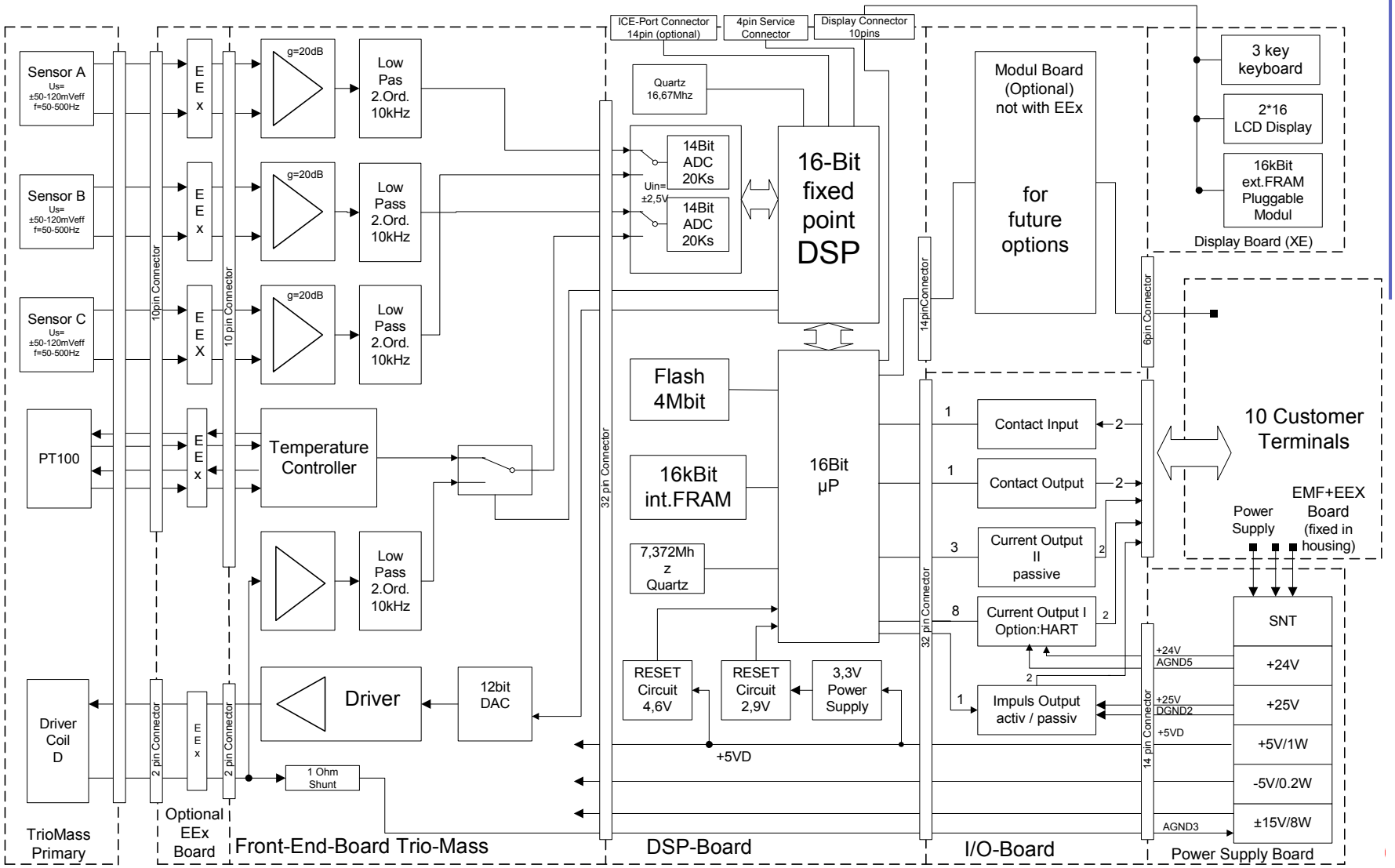
Coarse Block Diagram



Interconnection of the PCB´s



Fine Block Diagram

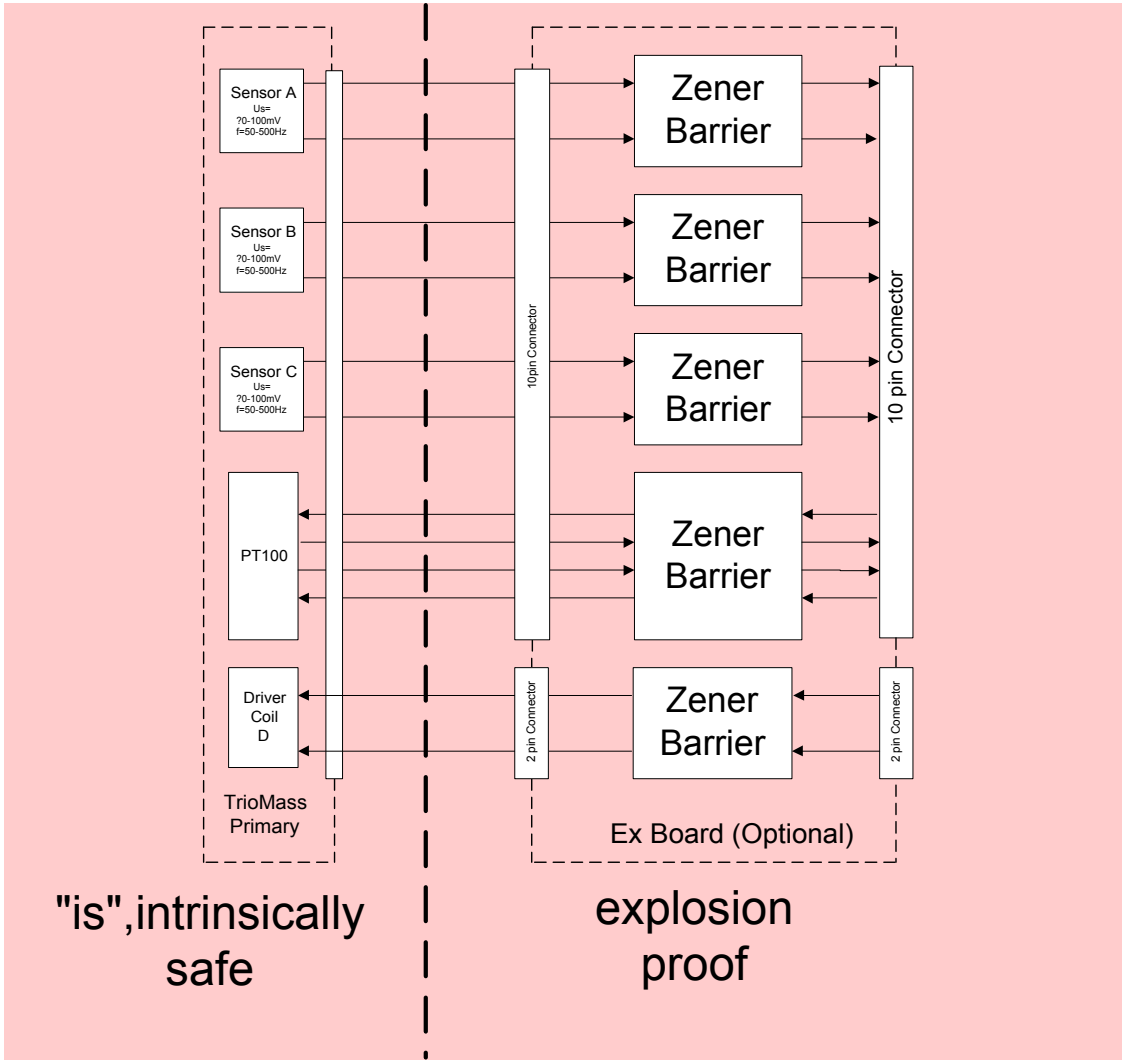


Block Diagram DSP-ELCO 50MM4000 TrioMass Compact Converter

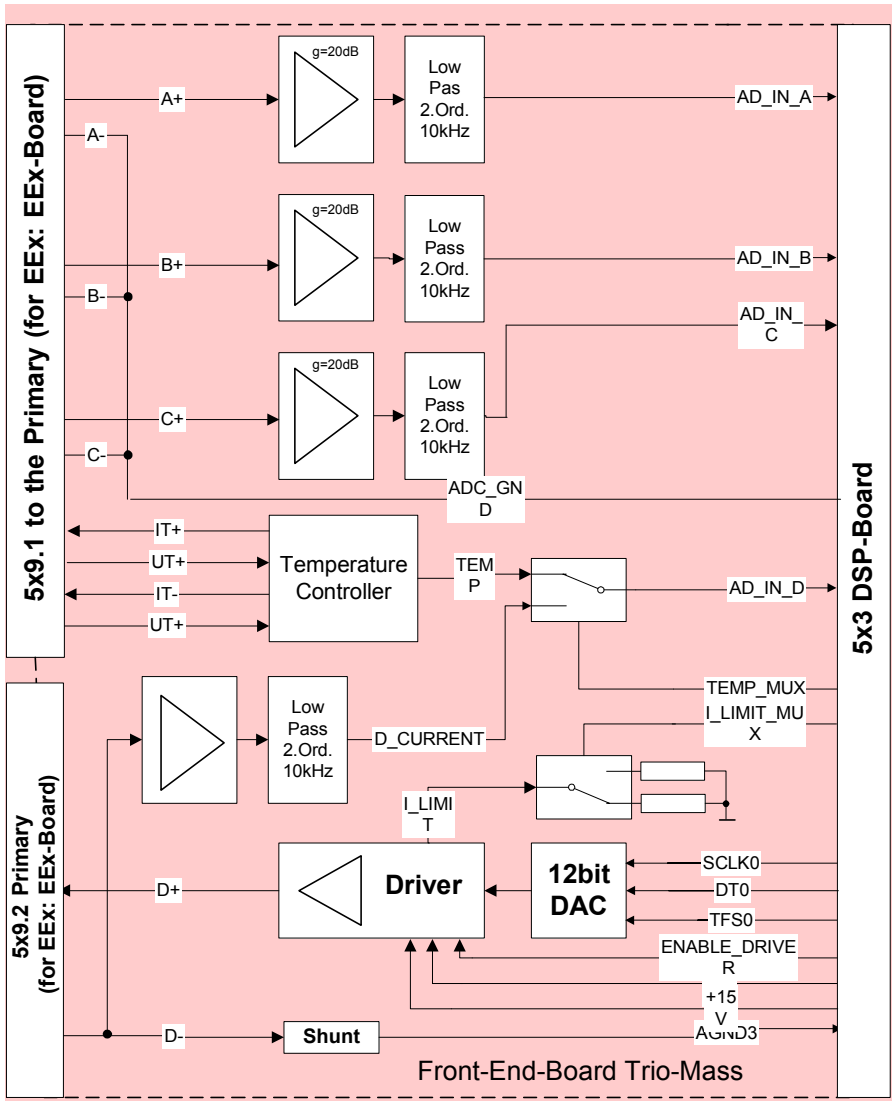
Electronic Converter

- The Converter is interchangeable without any recalibration (data stored in EEPROM)
- The Converter consists of 5 boards (+1for Ex/FM)
  - Power Supply Board
    - High voltage version and low voltage version
  - I/O Board
    - Interface to the customer with 10 terminals
  - DSP-Board
    - Brain Board with 2 processors and digital signal processing
  - Front End Board
    - Interface to the primary
  - Display Board
    - Display and keyboard for the customer
  - EEx Board (Only for Ex/FM)
    - Ex/FM protection

Eex Board (FM-Certification)



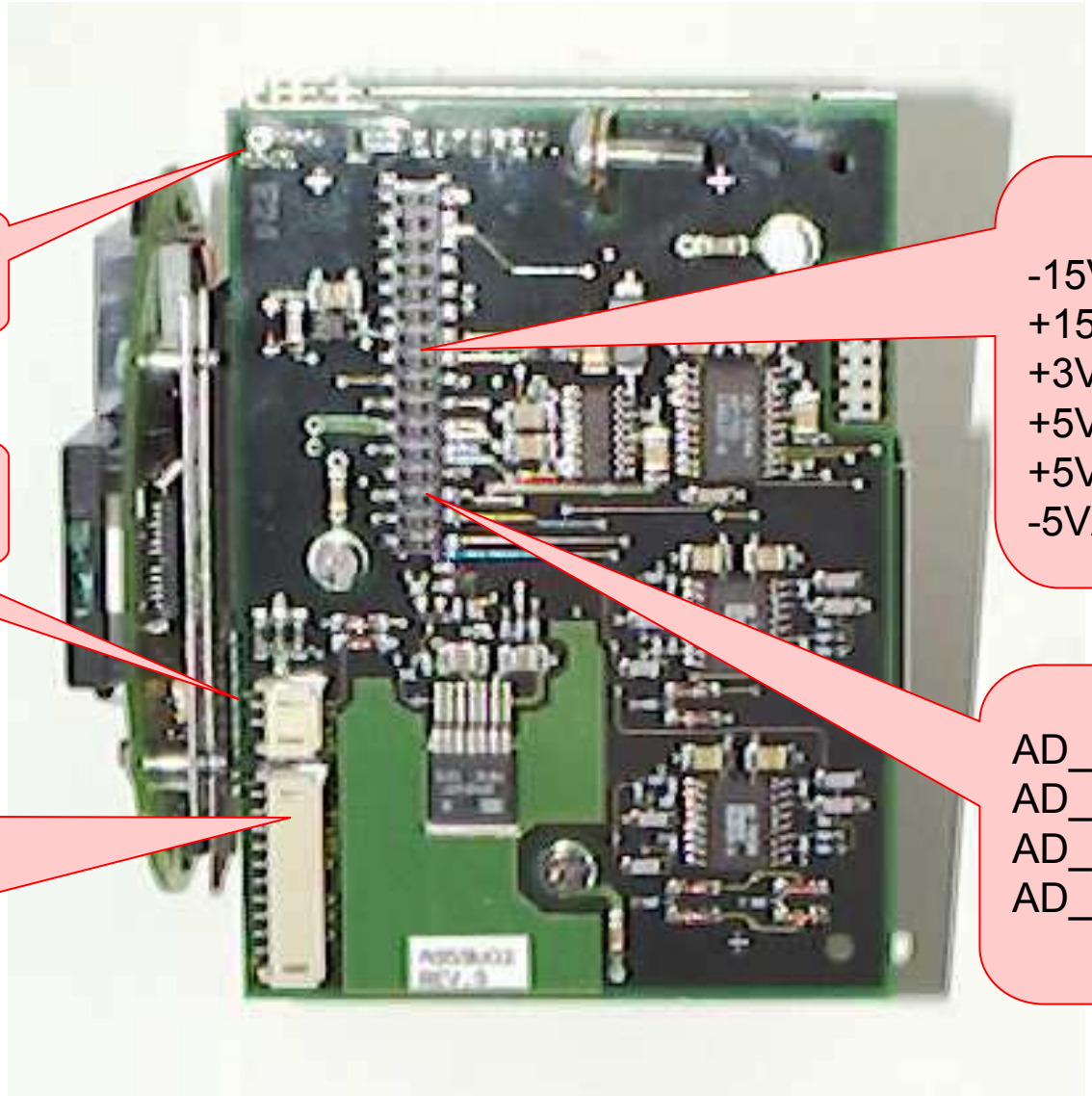
Front End Board: Block Diagram



Front End Board: Description

- Signal conditioning of the three sensor coils
  - Preamplifier
  - 10khz Anti Alias Filter
- Signal conditioning of the temperature
  - PT100 in 4wire technique
  - 1mA current source
- Excitation for the driver coil
  - The DSP generates the driver signal by help of a DAC
  - max. voltage output signal: ±13Vss
  - Software controlled driver enable/disable
  - Driver current measurement
  - Thermal shutdown
  - Driver current limitation
    - standard: max Driver Current=350mA; Pmax=13V*0,35A=4,5W
    - Ex/FM >DN10C :max Driver Current=160mA; Pmax=13V*0,16A=2,1W
    - Ex/FM <=DN10C: max Driver Current=100mA; Pmax=13V*0,10A=1,3W

