FLUKE®

Fluke 433/434

Three Phase Power Quality Analyzer

Service Manual

PN 4822 872 05392
February 2005

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Chapter 1
Safety Instructions

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1.1 Introduction

Read these pages carefully before beginning to install and use the Analyzer.

The following paragraphs contain information, cautions and warnings which must be followed to ensure safe operation and to keep the Analyzer in a safe condition.

Warning

Servicing described in this manual is to be done only by qualified service personnel. To avoid electrical shock, do not service the Analyzer unless you are qualified to do so.

1.2 Safety Precautions

For the correct and safe use of this Analyzer it is essential that both operating and service personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the Analyzer.

1.3 Caution and Warning Statements

Caution

Used to indicate correct operating or maintenance procedures to prevent damage to or destruction of the equipment or other property.

Warning

Calls attention to a potential danger that requires correct procedures or practices to prevent personal injury.

1.4 Symbols

The following symbols are used on the Analyzer, in the Users Manual, in this Service Manual, or on spare parts for this Analyzer.

	See explanation in Users Manual		DOUBLE INSULATION (Protection Class)
	Live voltage		Earth Ground
	Static sensitive components (black/yellow).	Ni MH	Recycling information
	Disposal information		Conformité Européenne
	Safety Approval		Safety Approval

1.5 Impaired Safety

Whenever it is likely that safety has been impaired, the Analyzer must be turned off and disconnected from line power. The matter should then be referred to qualified technicians. Safety is likely to be impaired if, for example, the Analyzer fails to perform the intended measurements or shows visible damage.

1.6 General Safety Information

Warning

Removing the Analyzer covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to life.

The Analyzer shall be disconnected from all voltage sources before it is opened.

Capacitors inside the Analyzer can hold their charge even if the Analyzer has been separated from all voltage sources.

When servicing the Analyzer, use only specified replacement parts.

Chapter 2
Characteristics

2.1 Introduction

Performance Characteristics

Fluke guarantees the properties expressed in numerical values within the tolerances stated. Numerical values without tolerances are typical and represent the characteristics of an average instrument excluding accessories. The Analyzer meets the specified accuracy 30 minutes and two complete acquisitions after power-on. All operational specifications are valid under the restrictions mentioned in section 'Environmental' unless otherwise specified.
Specifications are based on a one year calibration cycle.

Environmental Data

The environmental data mentioned in this manual are based on the results of the manufacturer's verification procedures.

Safety Characteristics

The Analyzer has been designed and tested in accordance with standard EN61010-1 2nd edition (2001), Safety Requirements for Electrical Equipment for Measurements Control and Laboratory Use for Class III Pollution Degree 2 instruments.

This manual contains information and warnings that must be followed by the user to ensure safe operation and to keep the Analyzer and its accessories in a safe condition.

Use of this Analyzer and its accessories in a manner not specified by the manufacturer may impair the protection provided by the equipment.

2.2 Electrical Measurements

The following specifications of the instrument are verified using the "implementation verification" table 3 as specified in 61000-4-30 chap-6-2.

2.2.1 Frequency Measurement

Selected Nominal Frequency (Fnom)	Measurement Range	Resolution	Accuracy
50 Hz	42.50 ... 57.50 Hz	0.01 Hz	± 0.1 % of Fnom
60 Hz	51.00 ... 69.00 Hz	0.01 Hz	± 0.1 % of Fnom

Note: measured on Reference Voltage Input A/L1.

2.2.2 Voltage Measurements

Voltage Inputs

Item	Specification	Additional Information
Nominal voltage input range of Vnom (Nominal voltage)	60 V-500 V	Internal divided in three ranges 500 V, 250 V, 125 V
Voltage Scaling factor (Vscale) (display only)	1:1, 10:1, 100:1, 1000:1 variable: xxxx : yyy	All displayed Voltage results are multiplied by the selected Vscale factor.
Numbers of inputs	4	L1/L2/L3 and N(neutral) banana inputs
Input impedance	4 Mohm // 5 pF	
Max range	0 %-200 %	% of selected Vnom
Max continuous input voltage	1000 Vrms	This is an overload in all ranges except 500V
Max Vpeak input voltage within dynamic range	≥ ±2,8x selected Vnom	
Absolute max Vpeak input voltage	6 kV	Max 1,2/50us ;these voltage input pulse is out of dynamic range
Bandwidth	>10 kHz	
Crosstalk between Voltage channels (L1/L2/L3/N)	-60 dB	@ 42,5-67Hz (measured channel grounded)
Crosstalk between Voltage and Current channels	-95 dB	

Note: all following Voltage specifications are based on a Voltage Scaling Factor of 1:1, unless otherwise indicated.

RMS Voltage

Selected Nominal Voltage (Vnom)	Measurement Range (CF ≤ 1.4 at full scale)	Resolution	Accuracy
60 ... 125 Vrms	1.0 ... 250.0 Vrms	0.1 Vrms	± 0.5 % of Vnom
125 ... 250 Vrms	1.0 ... 500.0 Vrms	0.1 Vrms	± 0.5 % of Vnom
250 ... 500 Vrms	1.0 ... 999.9 Vrms	0.1 Vrms	± 0.5 % of Vnom

Peak Voltage

Selected Nominal Voltage (Vnom)	Measurement Range (CF ≤ 1.4 at full scale)	Resolution	Accuracy
60 ... 125 Vrms	0 ... 350 V	1 V	± 5 % of Vnom
125 ... 250 Vrms	0 ... 700 V	1 V	± 5 % of Vnom
250 ... 500 Vrms	0 ... 1400 V	1 V	± 5 % of Vnom

Voltage Crest Factor

Condition	Measurement Range	Resolution	Accuracy
Umeas ≈ Vnom	1.0 ... 2.8	0.1	± 5 %

Harmonic and Interharmonic Voltages

Settings	Range	Additional Information
Harmonic selection (n):	DC, 1 ... 50	Grouping: Harmonic Groups according to IEC61000-4-7
Interharmonic selection:	OFF, 1 ... 49	Grouping: Harmonic and Interharmonic Subgroups according to IEC61000-4-7
Amplitude Reference	total RMS / fund. RMS	Used for Relative Amplitude
THD	% total / % fundamental	based on H1 ... H40

Measurement	Measurement Range	Resolution	Accuracy
Relative Amplitude	0.0 ... 100.0 %	0.1 %	± 0.1 % ± n x 0.1 %, (±0.4% for %r)
Absolute Amplitude Vnom: 60 ... 125 Vrms Vnom: 125 ... 250 Vrms Vnom: 250 ... 500 Vrms	 0.0 ... 250.0 Vrms 0.0 ... 500.0 Vrms 0.0 ... 999.9 Vrms	0.1 Vrms	± 5 % of meas ± 2 counts
Phase	-360º ... +360º	1º	± n × 1.5º
Frequency	0 ... 3500 Hz	1 Hz	± 1Hz
THD	0.0 ... 100.0 %	0.1 %	± 2.5 %
DC relative absolute	0.0 ... 100.0 % 0.0 ... 100.0 V	0.1 % 0.1 V	± 1 % ± 5 % of meas ± 10 counts

Voltage Dips

Settings	Adjustment Range	Resolution	Additional Information
Dip Threshold level	50.0 ... 100.0 % of Vnom	0.1 %	results based on ½ cycle rms
Dip Hysteresis level	0.0 ... 10.0 % of Vnom	0.1 %	

Measurements	Measurement Range	Resolution	Accuracy
Dip Magnitude	0.0 % ... 100.0 % of Vnom	0.1 %	± 1 % of Vnom
Dip Duration	hhh,mm,ss,mmm	10 ms	± 20 ms (at F=50 Hz)

Voltage Swells

Settings	Adjustment Range	Resolution	Additional Information
Swell Threshold level	100.0 ... 200.0 % of Vnom	0.1 %	results based on ½ cycle rms
Swell Hysteresis level	0.0 ... 10.0 % of Vnom	0.1 %	