Front End Board: Measurement Points



MP501 AGND1

5x9.2

91(D+)	(1)

5x9.1

85(A+)	(1)
87(B+)	(4)
89(C+)	(7)
83(UT+)	(11)
82(UT-)	(12)

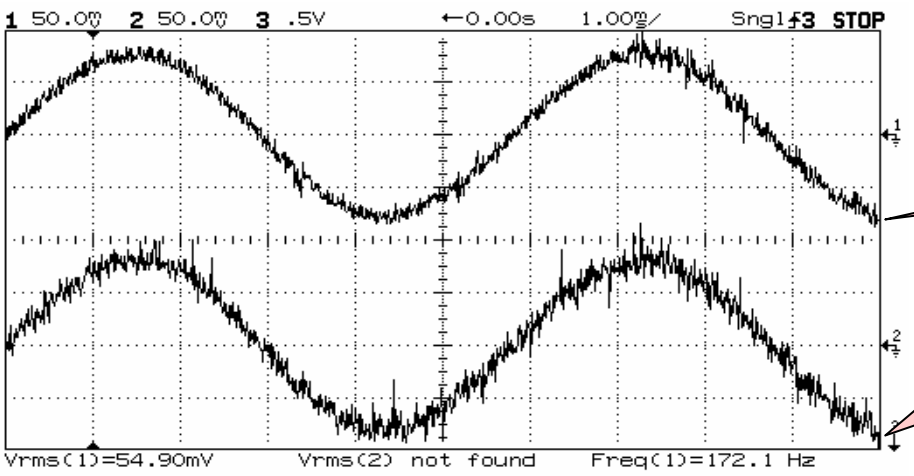
5x3

-15V	(20)
+15V	(21)
+3VD3	(23)
+5VD	(24)
+5VA	(26)
-5VA	(27)

5x3

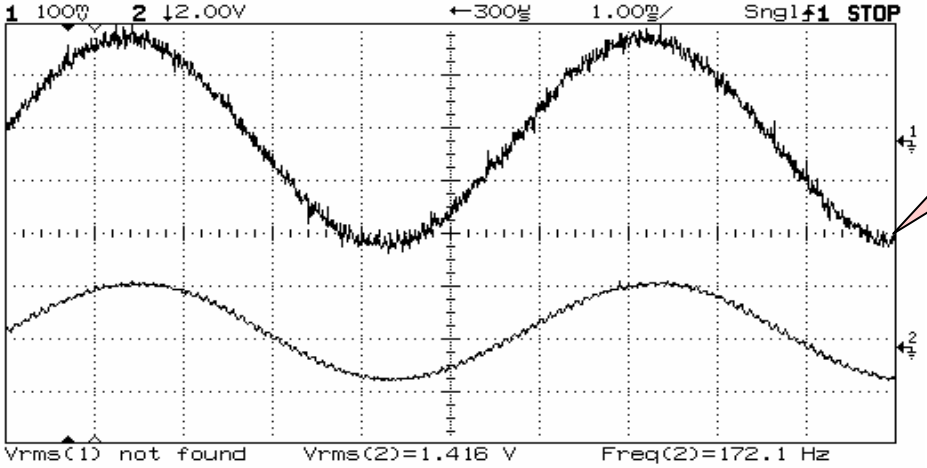
AD_IN_A	(29)
AD_IN_B	(30)
AD_IN_C	(31)
AD_IN_D	(32)

Front End Board: Plot of the Sensor Signals



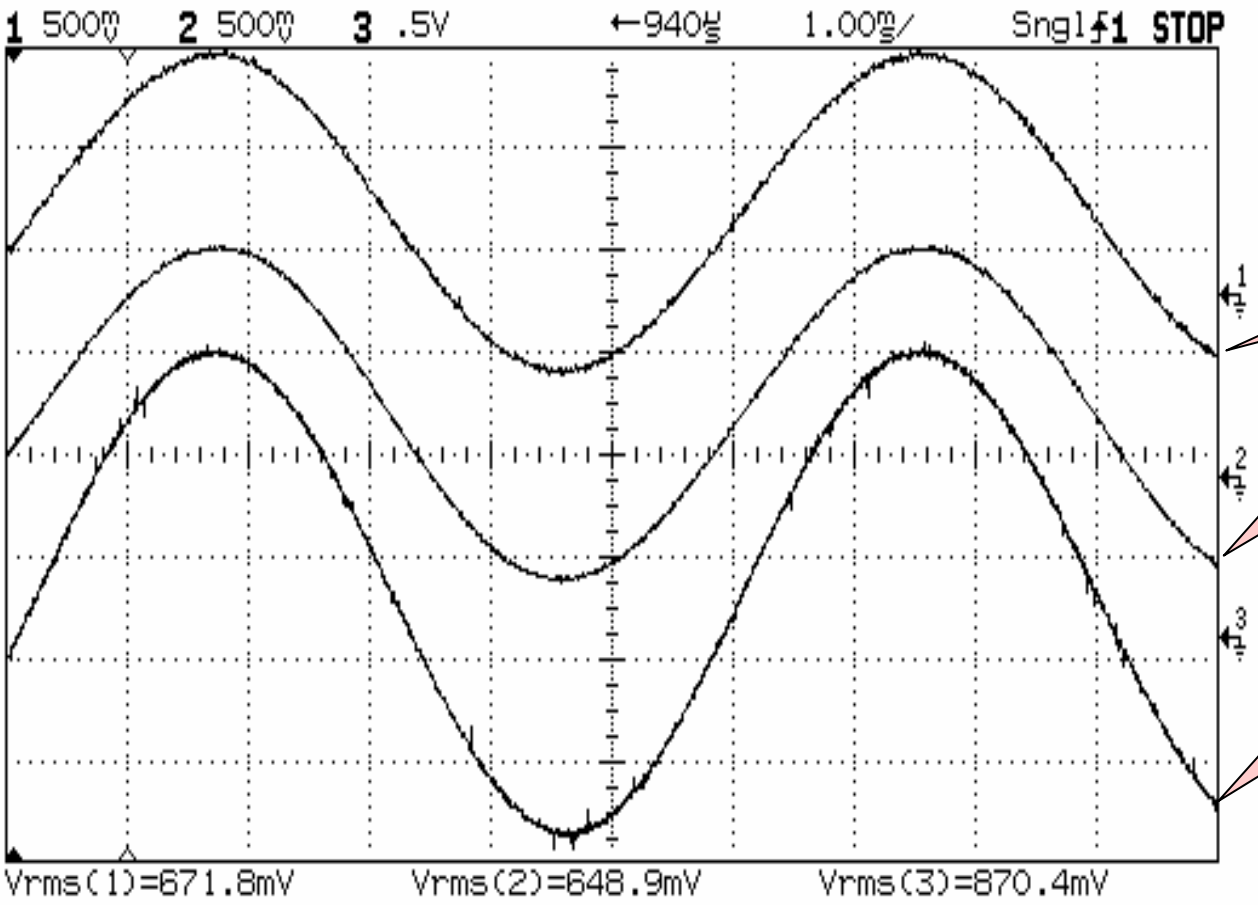
Sensor A+
5x9.1 pin1

Sensor B+
5x9.1 pin3



Sensor C+
5x9.1 pin5

Front End Board: Plot of the ADC Inputs

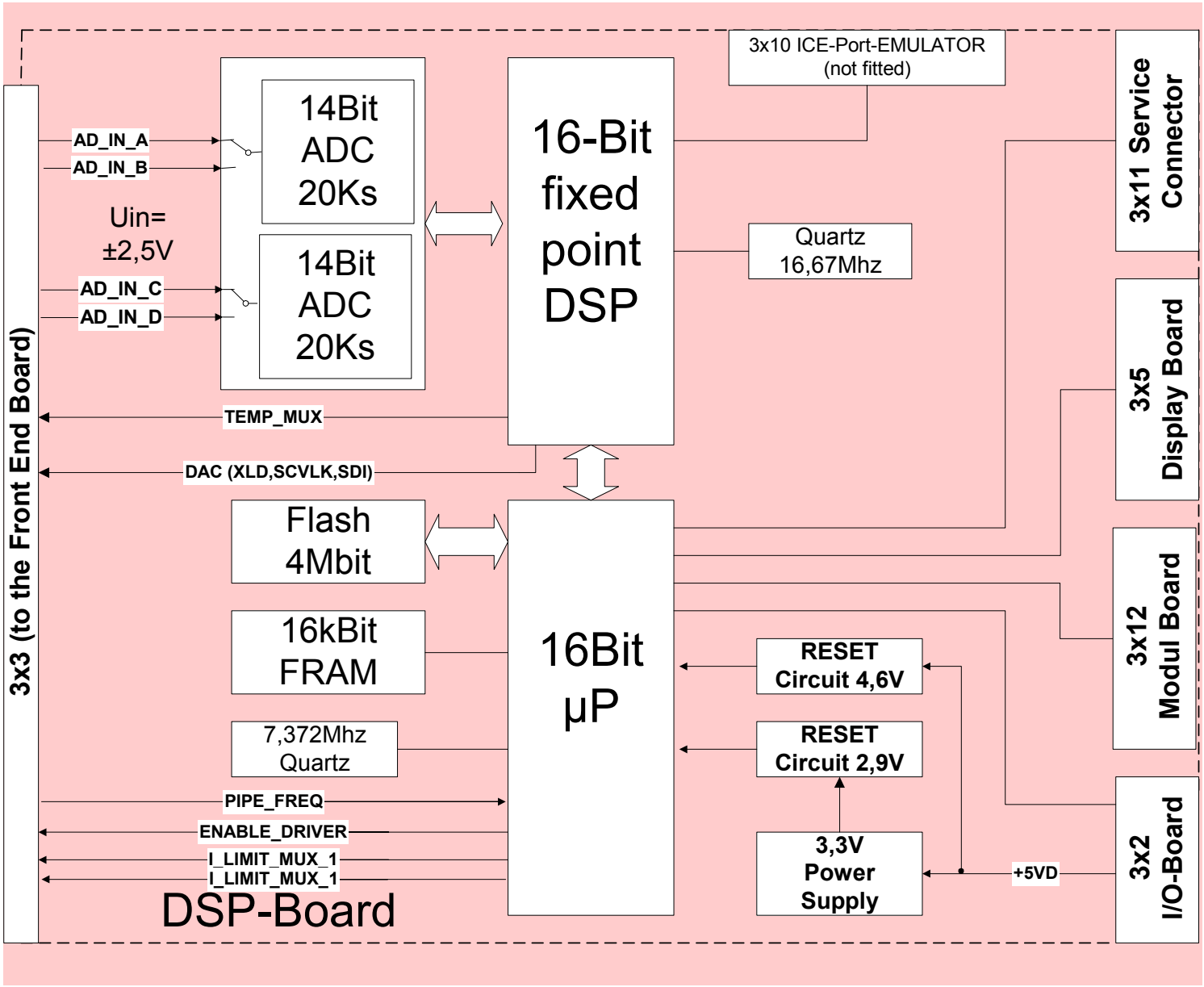


AD_IN_A
5x3 pin29

AD_IN_B
5x3 pin30

AD_IN_C
5x3 pin31

DSP-Board: Block Diagram

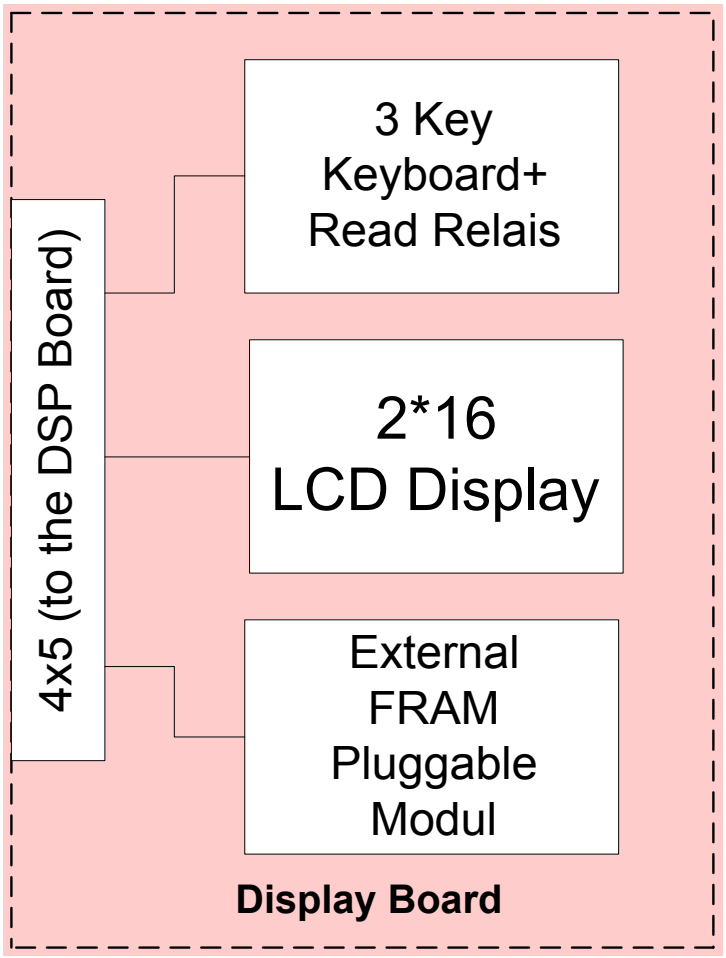


DSP-Board: Description

- 16-Bit fixed point DSP for signal processing
  - 33 MIPS (Million Instructions per second)
- 2 Simultaneous 14-Bit sampling ADC´s
  - Sensor A and sensor B are sampled simultaneous
  - Advantage: no sampling phase shift,
    additive errors are sampled simultaneous
    -> good change to figure it out
- 4M-Bit flash for storing the DSP and uP program
  - Software update via the service connector
- 16kBit FRAM for non voltaire storing (internal data memory)
  - storing of the primary, converter and customer data
  - storing of the counter values
- Supervisor circuit for 3,3V and 5V power supply
- 3,3V Power supply on board

ABB

Display Board: Block Diagram

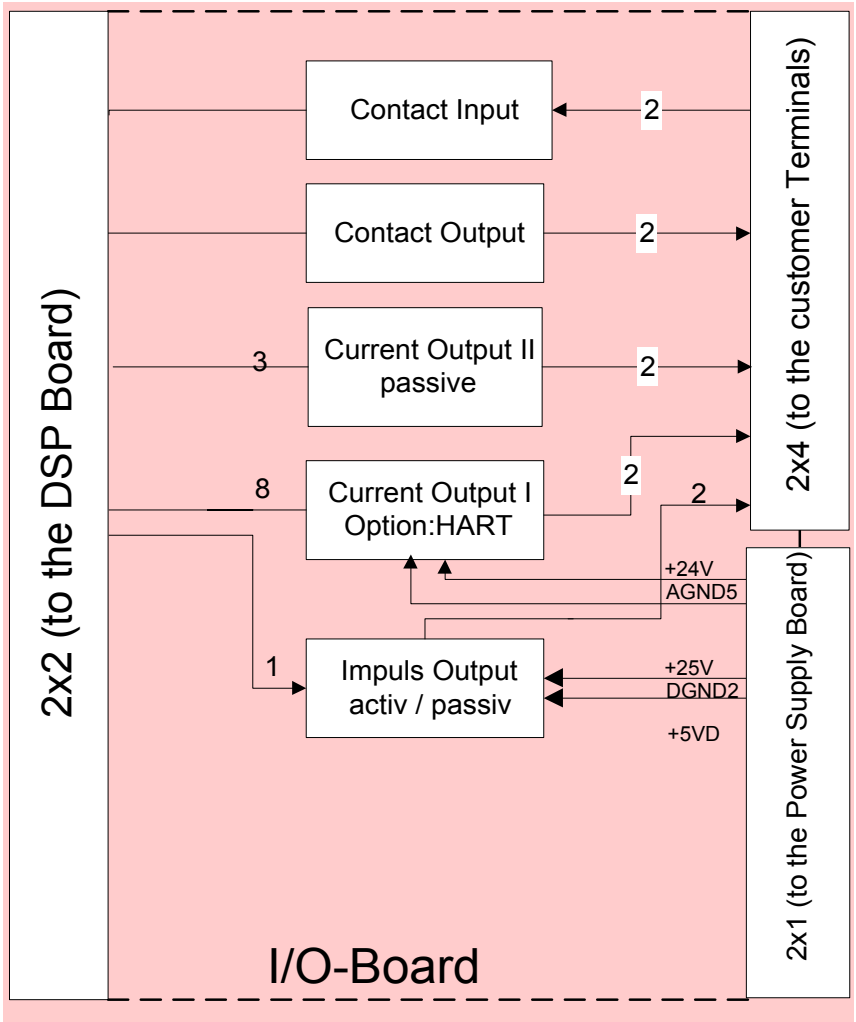


Display Board: Description

- 3 Key keyboard
  - Operation without opening the housing by help of a magnetic pencil
- 2*16 LCD display
  - illuminated
- External data memory
  - Pluggable module (like the XE)
  - 16kbit nonvoltaire FRAM

ABB

I/O- Board: Block Diagram



I/O-Board: Specification I

Current output 1:

Active output

0 mA to 24 mA

560 Ohm maximum load

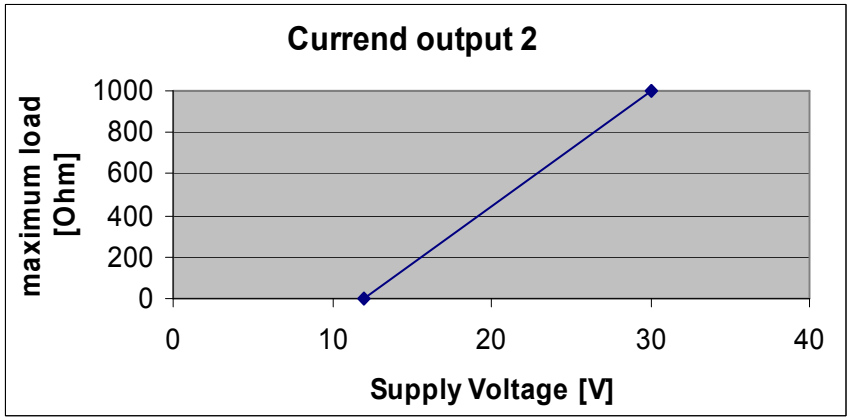
Current output 2:

Passive output

Supply voltage 12 V to 30 V

3.25 mA to 22 mA

1000 Ohm maximum load



I/O-Board: Specification II

Pulse output: Active or passive output (user selectable)

16 V - 30 V

220 mA maximum current

5000 Hz maximum frequency

Contact output: Passive output

Supply voltage 16 V to 30 V

220 mA maximum current

500 Hz maximum frequency

output function is software programmable

I/O-Board: Specification III

Contact input: Passive input

Supply voltage 16 V to 30 V

input function is software programmable

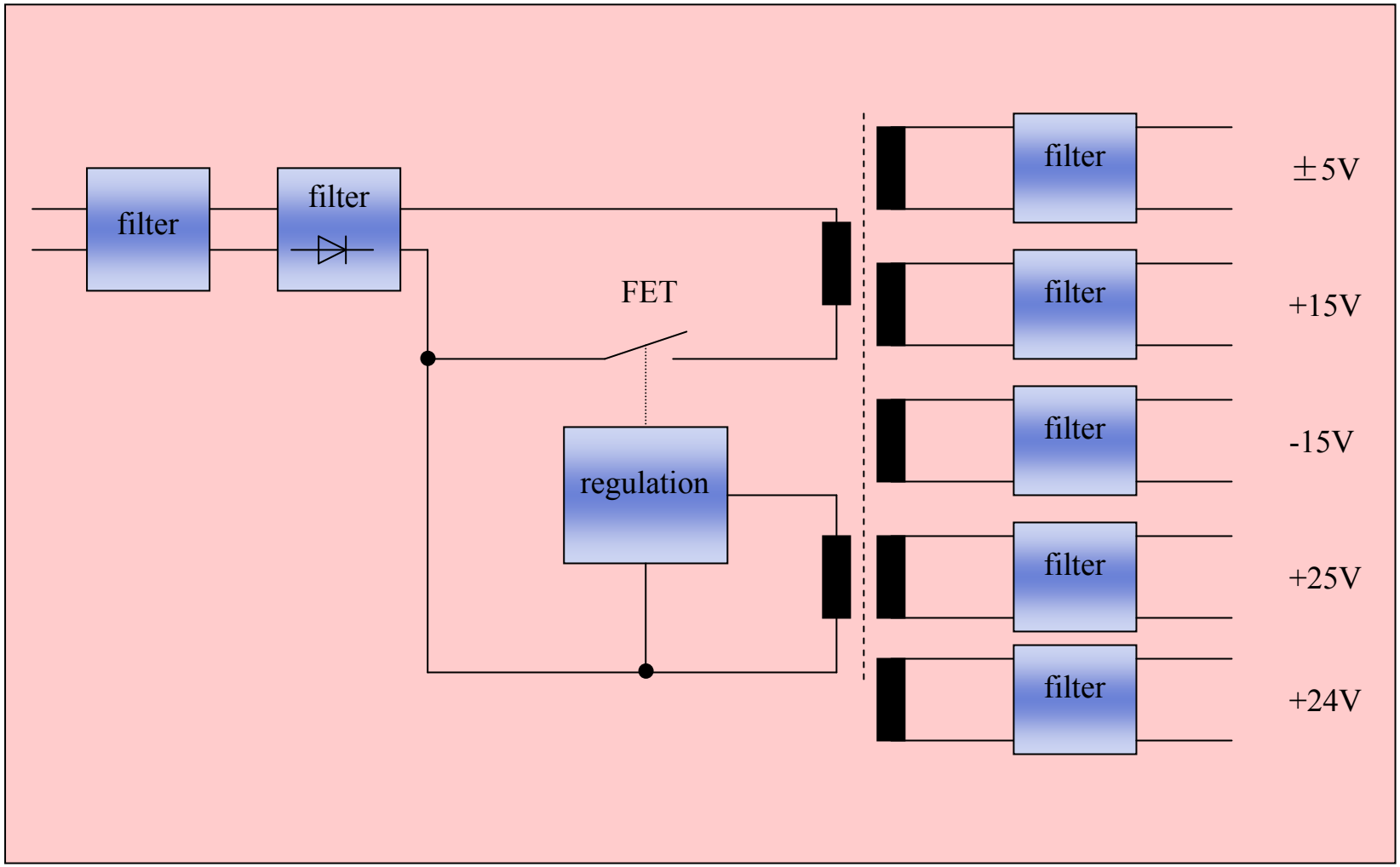
HART: Superimposed on current output 1

1.2 mA current modulation

250 Ohm to 560 Ohm load

Frequency: 1200Hz / 2200Hz

Power Supply Board: Block Diagram



Power Supply Board: Specification

Power supply:

AC-high

Input voltage : 85 V to 253 V

Input frequency: 47Hz to 64Hz

AC-low

Input voltage: 16.8 V to 26.4 V

Input frequency: 47Hz to 64Hz

DC

Input voltage: 16.8 V to 31.2V

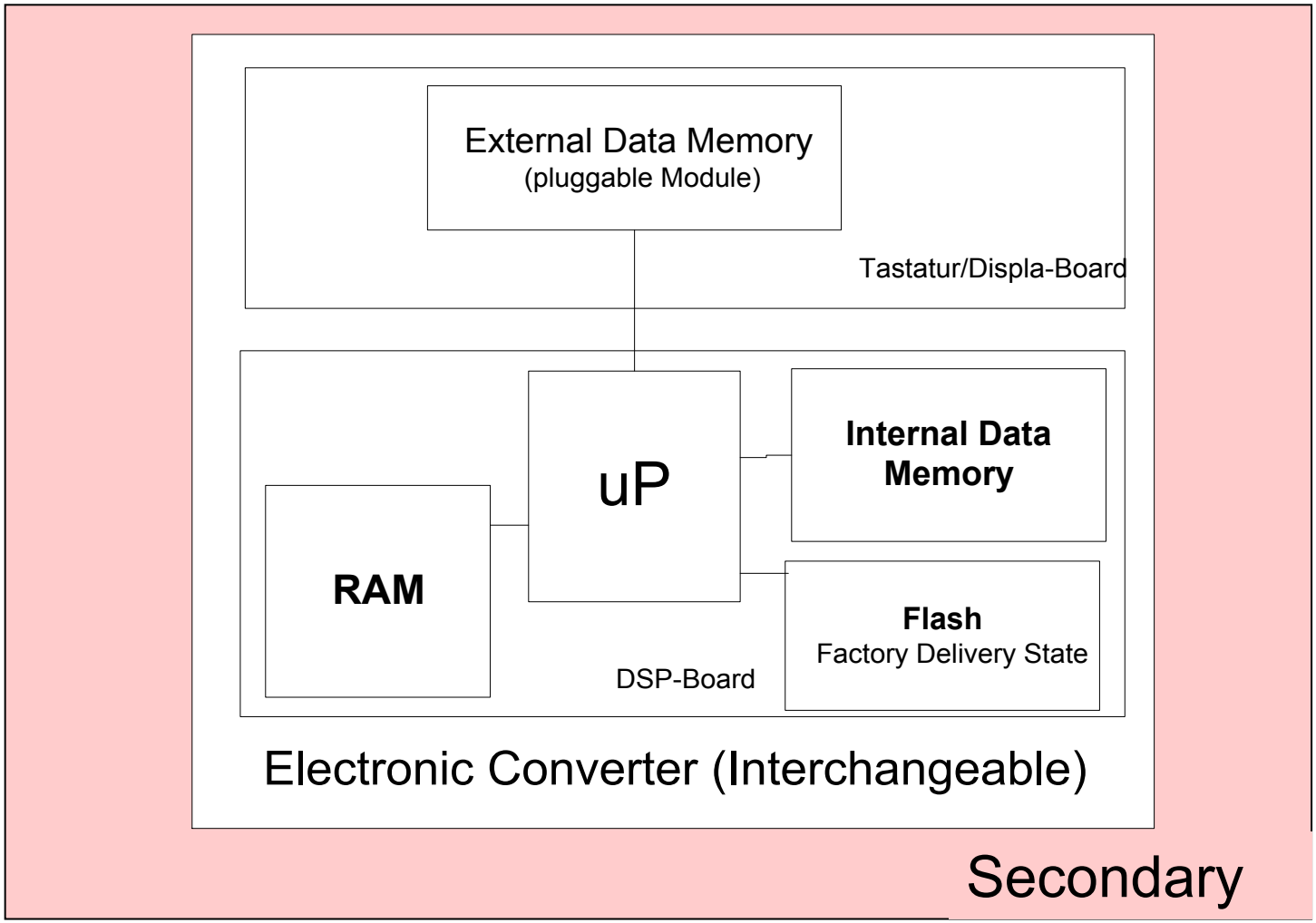
Same pcb

Variants of the Electronic Converter

No.	Power Supply	I/O-Board	EEx/FM
1	AC/DC Low	Standard	-
2	AC/DC Low	HART	-
3	AC-High	Standard	-
4	AC-High	HART	-
5	AC/DC Low	Standard	Yes
6	AC/DC Low	HART	Yes
7	AC-High	Standard	Yes
8	AC-High	HART	Yes

ABB

Data Memory Management



Customer Software Menu Structure

Three different menu structures can be selected in the Program Level Menu:

- Prog. Level Blocked
  - Standard Menu, data cannot be entered
- Prog. Level Standard
  - Standard Menu with all customer specific entries required for operating the instrument available
- Prog. Level Special
  - Special Menu with the complete customer specific entries available
- Prog. Level Service
  - Additional values are displayed after the correct Service Code number has been entered

DSP: Advantage of the DSP

- Reduced Analog Hardware
  - only input amplifier, output amplifier and anti alias filter are analog
  - decreased temperature effects
  - decreased changing over the time
- Parts of the Analog Hardware are moved to the Software
  - Filter Algorithm (Possibility to design ideal filters)
  - Software PD-Controller
- Complex Algorithms are possible
  - e.g Fourier Transformation and Correlation
- No changing of the hardware to get another behavior
  - only the algorithms have to be changed
- Increasing of the self diagnostic
  - diagnostic of the installation
  - diagnostic of the primary

ABB

Agenda

1. Startup / Calibration
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3. **Where can I measure what?**
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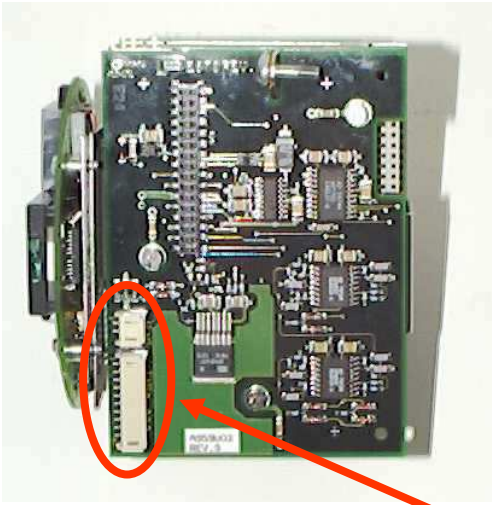
6. Contact