Measurements	Measurement Range	Resolution	Accuracy
Swell Magnitude	100.0 %...200.0 % of Vnom	0.1%	± 1 % of Vnom
Swell Duration	hhh,mm,ss,mmm	10 ms	± 20 ms (at F= 50 Hz)

Voltage Interrupts

Settings	Adjustment Range	Resolution	Additional Information
Interrupt Threshold level	0.0 ... 50.0 % of Vnom	0.1 %	results based on ½ cycle rms
Interrupt Hysteresis level	0.0 ... 10.0 % of Vnom	0.1 %	

Measurements	Measurement Range	Resolution	Accuracy
Interrupt Magnitude	0.0 % ... 100.0 % of Vnom	0.1 %	± 1 % of Vnom
Interrupt Duration	hhh:mm:ss:mmm	10 ms	± 20 ms (at F= 50 Hz)

Voltage Unbalance

Measurements	Measurement Range	Resolution	Accuracy
Negative Unbalance Ratio	0.0 ... 5.0 %	0.1 %	± 0.5 %
Zero Unbalance Ratio	0.0 ... 5.0 %	0.1 %	± 0.5 %

Rapid Voltage Changes

Settings	Adjustment Range	Resolution	Additional Information
Steady Voltage Tolerance	0.0 ... 10.0 % of Vnom	0.1 %	results based on ½ cycle rms
Minimum Steady Time	0.0 ... 10.0 s	0.1 s	
Minimum Voltage Difference	0.0 ... 10.0 % of Vnom	0.1 %	
Minimum Rate of Change	0.0 ... 10.0 %/s of Vnom	0.1 %/s	

Measurements	Measurement Range	Resolution	Accuracy
Steady Voltage Difference	0.0 ... 100.0 % of Vnom	0.1 %	± 1 % of Vnom

Transient Voltages

Settings	Range	Additional Information
Transient Capture Threshold	0 ... 999 % of Vnom	Percentual deviation from the repetitive waveform

Measurements	Measurement Range	Resolution	Accuracy
RMS voltage in Transient Function	10 ... 1000 Vrms	1 Vrms	± 2.5 % of Vnom
Transient voltage (TTRANS > 10 μs)	0 ... ± 6000 Vpeak	1 V	± 15 % of meas

Flicker

Settings	Adjustment Range	Resolution	Additional Information
Steady Voltage Tolerance	0.0 ... 10.0 % of Vnom	0.1 %	
Minimum Steady Time	0.0 ... 10.0 s	0.1 s	
Maximum Deviation Threshold	0.0 ... 10.0 % of Vnom	0.1 %	

Measurement	Measurement Range	Resolution	Accuracy
PF5	0.00 ... 20.00	0.01	Within ±5 % of tabulated values according IEC61000-4-15
P1min	0.00 ... 20.00	0.01	
Pst	0.00 ... 20.00	0.01	
Plt	0.00 ... 20.00	0.01	
Dc	0.0 ... ± 100.0 %	0.1 %	± 1 % (if Umeas ≈ Vnom)
DMAX	0.0 ... ± 100.0 %	0.1 %	± 1 % (if Umeas ≈ Vnom)
TDEX	0.000 ... 9.999 s	10 ms	20 ms (at F = 50 Hz)

2.2.3 Current Measurements

Current Inputs

Item	Specification	Additional Information
⚠ Nominal input Range	0 - ±5.625 Vpeak	0 - 3.97 Vrms sinewave
Current Clamp Sensitivity	0.1 , 1, 10, 100, 1000 mV/A variable:	
Input impedance	50 k.ohm	
Bandwidth	>10 kHz	
Voltage resolution	1 mV	

RMS Current

Selected Clamp Sensitivity	Measurement Range (CF ≤ 2.8 at full scale)	Resolution	Accuracy (excl. Clamp error)
0.1 mV/A	0.00 ... 20.00 kArms	10 Arms	± 1 % of meas ± 5 counts
1 mV/A	0 ... 2000 Arms	1 Arms	
10 mV/A	0.0 ... 200.0 Arms	0.1 Arms	
100 mV/A	0.00 ... 20.00 Arms	0.01 Arms	
1 V/A	0.000 ... 2.000 Arms	0.001 Arms	

Harmonic Currents

Settings	Range	Additional Information
Harmonic selection (n):	DC, 1 ... 50	Grouping: Harmonic Groups according to IEC61000-4-7
Interharmonic selection:	OFF, 1 ... 49	Grouping: Harmonic and Interharmonic Subgroups according to IEC61000-4-7
Amplitude Reference	total RMS / fund. RMS	Used for Relative Amplitude
THD	% total / % fundamental	based on H1 ... H40

Measurement	Measurement Range	Resolution	Accuracy (excl. Clamp error)
Relative Amplitude	0.0 ... 100.0 %	0.1 %	± 0.1 % ± n x 0.1 %
Absolute Amplitude			
0.1 mV/A	0.00 ... 20.00 kArms	10 Arms	± 5 % of meas ± 5 counts
1 mV/A	0 ... 2000 Arms	1 Arms	
10 mV/A	0.0 ... 200.0 Arms	0.1 Arms	
100 mV/A	0.00 ... 20.00 Arms	0.01 Arms	
1 V/A	0.000 ... 2.000 Arms	0.001 Arms	
Phase	-360º ... +360º	1º	± n × 1.5º
Frequency	0 ... 3500 Hz	1 Hz	± 1 Hz
THD	0.0 ... 100.0 %	0.1 %	± 2.5 %
DC relative	0.0 ... 100.0 %	0.1 %	± 1 %
absolute	0.0 ... 100.0 V	0.1 V	± 5 % of meas ± 10 counts

Inrush Current

Settings	Adjustment Range	Resolution	Additional Information
Inrush Threshold level	0 ... 999 % of Inom	1 %	Results based on $Irms_{1/2}$
Inrush Hysteresis level	0 ... 999 % of Inom	1 %	(Itrh - Ihys > Inom)
Inrush Evaluation time	7.5 s, 15 s, 30 s, 1.5 m, 3 m, 6 m, 12 m, 30 m	fixed ranges	

Measurements	Measurement Range	Resolution	Accuracy (excl. Clamp error)
Inrush Magnitude			
0.1 mV/A	0.00 ... 20.00 kArms	10 Arms	± 1 % of meas ± 5 counts
1 mV/A	0 ... 2000 Arms	1 Arms	
10 mV/A	0.0 ... 200.0 Arms	0.1 Arms	
100 mV/A	0.00 ... 20.00 Arms	0.01 Arms	
1 V/A	0.000 ... 2.000 Arms	0.001 Arms	
Inrush Duration	mm:ss:mmm	10 ms	± 20 ms (at F = 50 Hz)
Current Magnitude			
0.1 mV/A	0.00 ... 20.00 kArms	10 Arms	± 1 % of meas ± 5 counts
1 mV/A	0 ... 2000 Arms	1 Arms	
10 mV/A	0.0 ... 200.0 Arms	0.1 Arms	
100 mV/A	0.00 ... 20.00 Arms	0.01 Arms	
1 V/A	0.000 ... 2.000 Arms	0.001 Arms	

Current Unbalance

Measurements	Measurement Range	Resolution	Accuracy (excl. Clamp error)
Negative Unbalance Ratio	0.0 ... 20.0%	0.1%	± 1%
Zero Unbalance Ratio	0.0 ... 20.0%	0.1%	± 1%

2.2.4 Power Measurement

RMS Power (Total or Fundamental)

W, VA, VAR Ranges:

	V∗1	V∗10	V∗100	V∗1000
0.1 mV/A	0.010 MW ... 9.999 MW 10.00 MW ... 20.00 MW	00.10 MW ... 99.99 MW 100.0 MW ... 200.0 MW	001.0 MW ... 999.9 MW 1000 MW ... 2000 MW	0.010 GW ... 9.999 GW 10.00 GW ... 20.00 GW
1 mV/A	001.0 kW ... 999.9 kW 1000 kW ... 2000 kW	0.010 MW ... 9.999 MW 10.00 MW ... 20.00 MW	00.10 MW ... 99.99 MW 100.0 MW ... 200.0 MW	001.0 MW ... 999.9 MW 1000 MW ... 2000 MW
10 mV/A	00.10 kW ... 99.99 kW 100.0 kW ... 200.0 kW	001.0 kW ... 999.9 kW 1000 kW ... 2000 kW	0.010 MW ... 9.999 MW 10.00 MW ... 20.00 MW	00.10 MW ... 99.99 MW 100.0 MW ... 200.0 MW
100 mV/A	0.010 kW ... 9.999 kW 10.00 kW ... 20.00 kW	00.10 kW ... 99.99 kW 100.0 kW ... 200.0 kW	001.0 kW ... 999.9 kW 1000 kW ... 2000 kW	0.010 MW ... 9.999 MW 10.00 MW ... 20.00 MW
1 V/A	001.0 W ... 999.9 W 1000 W ... 2000 W	0.010 kW ... 9.999 kW 10.00 kW ... 20.00 kW	00.10 kW ... 99.99 kW 100.0 kW ... 200.0 kW	001.0 kW ... 999.9 kW 1000 kW ... 2000 kW

W, VA, VAR Resolution and Accuracy:

	Maximum Resolution (lowest range)				Accuracy (excl. Clamp error)
	V∗1	**V∗10**	**V∗100**	**V∗1000**	
0.1 mV/A	1 kW	10 kW	100 kW	1 MW	± 1.5 % of meas ± 10 counts
1 mV/A	100 W	1 kW	10 kW	100 kW	
10 mV/A	10 W	100 W	1 kW	10 kW	
100 mV/A	1 W	10 W	100 W	1 kW	
1 V/A	0.1 W	1 W	10 W	100 W	

PF, DPF, COSΦ:

Measurement	Measurement Range	Resolution	Accuracy (excl. Clamp error)
Power Factor	0.00 ... 1.00	0.01	± 0.03
Displacement Power Factor	0.00 ... 1.00	0.01	± 0.03
COSΦ	0.00 ... 1.00	0.01	± 0.03

Harmonic Power (Watts only)

Settings	Range	Additional Information
Harmonic selection (n):	DC, 1 ... 50	Grouping: Harmonic Groups
Amplitude Reference	total Power / fund. Power	Used for Relative Amplitude
THD	% total / % fundamental	based on H1 ... H40

Measurement:	Measurement Range	Resolution	Accuracy (excl. Clamp error)
Relative Amplitude	0.0 ... 100.0 %	0.1 %	± n x 2 %
Absolute Amplitude 0.1 mV/A ... 1 V/A V∗1 ... V∗1000	as indicated under W, VA, VAR ranges	as indicated under W, VA, VAR resolution and accuracy	± 5 % ± n x 2 % of meas ± 10 counts
Phase between In - Vn	-360º ... +360º	1º	± n × 1.5º
Frequency	0 ... 3500 Hz	1 Hz	± 1Hz
THD	0.0 ... 100.0 %	0.1%	± 5 %
DC relative absolute	0.0 ... 100.0 % 0.0 ... 100.0 V	0.1 % 0.1 V	± 2 % ± 5 % of meas ± 10 counts

Energy

Whr, VAhr, VARhr Ranges:

	V*1	V*10	V*100	V*1000
0.1 mV/A	000.0 kWhr ... 200.0 GWhr	0.000 MWhr ... 2.000 TWhr	00.00 MWhr ... 20.00 TWhr	000.0 MWhr ... 200.0 TWhr
1 mV/A	00.00 kWhr ... 20.00 GWhr	000.0 kWhr ... 200.0 GWhr	0.000 MWhr ... 2.000 TWhr	00.00 MWhr ... 20.00 TWhr
10 mV/A	0.000 kWhr ... 2.000 GWhr	00.00 kWhr ... 20.00 GWhr	000.0 kWhr ... 200.0 GWhr	0.000 MWhr ... 2.000 TWhr
100 mV/A	000.0 Whr ... 200.0 MWhr	0.000 kWhr ... 2.000 GWhr	00.00 kWhr ... 20.00 GWhr	000.0 kWhr ... 200.0 GWhr
1 V/A	00.00 Whr ... 200.0 kWhr	000.0 Whr ... 200.0 MWhr	0.000 kWhr ... 2.000 GWhr	00.00 kWhr ... 20.00 GWhr
Maximum Integration Time: 9999 hours				

Whr, VAHr, Resolution and Accuracy:

	Maximum Resolution (lowest range)				Accuracy (excl. Clamp error)
	V*1	**V*10**	**V*100**	**V*1000**	
0.1 mV/A	100 Whr	1 kWhr	10 kWhr	100 kWhr	± 1.5% of meas ± 10 counts
1 mV/A	10 Whr	100 Whr	1 kWhr	10 kWhr	
10 mV/A	1 Whr	10 Whr	100 Whr	1 kWhr	
100 mV/A	0.1 Whr	1 Whr	10 Whr	100 Whr	
1 V/A	0.01 Whr	0.1 Whr	1 Whr	10 Whr	

Note: The Usage scale (in Whrs) starts a factor 10 lower than the equivalent Power scale (in W). This means that after 6 minutes the Usage number and the Power number are of the same magnitude.

2.3 Trend Recording

General

Item	Specification
Resolution	1s, 5s, 30s, 1m, 5m, 15m, 30m, 1h, 3h, 6h
Duration	0.5h, 2.5h, 7.5h, 15h, 30h, 150h, 450h, 900h, 75d, 225d, 450d
Memory	1800 min, max, and avg. points for each reading

Dips and Swells

Item	Specification
Resolution	25ms, 50ms, 100ms, 200ms, 500ms
Duration	90s, 180s, 6m, 12m, 30m, 1s ... 450d
Memory	3600 min, max, and avg. points for each reading

Inrush mode

Item	Specification
Resolution	25ms, 50ms, 100ms, 200ms, 500ms
Duration	90s, 180s, 6m, 12m, 30m
Memory	3600 min, max, and avg. points for each reading

2.4 Wiring Combinations

Abbreviation on Configuration Screen	Description
1Ø + NEUTRAL	Single Phase with Neutral
1Ø IT NO NEUTRAL	Single Phase IT without Neutral
2Ø Split Phase	Split Phase with Neutral
3Ø WYE	3-Phase Wye with Neutral
3Ø IT	3-Phase Wye IT without Neutral
3Ø DELTA	3-Phase Delta
3Ø HIGH LEG	3-Phase Delta High Leg
3Ø OPEN LEG	3-Phase Delta Open Leg

2.5 Display

Item	Specification	Additional Information
Type	LCD color ¼ VGA	Liquid Crystal Display color version
Viewing area	118.2 x 89.4 mm	
Resolution	320 x 240 pixels	
Contrast adjustment	between full white and full black	Adjustable/optimum contrast @ every operating temperature
Backlight:		All values are typical values
Type	CCFL	
light output (battery operated)	50 cd/m2 @ 25 °C	After warm-up time of 10 min.
	80 cd/m2 @ 25 °C	When backlight button pressed
	20 cd/m2 @ 25 °C	Low intensity mode
light output (with power adapter)	80 cd/m2 @ 25 °C	After warm-up time of 10 min.
	20 cd/m2 @ 25 °C	Low intensity mode

2.6 Memory

Item	Specification	Additional Information
Memory locations for screens	Fluke 434: 50. Fluke 433: 25.	Extended memory optionally available for Fluke 433
Memory locations for datasets	Fluke 434: 10. Fluke 433: 5.	