Typical sensor data

- Typical resistance driver coil: ca. 10 - 40Ω
- Typical resistance sensor coils: ca. 90 Ω (A and B must have ca. equal value)

- Check M6 - M7
- Check S1 - S2
- Check S3 - S4
- Check S5 - S6
- Results in Ω not kΩ area.
- UT+ and UT- ca. 110 Ω
- IT + and IT – ca. 110 Ω
- UT+ and IT+ ca. 0 Ω
- UT- and IT- ca. 0 Ω

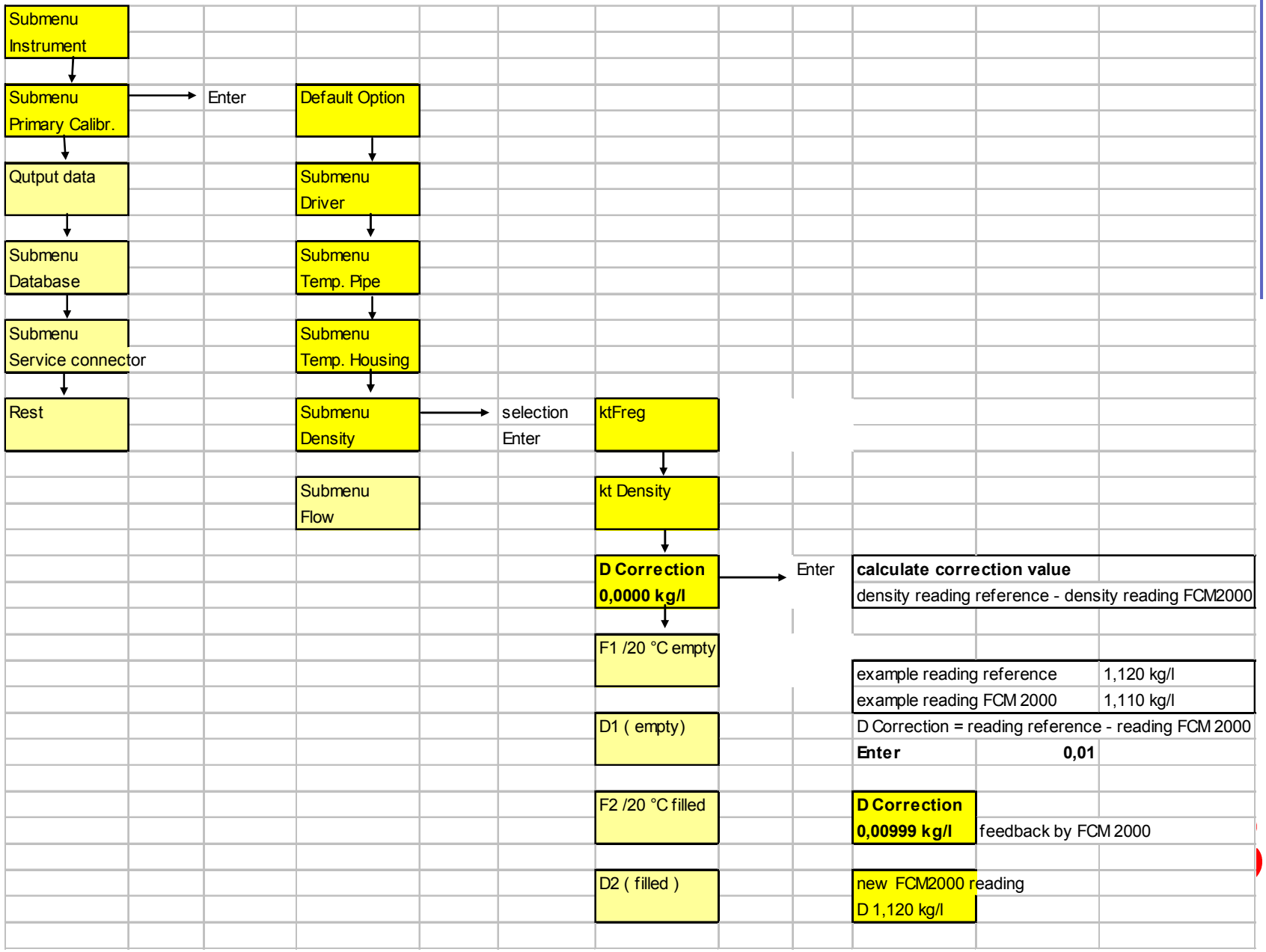


Standard	EEX
M7	M7 black (11)
M6 black	M6 black (12)
_____	_____
S1 red	IT+ black (4)
S2 blue	IT- black (3)
---	UT+ black (2)
S3 yellow	UT- black (1)
S4 green	----------
---	S6 black (5)
S5 brown	S5 black (6)
S6 grey	---
---	S4 black (7)
IT+ violet	S3 black (8)
IT- orange	---
UT+ violet or brown	S2 black (9)
UT- orange	S1 black (10)

With 3 X PT-100 (normally not in used)

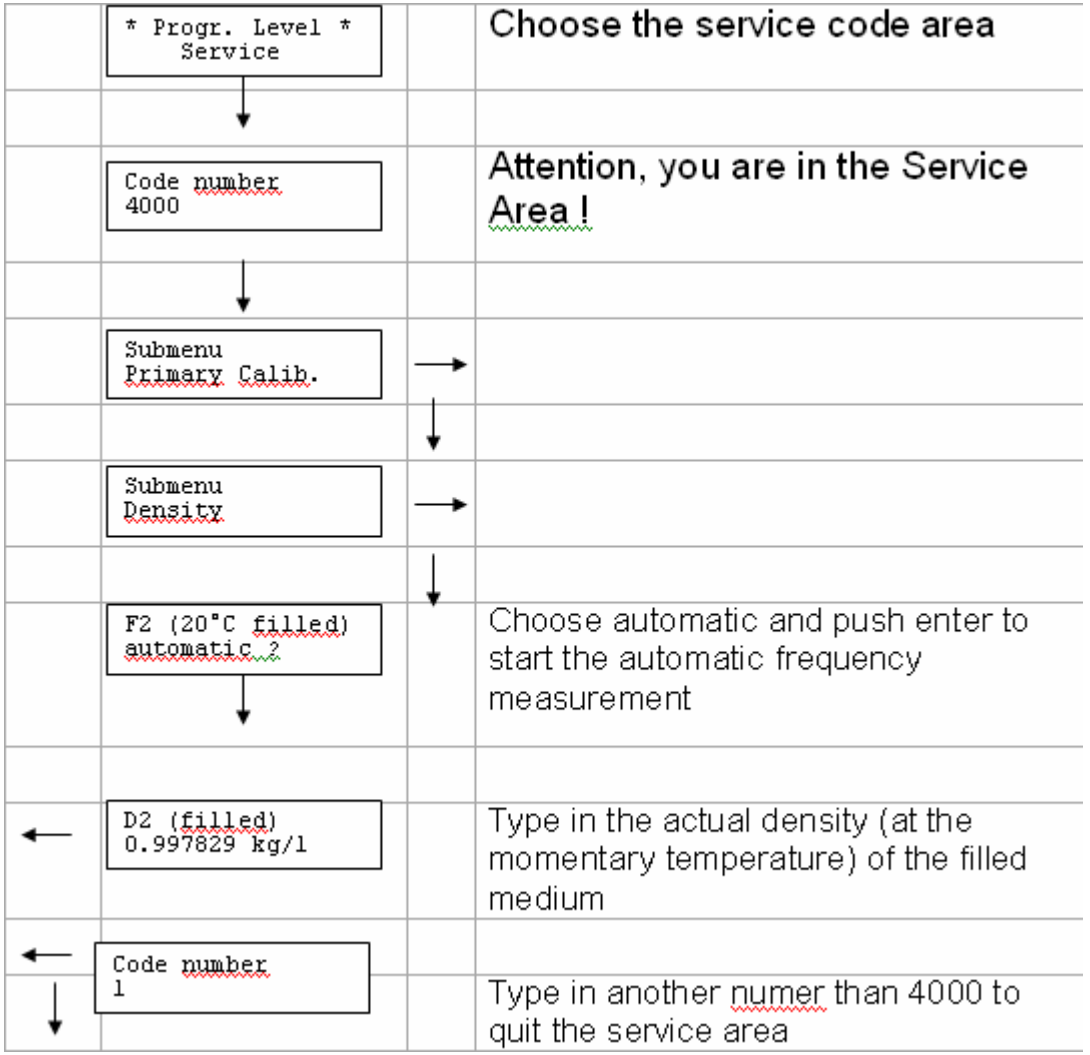
IT+ = 95	**IT- & UT- = 0 d**
IT- = 96	**UT- & IT+ = 110 d**
UT+ = 93	**IT+ & IT- = 110 d**
UT- = 94	**UT+ & IT+ = 220 d**
	UT+ & UT- = 330 d
	UT+ & IT- = 330 d

Density correction



Density calibration on site

- Conditions on site:
  - Filled pipes
  - Stable temp.
  - Known density in the pipe
  - Data storage of original data



Agenda

1. Startup / Calibration
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Common Problems

- Installation problems:
  - Air in medium (gas phase, bubbles etc.)
    -> air must be avoided, maybe vertical installation
    -> increase backpresure (data sheet: at least 0.2bar)
    -> Check driver current and density – may not be stable (service code requ.)
    -> medium might develop gas phase under certain conditions (no flow, high temp. etc.) -> turn meter 90° might help, if connect. Box was on top
  - Process vibrations
    - Problem only in case of process noise = resonance frequency
      -> compensators for damping process noise, for all fittings and support of meter
      -> good support of meter directly in font and behind of fitting
- Process problems:
  - Piston pumps: creating noise at resonance frequency
  - Sedimentation: cleaning of meter might be required
  - Abrasion: flow velocity not more than 1m/s (3.3ft/sec), vertical installation

ABB

Common problems

- Electrical problems:
  - Ensure correct grounding of meter (primary and converter)
  - Check outputs with simulation mode
  - Impuls outputs: check jumper for activ / passiv (Eex: jumper on position activ, although working as passiv)
  - Faulty sensor amplitudes / reverse measurement / Temp. Measurement
    - Check sensor amplitudes on display (service code 4000 requ.)
    - Coils / PT100 may be broken -> Check resistance
    - Wrong values: meter must be sent to Göttingen factory

ABB

Agenda

1. Startup / Calibration
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5. **Service Connector**
6. Contact

Bootloader: Tasks and Advantages

- Advantages in opposite to „normal“ eproms
  - Very fast software update
  - No replacement of the old eprom
  - No additional hardware costs for a software update
  - Update can sent via E-Mail

- Tasks
  - Load new converter programs into flash memory
  - Start up the real converter program
  - Store converter data and store process data

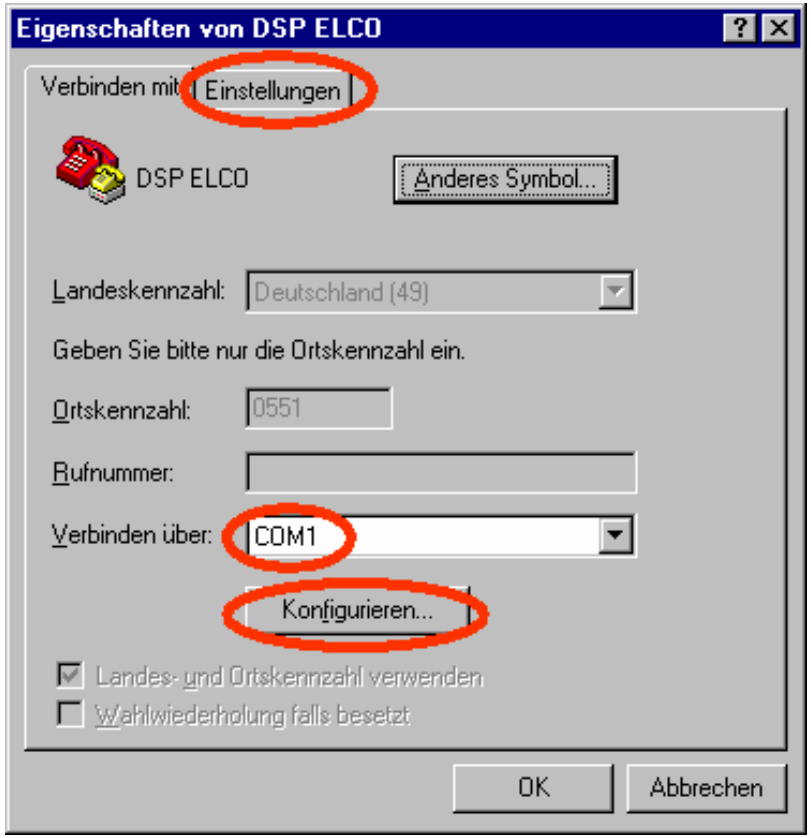
ABB

Bootloader: Before starting a Software Update

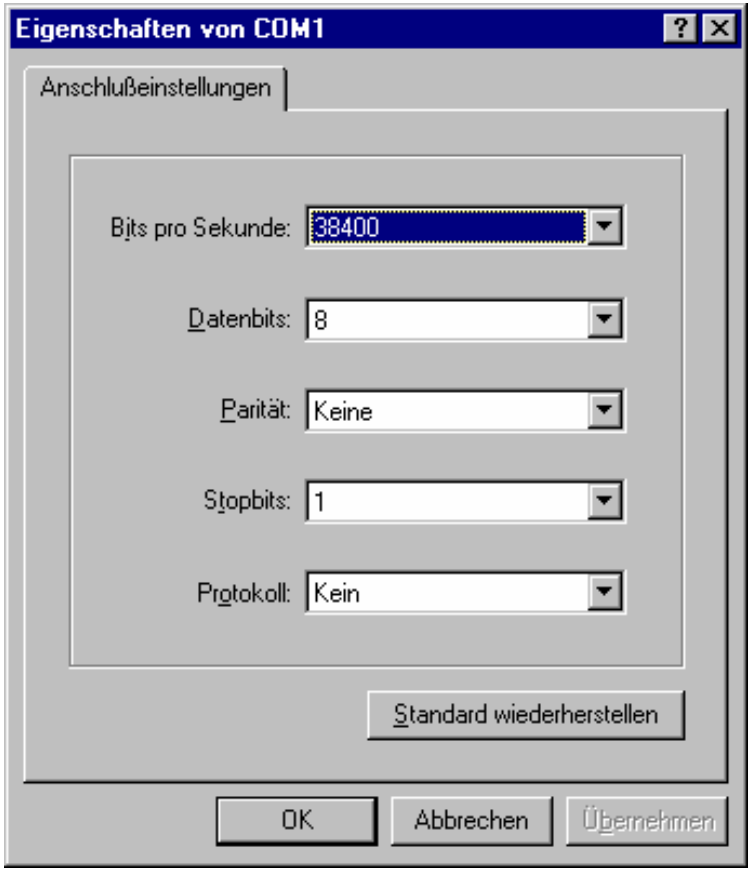
- You need
  - Computer with a terminal program (for example HyperTerminal)
  - TTL-Box
  - New converter program
- You have to
  - Connect the TTL-Box to the computer and to the service connector of the converter
  - Start the terminal program with appropriate settings

3x11
Service Connector

Bootloader: Terminal Settings (HyperTerminal)



Bootloader: Terminal Settings (HyperTerminal)



possible Baudrates:

2400 bit/s

4800 bit/s

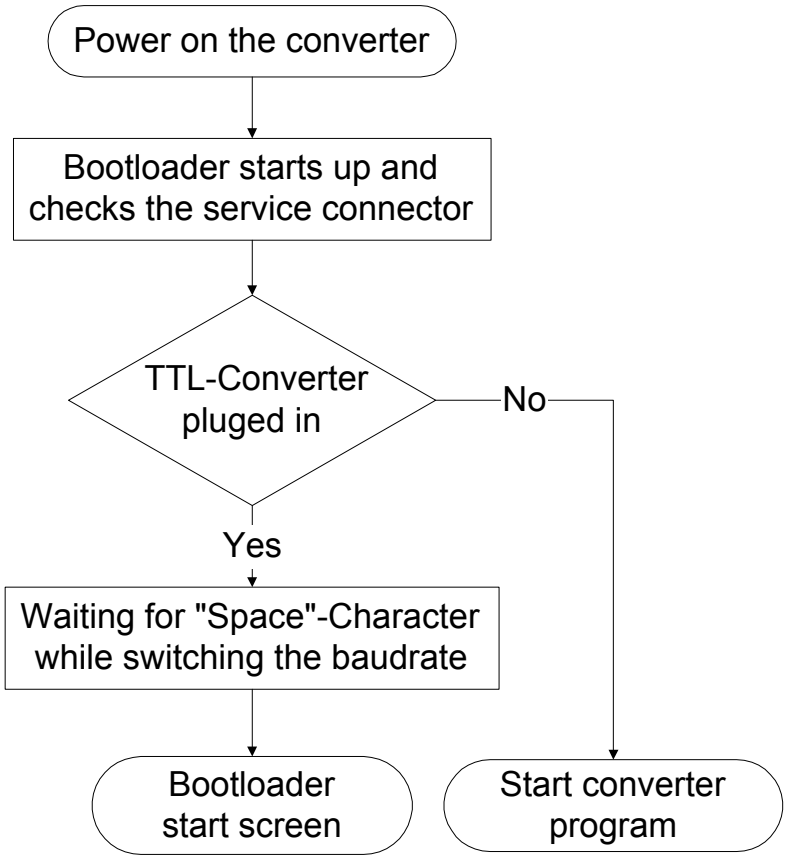
9600 bit/s

19200 bit/s

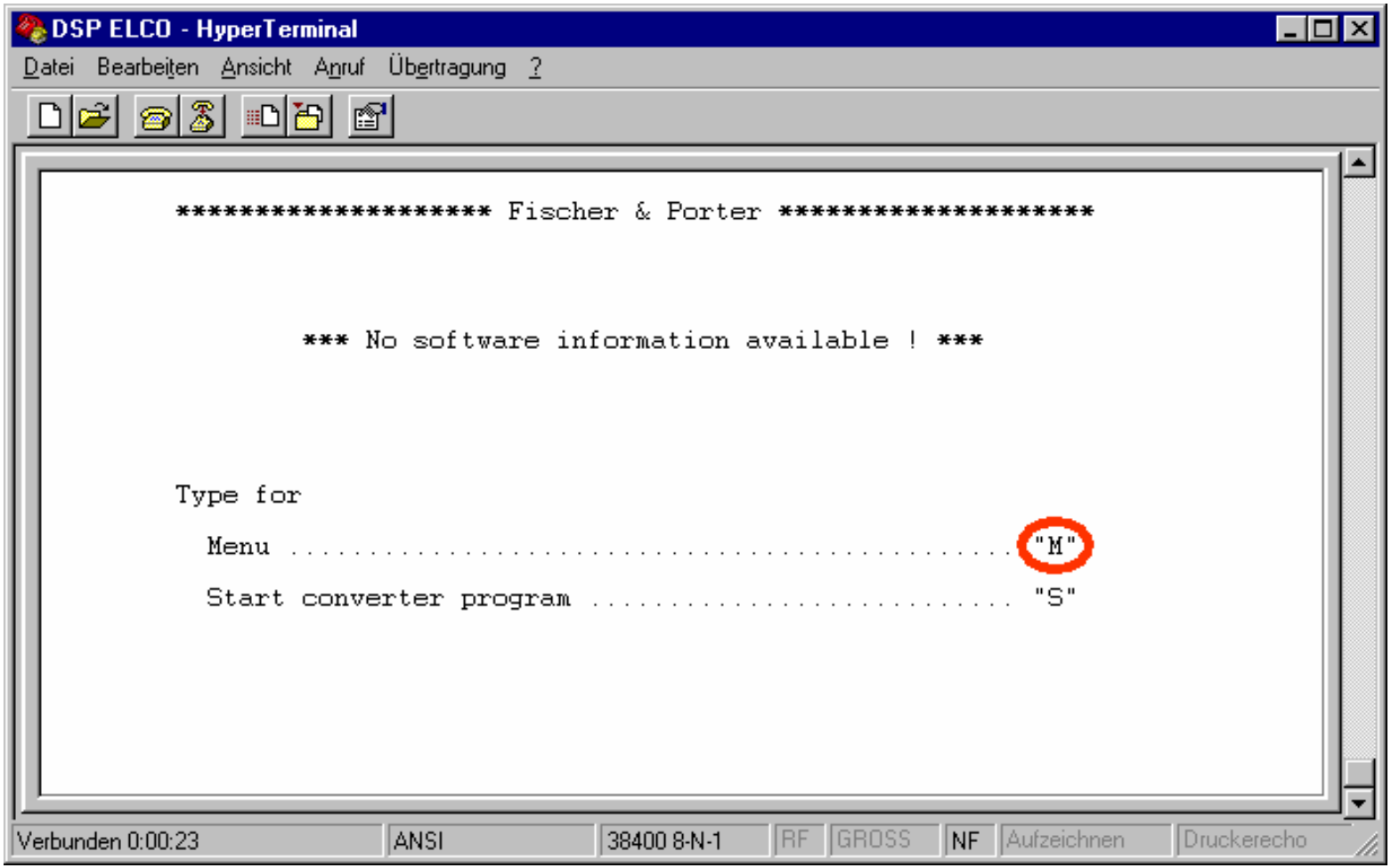
38400 bit/s

57600 bit/s

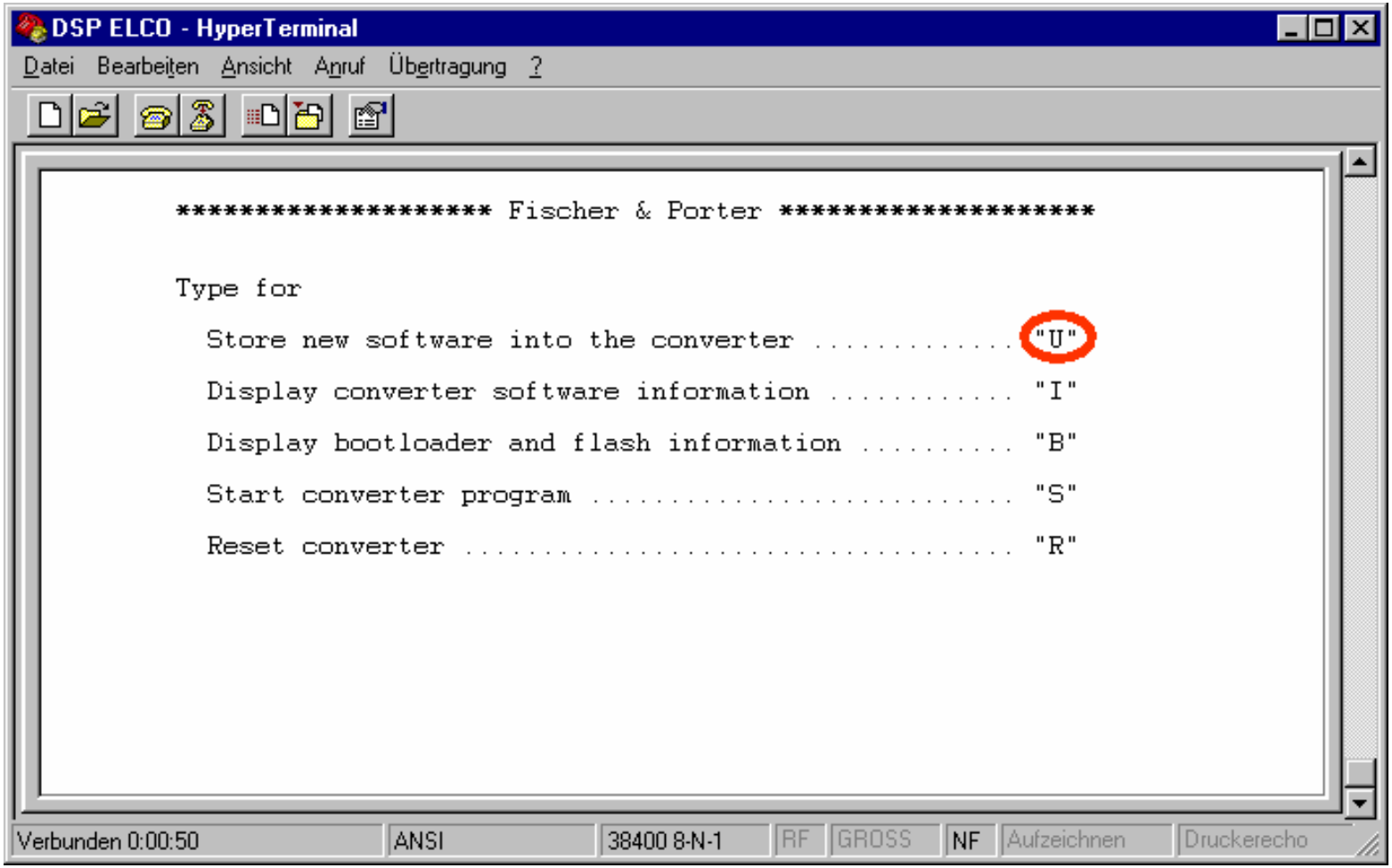
Bootloader: Start



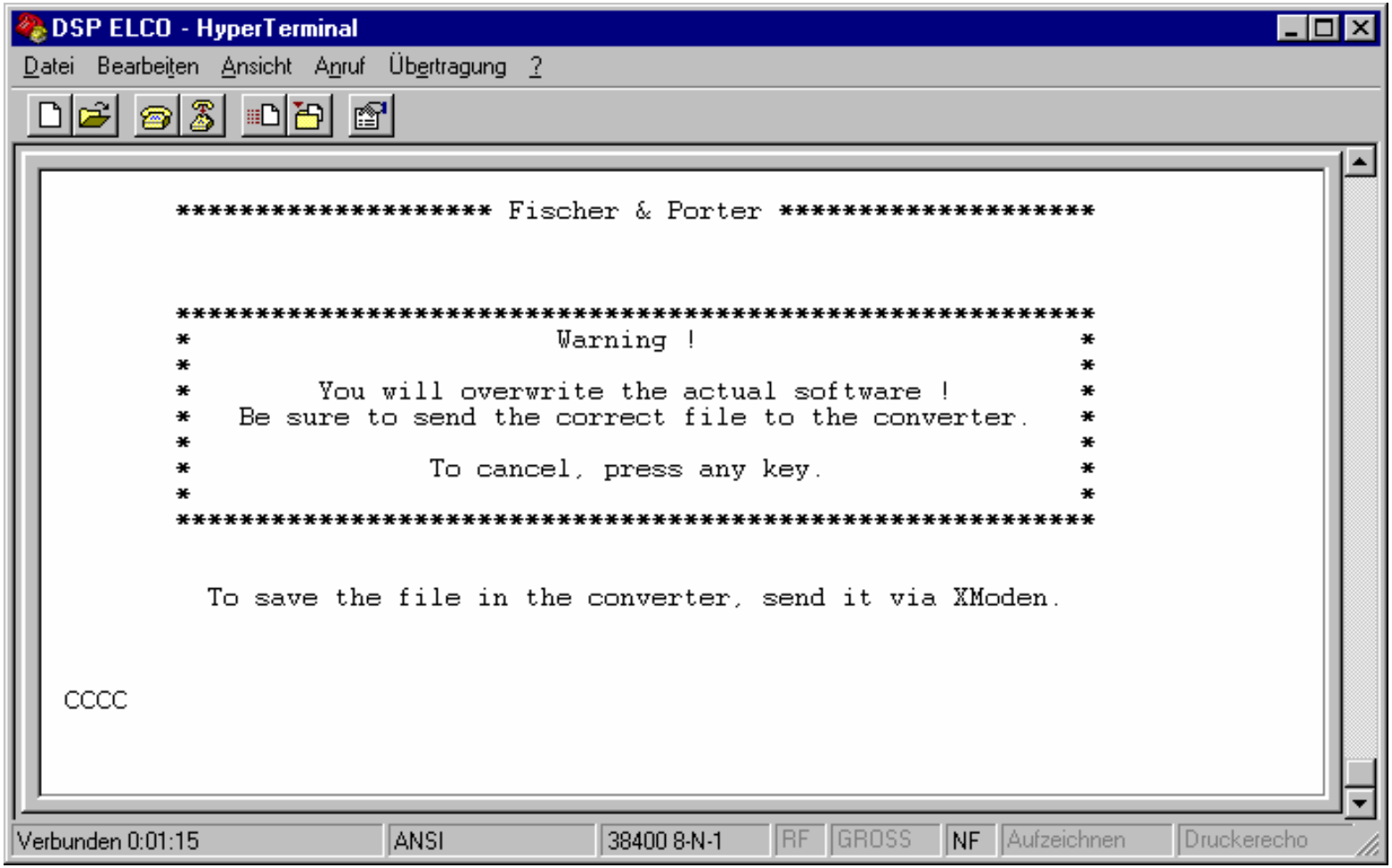
Bootloader: Start Screen



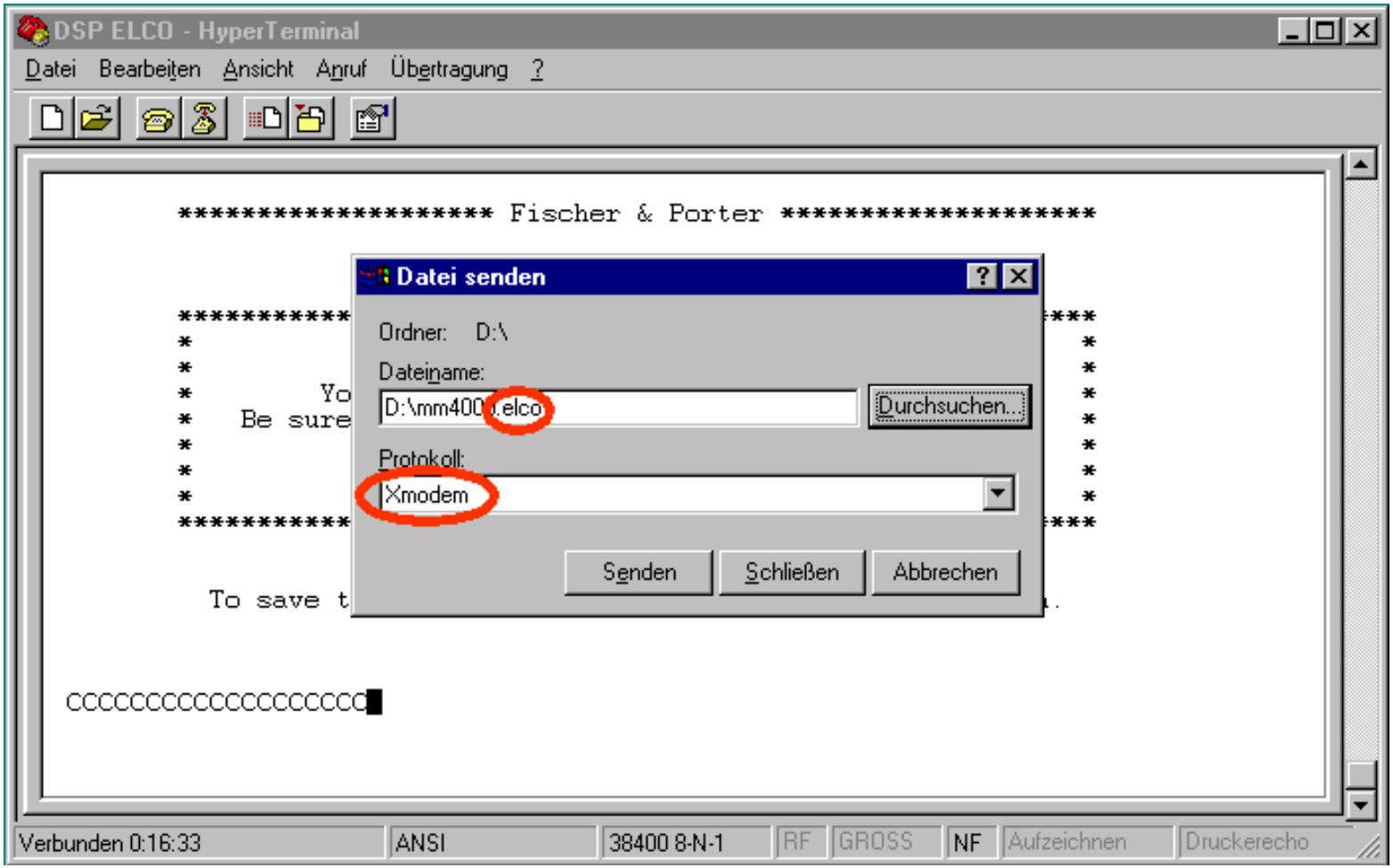
Bootloader: new software



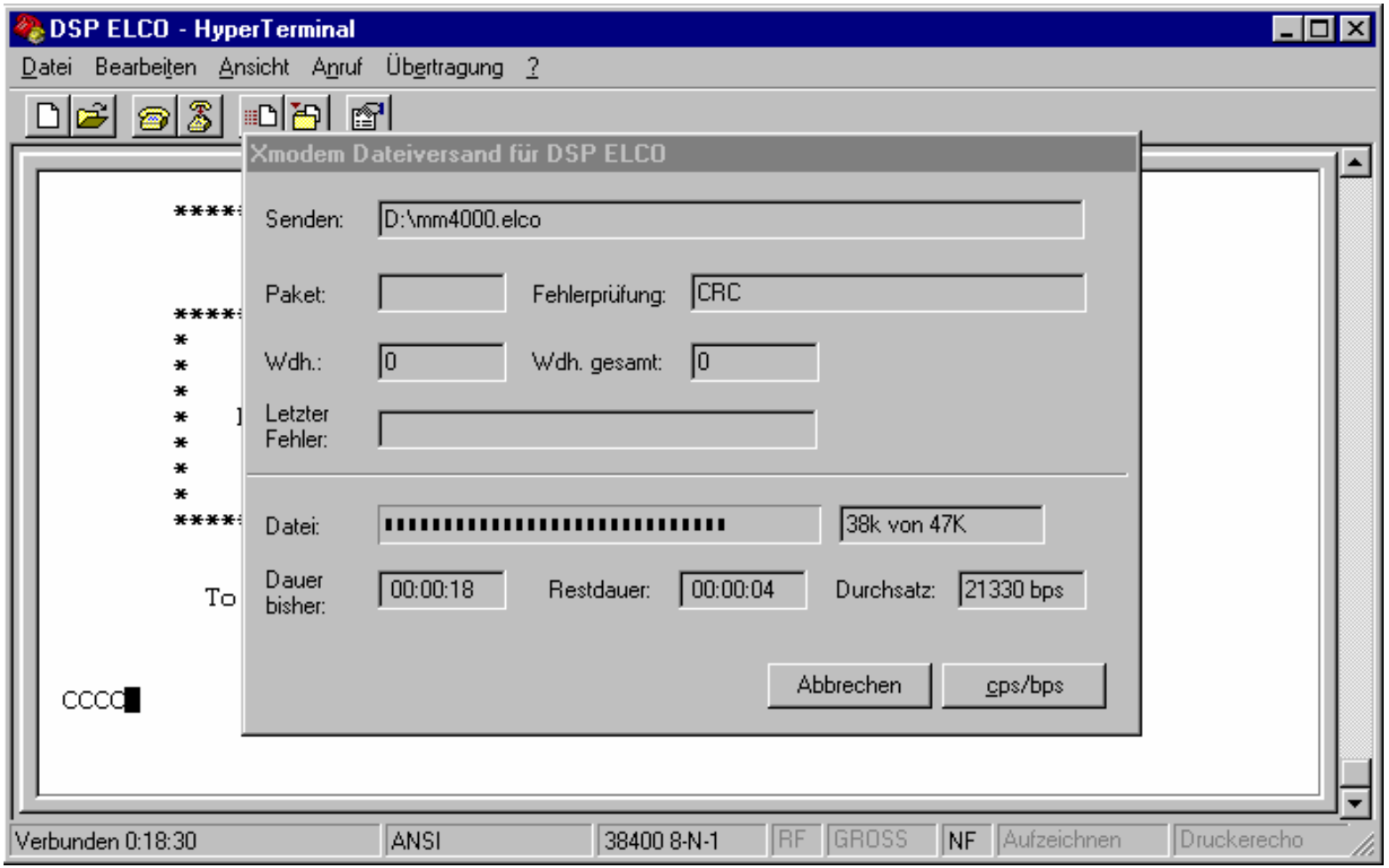
Bootloader: new software



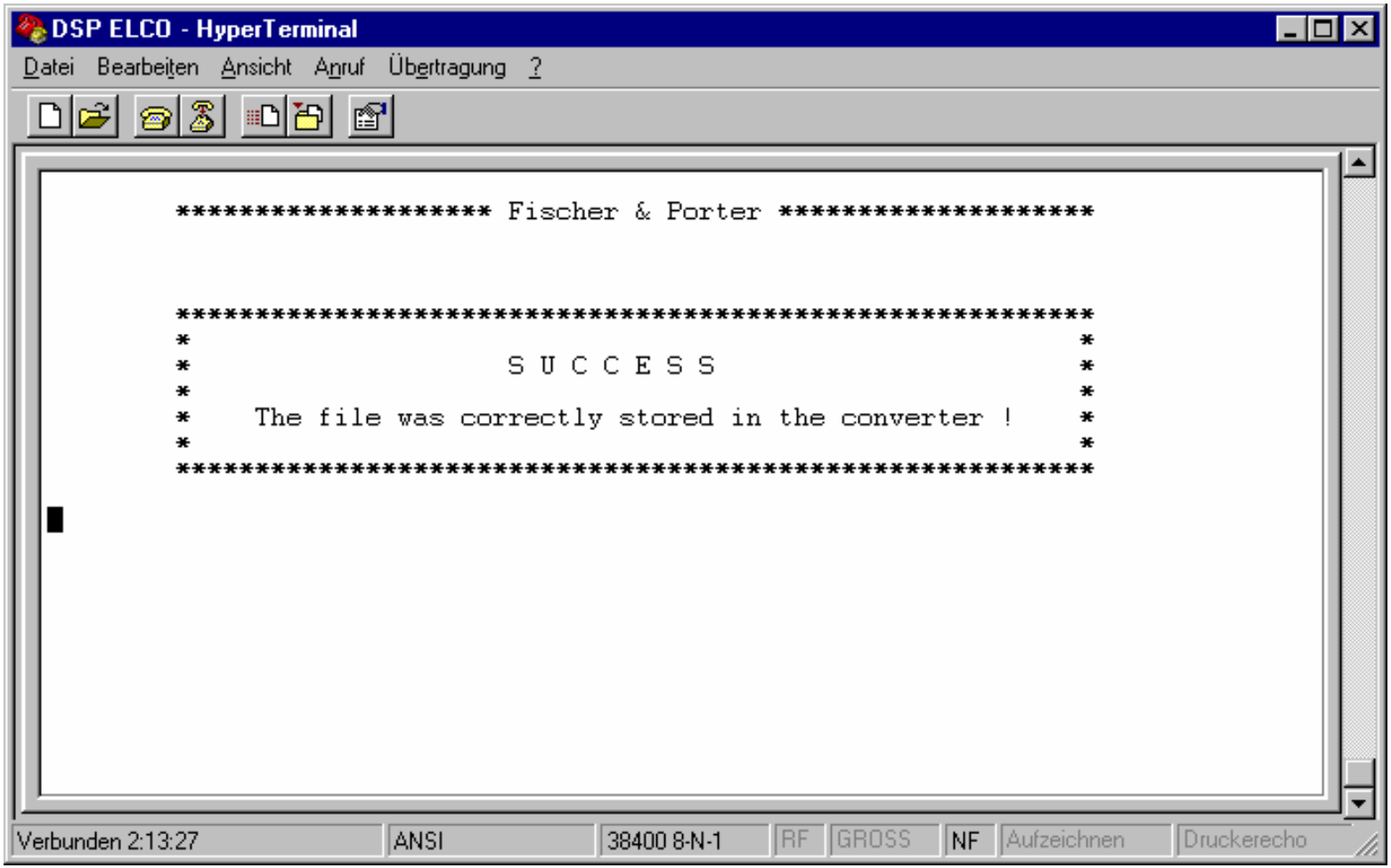
Bootloader: File Transfer Menu



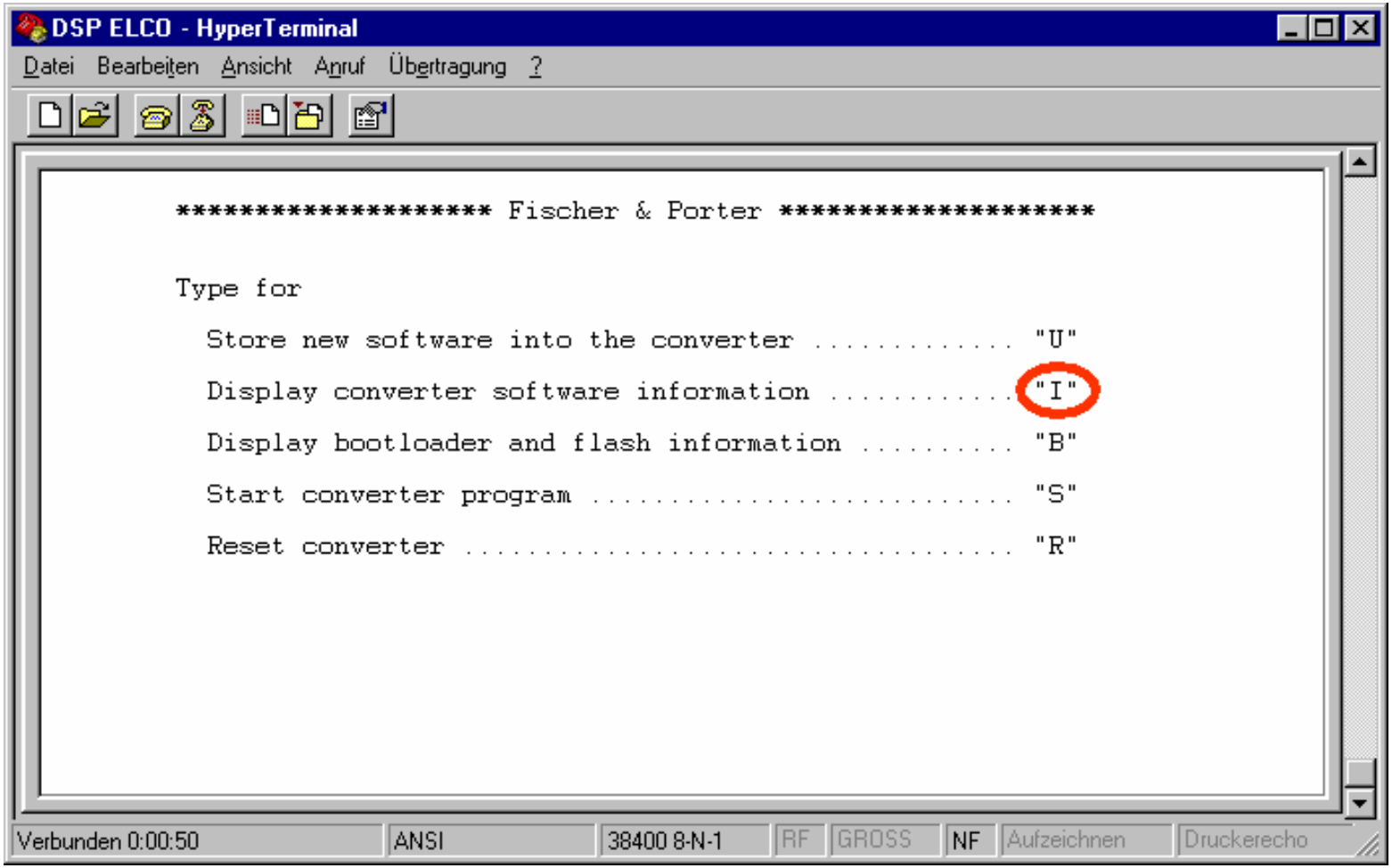
Bootloader: File Transfer



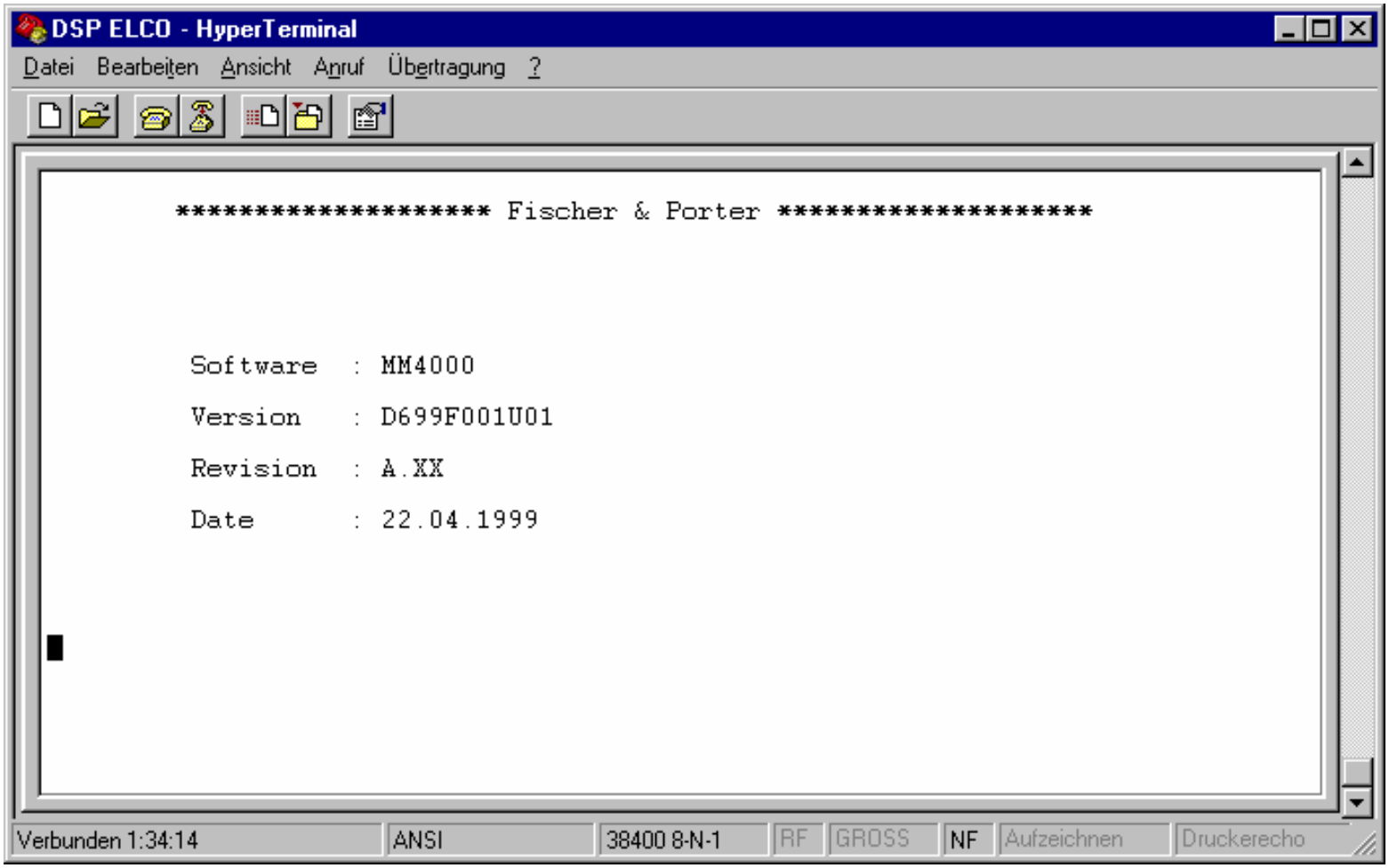
Bootloader: new software



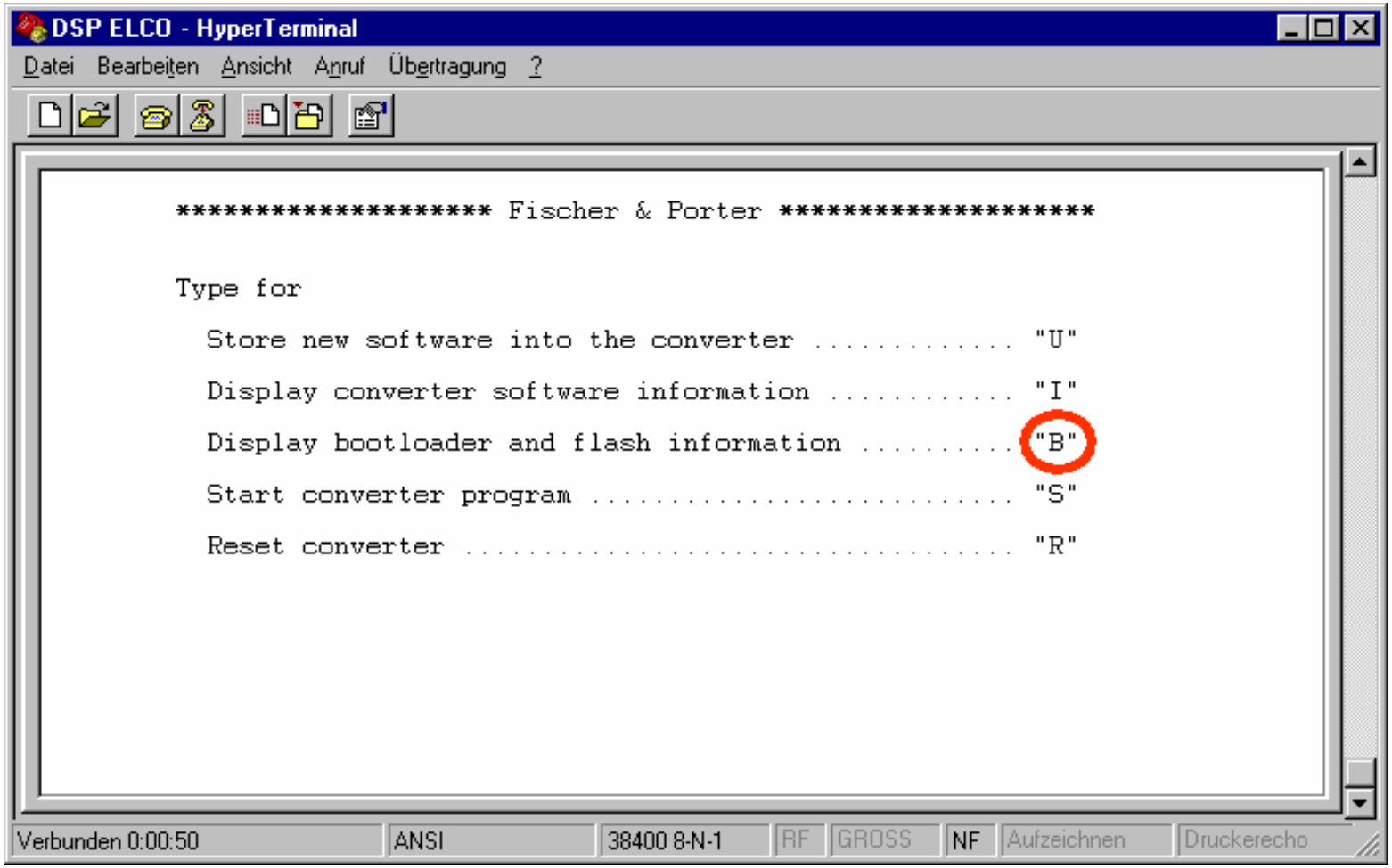