2.7 Printers and Interface

Item	Specification	Additional Information
Type	RS-232, optically isolated	To be used with interface cable to RS-232 with 9-pole D-plug male (PM9080) or USB (OC4USB)
Spacing “0” “1”	 Light No light	
Baud rate	1200, 2400, 9600 … 57k6	
Stop bits	1	
Data bits	8	
Parity	No	
Transmission mode	Asynchronous, full duplex	
Handshake	Xon Xoff	Software handshake only.
Print out facility	Via optical RS-232 Via serial/parallel converter	PM9080 or PAC 91
Protocol	Epson FX LQ compatible, Deskjet, LaserJet , DPU-414, PostScript	Pure B&W.

2.8 Power Supply and Battery Charger

Item	Specification	Additional Information
Operating Time	7 hours	With Backlight at low intensity
Charge Time	4 hours, 8 hours for /006 version	If instrument is Off
Allowed ambient temperature during charge	0 °C ... 40 °C	
Remaining Battery Time indicator	Yes, in five steps, NOT guaranteed	The instrument will show a remaining battery capacity. This indication has no absolute accuracy; it is only used as an indication.
⚠ Power adapter input Voltage	15 ... 23 V dc	Use only power adapter BC430.
NiMH Battery Pack	BP190	

2.9 Mechanical

Item	Customer Specification	Additional Information
Height x Width x Depth	256 x 169 x 64 mm	10.1 x 6.6 x 2.5 inch
Weight	2.1 kg (4.7 lbs)	Including battery pack excluding current clamps or test leads

2.10 Environmental

Item	Customer Specification	Additional Information
Temperature Operating within specifications Operating with reduced specifications Non Operating (Storage)	 +15 °C ... +35 °C 0 °C ... +50 °C 0 °C ... +40 °C -20°C ... +60 °C	 battery operation only with power adapter connected
Maximum Relative Humidity Non Operating (Storage): Operating: 0 ... 10 °C 10 ... 30 °C 30 ... 40 °C 40 ... 50 °C	 No precipitation (non cond.) No precipitation (non cond.) 95 % ± 5 % 75 % ± 5 % 45 % ± 5 %	 Recovery time two hours No precipitation (no condensing) battery operation only
Maximum Altitude Operating Non Operating	 3000 m (10 000 feet) 12 km (40 000 feet)	 Above 2000 m derated overvoltage category 1000V/CATII, 600V/CATIII, 300V/CATIV
Vibration: Random Sinusoidal	 0.03 g^2/Hz 3 g	Operating, maximum limits. MIL-PRF-28800F, class 2, 3.8.4.1&4.5.5.3.1 MIL-PRF-28800F, class 2, 3.8.4.2&4.5.5.3.2
Shock, functional	max 30 g	MIL-PRF-28800F, class 2, 3.8.5.1&4.5.5.4.1
Bench handling (operating)	yes	MIL-PRF-28800F, class 2, 3.8.5.3&4.5.5.4.3
Transit drop	1 meter, see Fluke SOP 39.1, dated Sept. 22, 1992	
Drip proof, Dust resistance	IP 51	IEC60529 (2001-02)

2.11 Electro Magnetic Compatibility (EMC)

Item	Customer Specification	Additional Information
Emission and Immunity	EN-61326	Fluke 433/434, including standard accessories, conforms with the EEC directive 89/336 for EMC immunity, as defined by EN-61326, with the addition of the table below

Frequency	Disturbance < 0.5 %	Disturbance < 10 %
80 – 400 MHz	All ranges	
400 – 600 MHz	All other ranges	125 V range
600 MHz – 1 GHz	All ranges	
The Analyzer is susceptible for RF fields with a field strength of 10 V/m, between 400 and 600 MHz (Performance criteria B).		

2.12 Safety

Item	Customer Specification	Additional Information
⚠ including approval Reference Standards	EN/IEC61010-1 2nd edition 1000V Measurement Category III, 600V Measurement Category IV, Pollution Degree 2. ANSI/ISA S82.01-1994 CAN/CSA C22.2 No. 61010-1-04 (including approval)	According to CE marking
⚠ Max voltage between any Voltage banana input and safety ground	1000 V CAT III 600 V CAT IV	At altitude 2000 m … 3000 m: 1000 V CAT II, 600 V CAT III, 300 V CAT IV
⚠ 42 Vpeak Max voltage on Current BNC input		REMARK: the BNC grounds of the BNC's are connected to the ground banana input

Chapter 3
Circuit Description

Title	Page

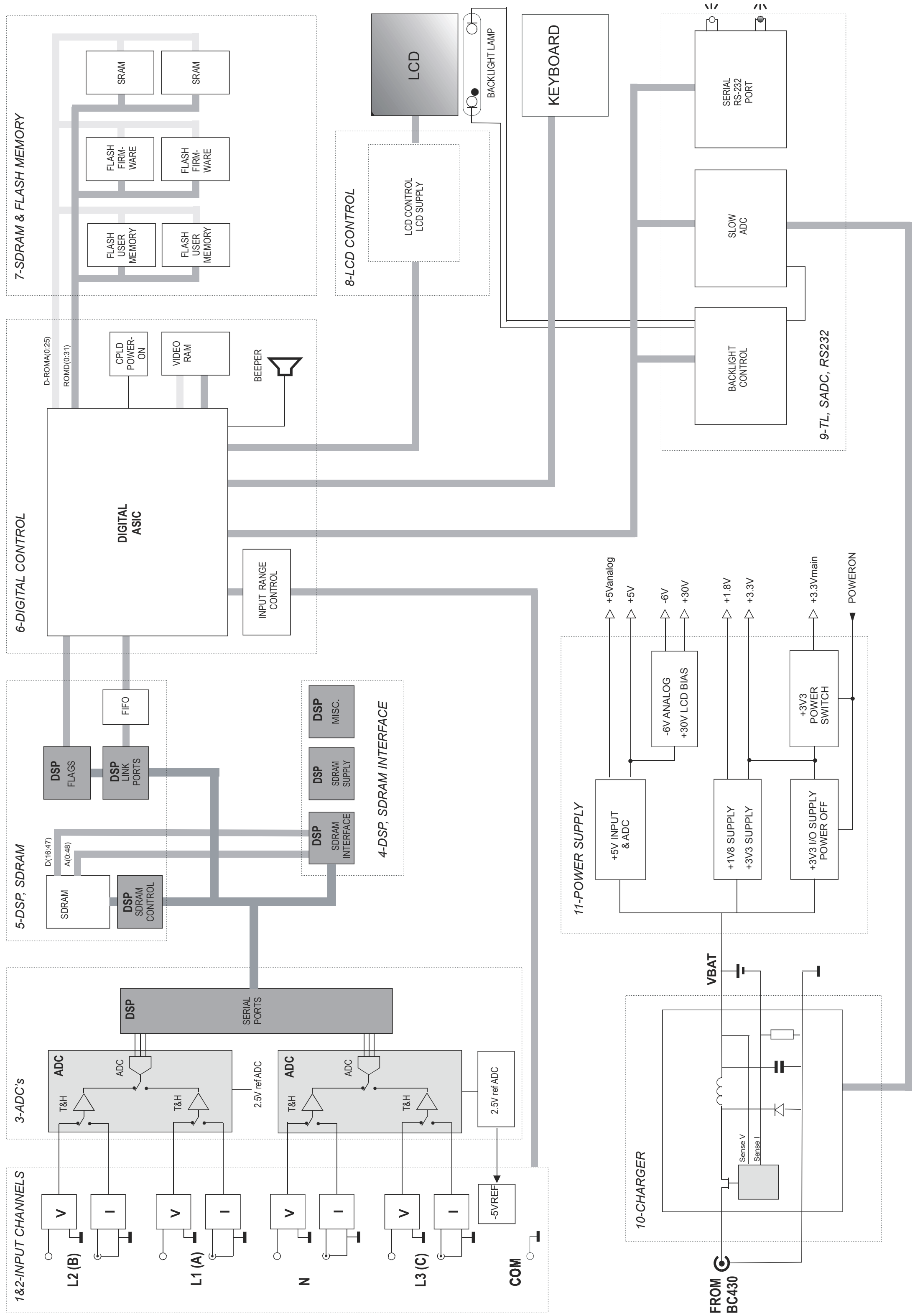


Figure 3-1. Fluke 433/434 Block Diagram

3.1 Introduction

There is no difference between the hardware of the Fluke-433 and the Fluke-434.