Bootloader: new software



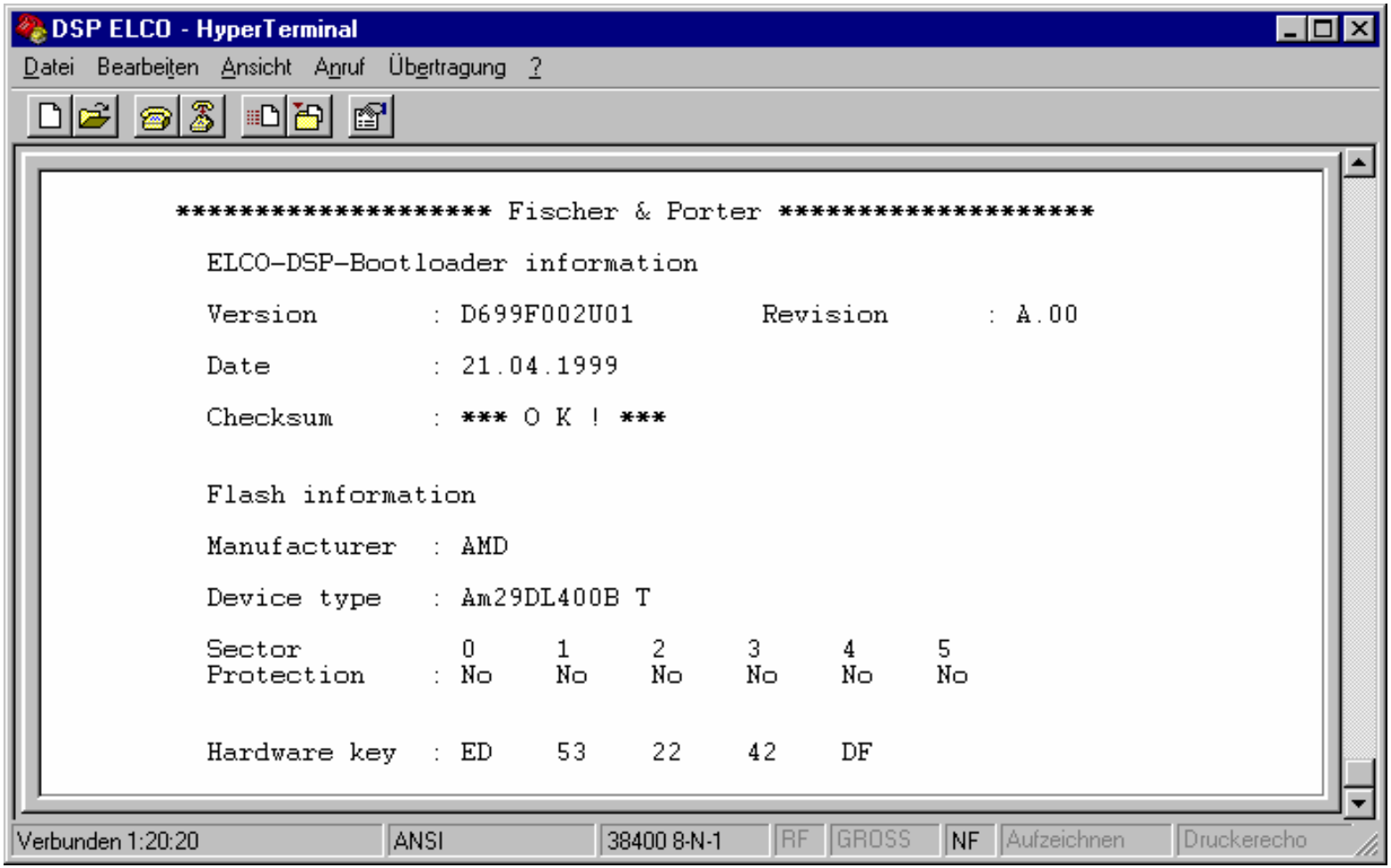
Bootloader: Software Information



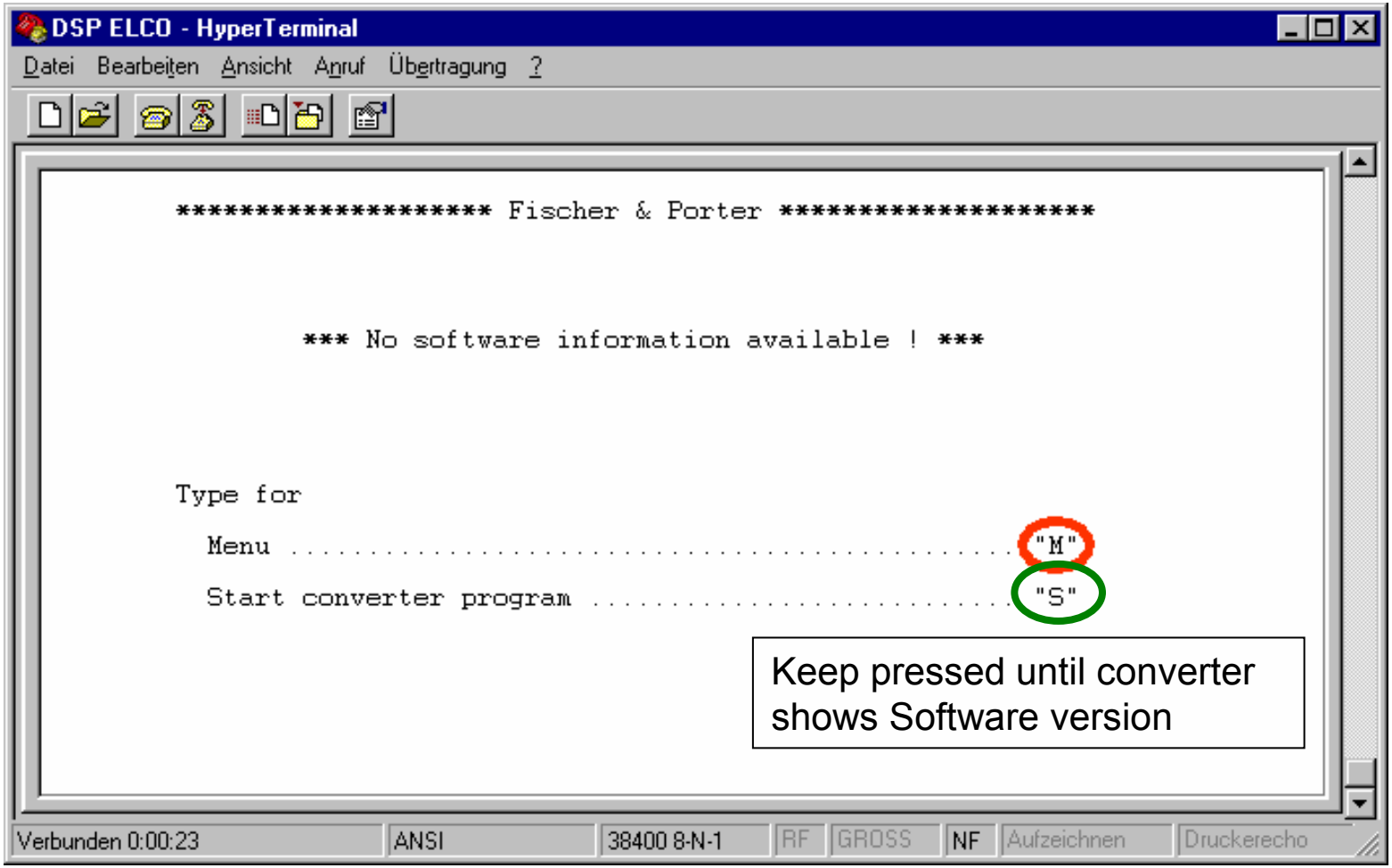
Bootloader: Check Flash



Bootloader and Flash Information

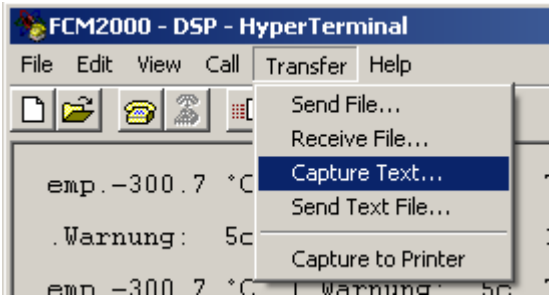


Bootloader: Converter access

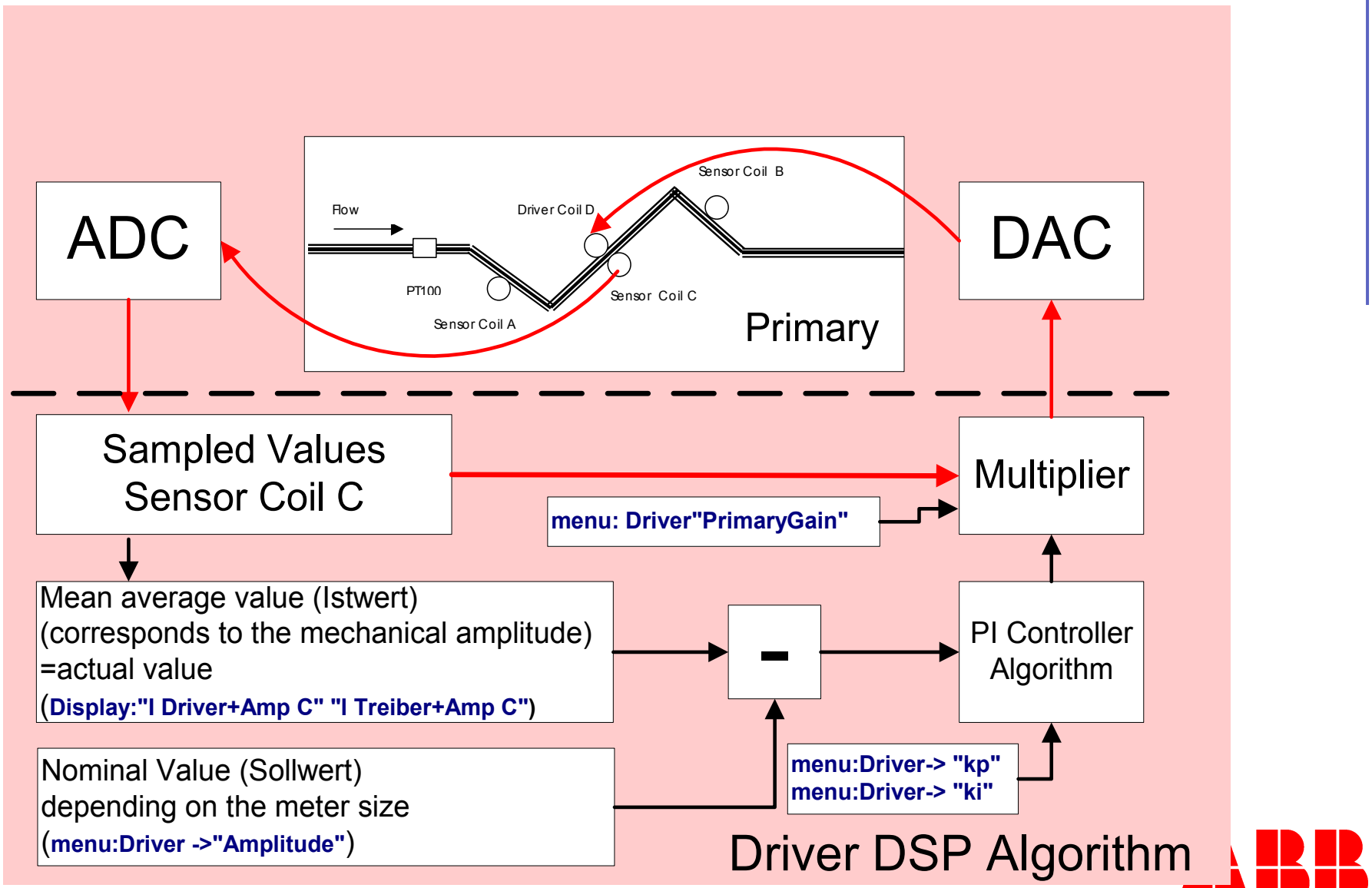


Bootloader: Converter access

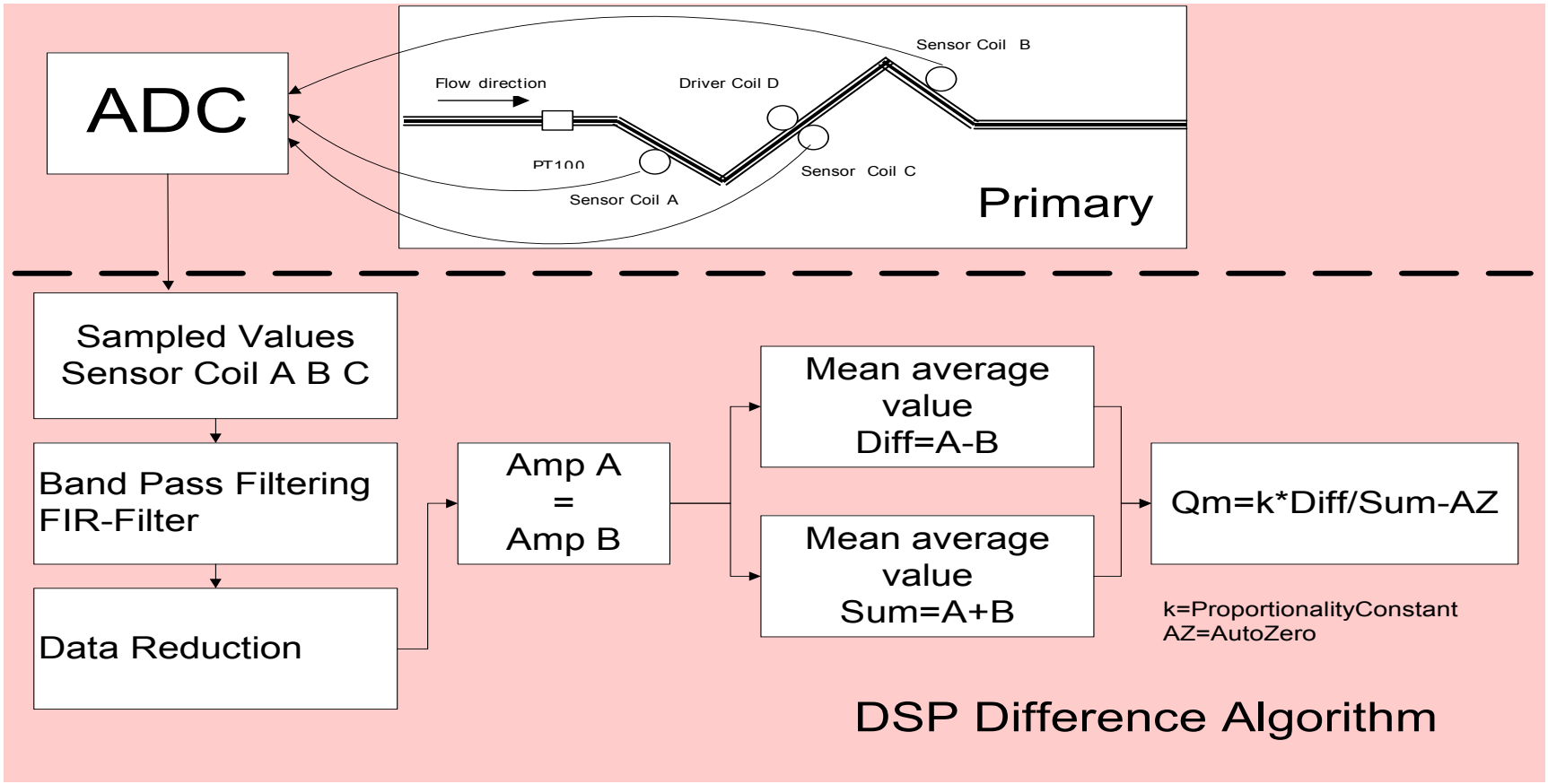
- Access converter through following keys:
  - „tab“, equ, to C/CE on converter
  - Arrow keys: up and down
  - Return key
  - Number keys
- Data storage:
  - First choose Transfer -> Capture Text
  - Choose in converter menu „output data“ variables to be stored
  - Start capture with „CTRL O“



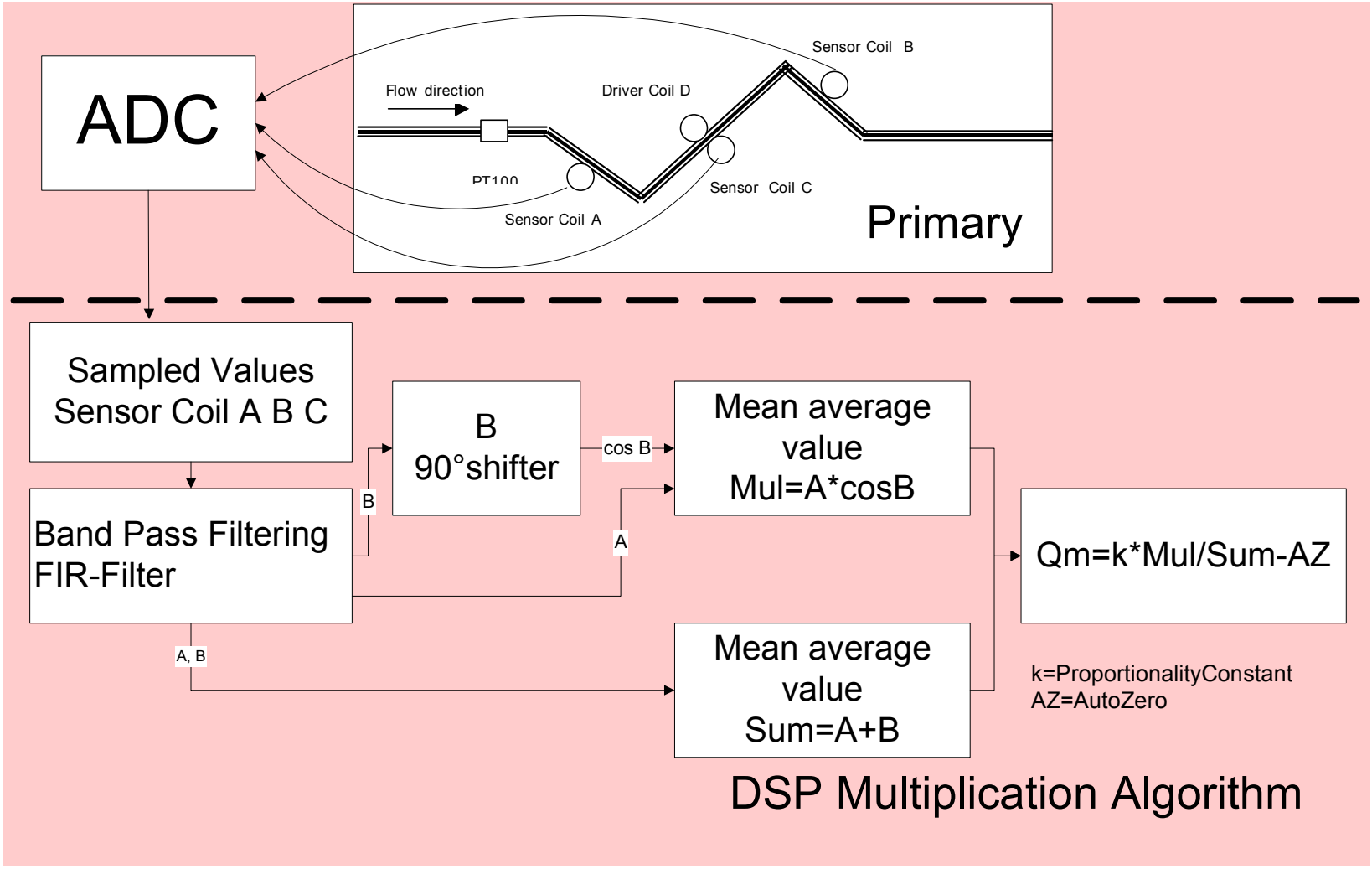
DSP: Driver Algorithm



DSP: Sensor Difference Algorithm



DSP: Sensor Multiplication Algorithm