The Analyzer has four identical pairs of input channels. Each pair consists of a voltage input and a current probe input.

Section 3.2 describes the functional block diagram. It provides a quick way to get familiar with the Analyzer basic build-up.

Section 3.3 describes the Analyzer start-up sequence, and basic operating modes.

Section 3.4 describes the principle of operation of the Analyzer functions in detail, on the basis of the circuit diagrams.

3.2 Block Diagram Description

For the overall block diagram of the Analyzer see Figure 3-1**Error! Reference source not found.**. The dashed frames indicate the division into the detailed circuit diagrams Figures 9-1 to 9-10.

Table 3-1 shows the main functions of the circuits in diagrams Figure 9-1 to 9-11.

Table 3-1. Fluke 433/434 Main Functional Blocks

Circuit Diagram Name	Main Functions	Figure
Arrangement of Input Channels	Arrangement of 4 Voltage Channels and 4 Current Channels.	9-1
Voltage and Current Channel A(L1)	Complete Circuit Diagram of A(L1). The other channels are identical.	9-2
Analog to Digital Conversion	Analog to Digital Conversion of 8 analog input signals, Auxiliary Circuits, Input section of Digital Signal Processor	9-3
Digital Signal Processor (DSP)	Processing of ADC samples, DSP Clock, Connection to SDRAM.	9-4
Digital Signal Processor (DSP), and Memories	Processing and storage of ADC samples, SDRAM. Passing results on to D-ASIC via FIFO memory	9-5
Digital Asic	Digital Asic, Video RAM, Input Range Control, Connection to Memories.	9-6
Flash Memories and RAM's	Storage of Embedded Software and User Data.	9-7
LCD Control and Supply	LCD control signals buffer, LCD supply voltages	9-8
Slow ADC, RS232, LCD Backlight Converter	ADC for control signals, Optical RS232 Interface, Illumination of LCD.	9-9
Battery Charger	Battery Charger and Auxiliary Circuits	9-10
Power Supply	Generation of Supply Voltages	9-11

All circuits, except the Liquid Crystal Display (LCD) unit and the KEYBOARD, are located on one Printed Circuit Assembly, called the MAIN PCA.

The Analyzer has 8 input channels: 4 are for high voltages and have banana inputs, the other 4 have BNC inputs to which the relatively low voltages from current clamps are applied. This configuration provides for each phase A (L1), B (L2), C (L3) and N(eutral) a voltage input V and a current input I. The 4 voltage inputs are capable to handle high voltages up to 1000 Vrms. The other 4 inputs can handle voltages from current clamps ranging between 0 – 4 Vrms approximately.
All 8 input signals are referred to safety ground which is the green banana input COM.
All inputs have a bandwidth of 10 kHz.

The 8 input signals are routed to analog circuitry for voltage (V) and current (I) signal conditioning. Then conversion to digital is done by ADC's (sampling speed is 8x200kS/s). During conversion, the analog voltages are kept stable by T&H (Track and Hold) gates. The digital information is applied to the Digital Signal Processor (DSP) and is stored in the SDRAM memory. DSP is the heart of the system and makes continuous and fast calculations on the applied data. During a loop of 200 ms approx. (covers twelve 60 Hz cycles or ten 50 Hz cycles) data is extracted such as: gain/offset correction, ½ cycle rms, dips/swells detection, frequency, 10 or 12 cycle rms, rapid voltage change detection, Fast Fourier Transformation (FFT), Flicker. Also data exchange (e.g. calculation results) with the DIGITAL ASIC (D-Asic) is done. Information to be displayed on the LCD is stored in the VIDEO RAM. The CPLD POWER ON circuit controls power on/off. Data exchange between DSP and D-Asic is done via the FIFO (First-in, First-out) memory. The D-Asic has a number of FLASH memories and SRAM's. Two FLASH memories are used to store screenshots and complete datasets. The other two contain the Analyzer's firmware. The SRAM's are used to store temporary data. The D-Asic reads the KEYBOARD and controls the Color LCD, the optical isolated SERIAL RS232 PORT, and the sensitivity and bandwidth of the analog inputs.

DSP is a complex IC that has interaction with many circuit parts. It is therefore that DSP is split-up in parts that reappear in the circuit diagrams. For an easy recognition, all DSP-sections have a gray color. DSP has 225 pins that are arranged as a ball-grid-array (BGA). The D-Asic is a 360 pin BGA.

Via the Slow-ADC the D-Asic can measure a number of analog signals: type of installed battery, momentary battery voltage and temperature, battery current, reference voltage for ADC's, and 3.3 V supply voltage.
The BACKLIGHT CONTROL generates the 400 V (!) supply voltage for the fluorescent lamp that lights the LCD screen.
The Analyzer can be powered by line voltage via Power Adapter BC430, or by the internal battery pack BP190. If the power adapter is connected, it powers the Analyzer and charges the battery via the CHARGER circuit. The battery charge current is sensed by a sense resistor (Sense-I signal).
The POWER SUPPLY consists of a number of supply blocks that generate the various supply voltages. The 3.3 V supply voltage is also present during power-off to keep the D-Asic powered (to allow that e.g. the power on key is read). The CPLD POWER-ON circuit brings the D-Asic in 'stand-by' mode during power-off: current drain is below 1 mA then. During power-off also the SRAM's, VIDEO RAM, and FLASH memories are powered to keep data stored.

Important:
1. The block diagram is divided into sections of which the numbering corresponds with the numbering of the circuit diagrams. This gives you a direct link between block diagram and circuit diagrams.
2. Signals are often indicated with signal names. Signals lines have arrows to indicated signal direction. When a signal is routed to another circuit diagram this is indicated: first the diagram number is given, then the location on the diagram.
3. Signal names with # at the end are active when low (L). An example is POWERON# that is L when power is on. Signal names without # are active when high (H): e.g. POWERON is H when power is on.

3.3 Start-up Sequence, Operating Modes

The Analyzer sequences through the following steps when power is applied. In the description below reference is made to the following circuit diagrams: Fig. 9-6 Digital Asic, Fig. 9-10 Battery Charger, Fig. 9-11 Power Supplies.

1. **Idle mode**: the Analyzer is not working. The D-Asic is powered by +3V3_SP derived from VBAT (VBAT is converted to +3V3 by linear power supply N604; then +3V3_SP is derived via filter capacitors). If the voltage +3V3_SP is below 2.95 V, this detected by Watchdog Circuit D5710/pin 5: D5710/pin 1 signals this to the D-Asic (pin N2, signal VDDVAL = L) and to the CPLD Circuit D3550/pin 46. The D-Asic will not start-up
2. If the voltage +3V3_SP is above 2.95 V, this is detected by Watchdog Circuit D5710 and signaled to the D-Asic via signal VDDVAL (H). The Analyzer is operative now. If it is powered by the battery only, and not turned on, it is in the off mode. In this mode the D-ASIC is active: the 32.768 kHz clock (B3501) runs, and the ON/OFF key is monitored to see if the Analyzer will be turned on.
3. If the **power adapter is connected** (Battery Charger, N500/pin 1 MAINVAL high), **and/or the Analyzer is turned on**, the embedded D-ASIC program, called mask software, starts up. The mask software checks if valid instrument software is present in the Flash ROM. If not, the Analyzer does not start up and the mask software continues running until the Analyzer is turned off, or the power is removed. This is called the **Mask active mode**. The mask active mode can also be entered by pressing the up (^) and right (>) arrow key when turning on the Analyzer.

   If valid instrument software is present, one of the following modes will become active:

   Charge mode

   The Charge mode is entered when the Analyzer is **powered by the power adapter, and is turned off**. The Power Supply IC's are off (linear supply N604 is on). The Battery Charger circuit N502 charges the batteries.

   Operational & Charge mode

   The Operational & Charge mode is entered when the Analyzer is **powered by the power adapter, and is turned on**. The Power Supply IC's are on (N604 is off now), the Charger circuit supplies its primary current. The battery will be charged.

   Operational mode

   The Operational mode is entered when the Analyzer **is powered by battery only, and is turned on**. The Power Supply IC's are on (N604 is off), the battery supplies its primary current. If the battery voltage (VBAT) drops below 6 V when starting up the Power Supply IC's, the Off mode is entered.

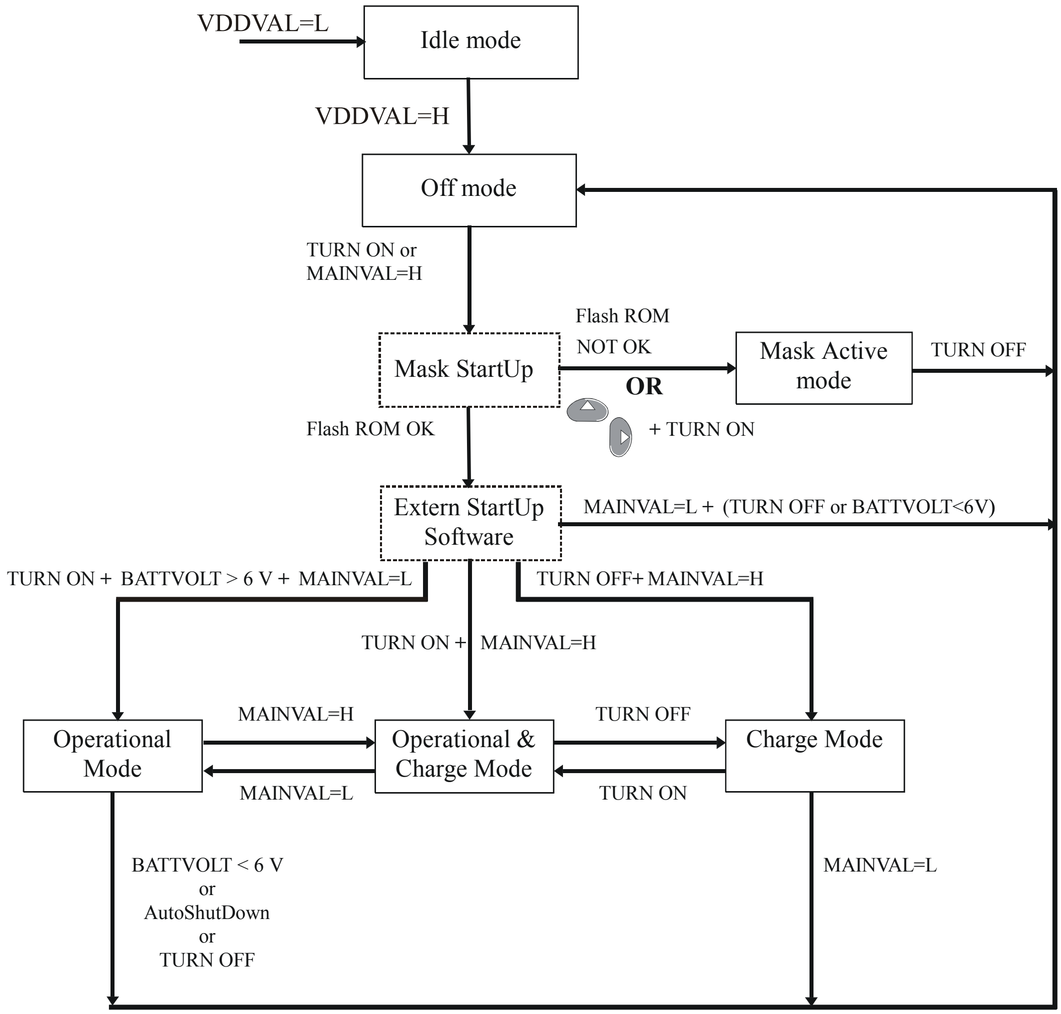


Figure 3-2. Fluke 433/434 Start-up Sequence, Operating Modes

Table 3-2 shows an overview of the Analyzer operating modes.

Table 3-2. Fluke 433/434 Operating Modes

Mode	Conditions	Remark
Idle mode	No power adapter and no battery	no activity
Off mode	No power adapter connected, battery installed, Analyzer off	D-ASIC, CPLD, Watchdog, Flash-ROM, SRAM, video RAM powered (VBAT & +3V3 & +3V3_SP).
Mask active mode	No valid instrument software, or ^ and > key pressed when turning on	Mask software runs
Charge mode	Power adapter connected and Analyzer off	Battery will be charged
Operational & Charge mode	Power adapter connected and Analyzer on	Analyzer operational, and batteries will be charged
Operational mode	No power adapter connected, battery installed, and Analyzer on	Analyzer operational, powered by batteries

3.4 Detailed Circuit Descriptions

3.4.1 Analog Input Channels

See circuit diagrams Figure 9-1 and Figure 9-2.

The Analyzer has identical channels for each phase A (L1), B (L2), C (L3) and N(eutral). Each channel has a voltage input and a current input. Diagram 9-1 gives an overview on how the channels are arranged. The circuit diagram for phase A (L1) is diagram 9-2 and is described below. The diagrams for the other phases are identical with the exception that the component numbers for the other channels are in a different range. The number range is shown on circuit diagram 9-1.

Voltage channel A (L1).
The voltage channel has an input impedance of 4 MΩ and is capable to withstand 1 kVrms and peak voltages up to 6 kV. The input stage has four measuring ranges (1000 V, 400 V, 230 V, 120 V) and a 2 V range for test and demonstration purposes. The input circuit consists of resistor array R1 and operational amplifier N1A. R1 incorporates the 4 MΩ input resistor R1A that applies the input signal to the inverting input of N1A and the 4 feedback resistors that are used to make the four voltages ranges. Input- and feedback-resistors in one array assures high accuracy. Capacitors are added in parallel with the resistors to obtain a good bandwidth in all ranges. The feedback resistors are selected with analog multiplexer D1. The multiplexer position is determined by the logic signals Range_L1_D0 (A0, least significant) and Range_L1_D1 (A1, most significant). The enable signal is Range_L1_LV (EN) and is H for the measuring ranges 1000 to 125 V. Parts that are active for each voltage range are shown in the table below:

Table 3-3. Voltage Range Selection

Range	**Feedback resistors in circuit**	**closed multiplexer connections** (state of A0, A1, EN: High/Low)
1000 V Transients mode	R1B (1.5 kΩ)	S4b to Db, S4a to Da (A0=H, A1=H, EN=H)
400 V	R1B+R1C (6.364 kΩ)	S3b to Db, S3a to Da (A0=L, A1=H, EN=H)
230 V	R1B+R1C+R1D (12.728 kΩ)	S2b to Db, S2a to Da (A0=H, A1=L, EN=H)
120 V	R1B+R1C+R1D+R1E (25.456 kΩ)	S1b to Db, S1a to Da (A0=L, A1=L, EN=H)
2 V DEMO (**)	R22 (4.7 MΩ, always in circuit)	all open (EN=L)

(**): Select Demo mode: SETUP, F3 – FUNCTION PREF., F1 – DEMO ON.

Feedback resistor switching for each range is done with 2 switches inside D2. Two switches are used to compensate for deviations in channel resistance of each switch. Gain in the 2 V demo position is determined by R25/C8 and R22/C7.