Appendix A: Design Documents

Einschub U-Gross	Standard HART RS_485 EEx EEx HART	D674A848U01 D674A848U02 D674A848U03 D674A848U04 D674A848U05		
Einschub 24V	Standard HART RS_485 EEx EEx HART	D674A849U01 D674A849U02 D674A849U03 D674A849U04 D674A849U05		
DSP Board		D685A956U03	Leiterplatte Bauanweisung Schaltplan	D358E872U01 BA-50-0816 SP-50-1742
Front End Board		D685A959U03	Leiterplatte Bauanweisung Schaltplan	D358E870U01 BA-50-0810 SP-50-1741
Power Supply Board	U-Gross U-Gross EEx 24V 24V EEx	D685A971U03 D685A971U04 D685A971U05 D685A971U06	Leiterplatte Bauanweisung Schaltplan	D358E877U01 BA-50-0835 SP-50-1744
I/O Board	Standard HART RS_485	D685A972U04 D685A972U05 D685A972U06	Leiterplatte Bauanweisung Schaltplan	D358E896U01 BA-50-0839 SP-50-1745
EEx Board	Standard FM-Zulassung	D685A964U03 D685A964U04	Leiterplatte Bauanweisung Schaltplan	D358E884U01 BA-50-0827 SP-50-1750
Displayplatte („XE“)		D685A667U15	Leiterplatte Bauanweisung Schaltplan	D358E691U01 BA-50-0838 SP-50-1615
Backplane Board*	Standard EEx	D685A986U03 D685A986U04	Leiterplatte Bauanweisung Schaltplan	D358E896U01 BA-50-0859 SP-50-1760
EMV Board*		D685A987U03	Leiterplatte Bauanweisung Schaltplan	D358E895U01 BA-50-0860 SP-50-1759
Baugruppe: *EMV+Backplane	Standard EEx	D682A009U01 D682A009U02	EMV Board Backplane Board Bauanweisung	D685A987... D685A986... BA-50-0861
FRAM Board		D685A999U01	Leiterplatte Bauanweisung Schaltplan	D358E892U01 BA-50-0848 SP-50-1758

Agenda

1. Startup / Calibration
2. Technical Details
3. Where can I measure what?
4. Common problems
5. Service Connector
6. Contact

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