Operational amplifier N1B has gain x1 and converts high input impedance to low output impedance. Operational amplifier N2 is used as a level shifter and brings signal ADC_V_L1 in the range between 0 and 5 V that matches with the input range of the Analog-to-digital converter (ADC) that follows. The feedback circuit of N2 consists of C1 and R2-2. Bandwidth of this stage is 150 kHz for Transients mode; in other measuring modes C29 is part of the feedback loop via FET V1 (control signal BWLIMIT is H then) which reduces bandwidth to 3 kHz. R2-2 is part of resistor array R2. The 10 kΩ resistors in this array are used for the stage with N2.

Current channel A (L1).
The current channel has a fixed input sensitivity and an input impedance of 50 kΩ. The input stage is formed by operational amplifier N3 and the input resistors R13 ... R17 in series (5x 10 kΩ) and the feedback resistors R18/R19. Operational amplifier N4 is used as a level shifter and brings signal ADC_I_L1 in the range between 0 and 5 V that matches with the input range of the Analog-to-digital converter (ADC) that follows. Bandwidth of this stage is 3 kHz.

Supply lines.
The circuit is supplied by +5 V Analog and –6 V Analog. Supply voltages are routed to individual IC's via series resistors of 10 Ω and smoothing capacitors of 100 nF.

3.4.2 Analog to Digital Conversion

See Circuit Diagram Figure 9-3.

This section converts 8 analog input signals (all in the range 0 – 5 V) into two serial digital data streams that are applied to the DSP (section D701C). For this 2 Analog-to-digital converters (ADC's) D5707 and D5708 are used. Each channel is sampled at a rate of 200 kHz. The ADC's are master in the data exchange with DSP.

Analog input signals applied to the ADC D5707:
- signals that represent B (L2) voltage (ADC_V_L2) and B(L2) current (ADC_I_L2).
- signals that represent A (L1) voltage (ADC_V_L1) and B(L1) current (ADC_I_L1).

Analog input signals applied to the ADC D5708:
- signals that represent N (Neutral) voltage (ADC_V_N) and N current (ADC_I_N).
- signals that represent C (L3) voltage (ADC_V_L3) and C(L3) current (ADC_I_L3).

As shown in the block diagram, the inputs of the ADC's are multiplexed with internal 2-position switches that are followed by Track & Hold circuits. Switch positions are determined by selection signal A0 (pin 3). This is setup so that either 4 voltages are converted (A0 = L) or 4 currents are converted (A0 = H). The state of A0 is determined by the non-inverting output of toggle flip-flop D5703A. The flip-flop switches over when the BUSY outputs (pin 29) of both ADC's become H. The outputs are H during conversion to digital.

Each ADC has 3 output lines to send data to the DSP-inputs:
- SD0A, SD1A: serial data from respectively the ADC's D5707 and D5708.
- SCLK0, SCLK1: synchronization clock (34 MHz bursts).
- SFS0, SFS1: frame synchronization signal. Receives a positive-going pulse at the first bit of a sample.
Note: the DSP has 2 other sets of data inputs (SCLK2, SCLK3, etc.) that are not used.

Further details of diagram 9-3:
- D5704 converts +5 V supply into an accurate 2.5 V reference voltage for the ADC's. Supply voltages for the ADC's and digital circuits are filtered with inductors and capacitors.
- ADC_RST: reset signal for both ADC's and the toggle flip-flop D5703A. This signal comes from the DSP section D701D (section DSP FLAGS) on diagram 9-5. The signal is normally low and shows a positive going 13 ms pulse when switching to another measuring function (or after detection of an error).
- ACQ_START: 400 kHz signal that starts data acquisition (sampling speed for each channel is 200 kHz). The signal comes from D-Asic D3500 on Diagram 9-6.

- MISO, MOSI, SPIDS#, SPICLK: signals that build the control interface between DSP and D-Asic (SPI = Serial Peripherals Interface).

3.4.3 Digital Signal processor (DSP) and Related Memories.

See circuit diagrams Figures 9-4 and 9-5.

Diagram 9-4.
On this diagram 3 DSP sections are shown:
- D701A: controls data exchange with SDRAM D3701 via address lines (A0 ... 18), data lines (D16 ... 47), and some control lines such as MSO# (serves as chip select for the SDRAM). The SDRAM is the memory where measuring data is stored.
- D701F: a PLL circuit inside DSP makes the 100 MHz clock for this device. This clock is derived from the 25 MHz clock from the Digital Asic (D-Asic) that is applied to DSP pin P12.
- D701G: supply lines are well filtered to suppress interference originating from DSP. Bootstrap diode V604 avoids that the 3V3 supply voltage gets lower than the 1V8 supply voltage.

Voltage names with the extension SHARC are used for the DSP.

Diagram 9-5.
On this diagram the remaining DSP sections are shown and the memories SDRAM D3701 and FIFO. SDRAM is a Synchronous Dynamic Read Only Memory working at 100 MHz clock speed.

- D701E: in addition to address, data, and MSO# from D701A, there are signals from D701E to control the SDRAM. Pin L12 CAS is used for Column selection. Pin M11 RAS is used for Row selection. Pin R14 SDWE is the write enable. Pin N10 and P10 carry 100 MHz clock signals.
- D701B and FIFO: The FIFO memory D2701 is used for data transfer between DSP and the D-Asic. Both IC's use the 25 MHz clock for data exchange, but there may be phase differences which is compensated by FIFO. Data transfer between DSP and FIFO is done via 8 bits L0D0 ... L0D7. The 25 MHz clock is available at DSP pin B10 and FIFO pin 25 (WRite CLK). DSP pin A10 (WRite ENable 1) is always H via pull-up resistor R1702.

Data transfer between FIFO and D-Asic is done via 8 bits FAMD0 ... FAMD7. The D-Asic reads data from FIFO with the use of clock signal FIFO_RCLK (pin 32). FIFO applies signal FIFO_OR (Output Ready, pin 29) to the D-Asic to inform it that data is ready for transfer. This triggers the D-Asic to capture data.

D701D: this DSP section generates and receives a number of control signals that are used throughout the circuit.
SPIDERINT: interrupt signal from DSP to D-Asic (only active after fault condition).
DSPCONTROL: control signal from D-Asic to DSP (normally high, goes low when e.g. keys are pressed to select another measuring mode).
ADC_RST: reset signal for the ADC's and the toggle flip-flop.
FIFO_RST: reset signal for FIFO at start-up (goes L then, normally H).
ADC_A0: signal to inform the DSP if the ADC's are in voltage (L) or current mode (H).

3.4.4 Digital Asic (D-Asic), Memories, and Related Circuits

See circuit diagrams Figures 9-6 and 9-7.

Diagram 9-6.
The D-Asic controls Analyzer functions such as: reading the keyboard, controlling the LCD display, DSP and input circuits. The keyboard is connected via connector X3600.

Keys are grouped in a matrix of 6 rows (ROW0 ... 5) and 6 columns (COL 0 ... 5). The power-on key is directly connected between the line ONKEY and ground.

Information to be displayed is stored in VIDEO RAM D3502. The LCD is controlled via LCDDAT0 ... 7 (data bits), DATACLK, M_ENAB (back plane modulation signal), FRAME (the LCD contents is refreshed during a frame pulse), DISPON (turns the display on/off), LINECLK_C (sequentially transfers data to the column driver outputs). The CONTRAST voltage determines display contrast by influencing the LCD supply voltages (diagram 9-8).

Data exchange with the FIFO (and DSP) happens via FAMD0 ... 7 (D-Asic inputs CHA7 ... 0; the inputs CHB7 ... 0 are not used and connected to ground).

Important signals and their purpose:
- FIFO_RCLK: 25 MHz clock signal applied to FIFO memory. Is used by the D-Asic to read data from FIFO.
- DSP_CLOCK: 25 MHz clock signal that is applied to DSP where it is used by an internal PLL circuit to derive the 100 MHz clock.
- ACQ_START: 400 kHz signal applied to D5701C in AD conversion section to start acquisition.
- FIFO_OR: output ready (data available) signal from FIFO memory.
- REFPWM: 3.3 Vdc REFerence voltage from N503 for Pulse Width Modulator outputs BACKBRIG, CONTRAST and SADCLEV. These voltages switch between reference voltage and ground.
- BACKBRIG: square wave with variable duty cycle (high duty for high intensity) to control backlight converter of LCD.
- CONTRAST: adjustable DC voltage to control LCD contrast. DSP generates a square wave with variable duty cycle resulting in an adjustable DC voltage at the output of low-pass filter R3328/C3311.
- SADLEV: adjustable DC voltage (range 0 ... 3 V) via low-pass filter R3327/C3312) used for the Slow-ADC on diagram 9-9.
- CHARCUR: square wave with variable duty cycle to control the battery charging current.
- SLOWADC: output voltage from comparator of Slow-ADC on diagram 9-9 applied to D-Asic input pin A4.
- MISO: control interface signal from DSP to D-Asic.
- BATIDENT: identification signal for battery type. Uses an identification resistor in the battery pack (0Ω for NiMH).

Input Range Control.
The signals SDA (Serial Data) and SCL (Serial Clock) from the D-Asic shift 2x8 bits of serial data into register D401, D403. A resulting bit pattern becomes available at 2x8 outputs. These outputs control the following functions:
- Range_xx_zz: range selection of analog input channels (diagram 9-1, 9-2).
- TLON: turns backlight (TL) on when H.
- DSP_RESET#: DSP reset by D-Asic.
- CHAOFF: turns battery charger off when H.
- BWLIMIT: limits bandwidth of voltage channels to 3 kHz when H.
D401, D403 are also controlled by SR_MR# and SR_SCLK.

D-Asic Clocks:
- 50 MHz oscillator with Xtal B3502: the main clock signal, runs when the Analyzer is on and/or if the power adapter is present.
- 3.68 MHz oscillator with Xtal B3500: UART oscillator for serial RS232 interface communication. Runs if the 50 MHz runs.
- 32.76 kHz oscillator with Xtal B3501: runs if any power source is present. Is used for power on/off control and for the real time clock.

Important signals and their purpose (cont'd):
- SELMUX2/1/0: 3 bit positioning address for 8-position multiplexer in Slow-ADC.
- POWERON: switches power supply IC's on when H.
- MAINVAL: signal from Battery Charger circuit: is H when the power adapter voltage is present.
- TXD1, RXD1: Transmit, Receive signals used for optical RS232 interface.
- SPIDERINT: interrupt signal from DSP to D-Asic (only active after fault condition).
- DSPCONTROL: control signal from D-Asic to DSP (normally high, goes low after having changed the active measuring mode).
- SPIDS#, SPICLK, MOSI: control interface signals from D-Asic to DSP.

Beeper H3500: is driven via FET inverter V4211 from pin T4 of the D-Asic. If the Analyzer is on the 30 V supply voltage is present and the buzzer sounds loudly. If the 30 V is not present (e.g. in Mask Active mode), the buzzer runs on 3.3 V and sounds weak.

D3550-1, CPLD Power on circuit. This programmable logic device provides a controlled power down for the D-Asic. This assures a current drain < 1 mA after power down. D3550 is supplied by linear supply N3500 that converts 3.3 V to 1.8 V. Communication between D3550 and the D-Asic is done via CPLD TMS, CPLD_TDI, CPLD_OFF, CPLD TCK, ENABLEMAIN, VDDVAL.

Watchdog D5710. In case of a software hang-up (pin 4) or if +3V3_SP falls below 2.9 V (pin 5), D5710 will reset the D-Asic to restart the software (pin 1, signal VDDVAL as applied to D-Asic pin N2 and CPLD pin 46).

ROMA(0:25), ROMD(0:31): address- and data-lines. Together with a number of control lines, they are used for data exchange between the D-Asic and the Flash- and RAM-memories that are shown on diagram 9-7.

Diagram 9-7.
Shows the Flash memories and RAM's connected to the D-Asic:
- D3301, D3302 are Flash-ROM's to store screenshots and complete datasets.
- D3303, D3304 are Flash-ROM's to store the Analyzer's firmware.
- D3305, D3306 are RAM's for temporary data storage.

Data-exchange is done via the datelines ROMD(0:31); the address lines are ROMA(0:25). The printed circuit board is prepared for use of memories of different make and capacity. A table on the diagram indicates what jumper (0 Ω) resistors must be placed for a certain type of memory.

The table below shows how the control lines read (RD), write (WR), reset (RST), and chip select (MB, CS) are connected to the memories.

Table 3-4. Overview of Control Lines for Memories

	D3301	D3302	D3303	D3304	D3305	D3306
ROMRD#	*	*			*	*
ROMWR#	*	*			*	*
ROMRST#	*	*	*	*		
ROMB0#					*	
ROMB1#					*	
ROMB2#						*
ROMB3#						*
ROMCS0#			*	*		
ROMCS1#					*	*
ROMCS3#	*					
ROMCS4#		*				

3.4.5 LCD Control and LCD Supply

See circuit diagram Figure 9-8.

The LCD control receives data from the D-Asic and controls the Color LCD-module. The LCD has 320 columns of 240 pixels each. The D-Asic provides the following control signals to D3601, D3602 that function as level adapters from 3.3 V to 5 V:
- LCDDATA0 ... 7 and DATACLK: display data for the display column drivers.
- FRAME_C: during a frame pulse the LCD image is refreshed.
- LINECLK_C: sequentially transfers the data to the column driver outputs.
- DISPON: turns the display on (H) and off (L).
- M_ENAB: back plane modulation signal. For description see below.

The LCD supply circuit with 4 operational amplifiers N3601 (impedance converters: in- and output voltages are identical) generates the supply voltages V0 ... V4 for the LCD. On the LCD-module V0 ... V4 are applied to the driver outputs, depending on the applied data and the M(ultiplex) signal. The M signal (back plane Modulation) is used by the LCD drivers to supply the various DC voltages in such an order, that the average voltage does not have a DC component. to avoid memory effects in the LCD.

The CONTRAST voltage controls the LCD contrast by changing the LCD supply voltages. It is controlled by the D-Asic PWM (Pulse Width Modulation) signal from a low-pass filter. The voltage REFPWM is used as bias voltage for the contrast adjustment amplifier N3600.

3.4.6 Slow-ADC, Optical RS232 Interface, LCD Backlight Converter

See circuit diagram Figure 9-9.

Slow-ADC.
Measures the various DC voltages that are used for control and test purposes. The measuring principle is based upon voltage comparison by N4300 against an adjustable DC voltage SADLEV. The input DC voltages to be measured are selected by analog multiplexer D4300 (8 positions, 3 address bits) and are measured one-by-one. Input

voltages are:
- BATIDENT: battery identity (battery type, 0 Ω for NiMH, H if no battery installed)
- BATVOLT: battery voltage.
- BATTEMP: battery temperature as measured via an NTC-resistor (10 kΩ at 25 degrees C) inside the battery pack.
- BATCURR: battery current. Measures the voltage across a current sensing resistor.
- +2.5Vref_ADC: monitors the reference voltage for the ADC's. This voltage is important for measuring accuracy.
- +3V3_MAIN: monitors 3V3 supply voltage.

The Slow-ADC works according to the successive approximation principle and the process is controlled by the D-Asic. Multiplexer D4300 selects an input voltage. This voltage is applied to the inverting input (pin 4) of comparator N4300. The D-Asic varies the voltage on the non-inverting input (pin 3) of N4300 stepwise. The output SLOWADC of N4300 is monitored by the D-Asic, in order to detect if the previous input voltage step changed the state of output SLOWADC. By decreasing the voltage steps, the voltage level can be approximated within the smallest possible step of the SADFLEV voltage. From the duty cycle of SADLEVD, the D-Asic determines the voltage level at the selected input.

Optical RS232 Interface.
Transmit TXD1. The infrared output LED H3400 is directly connected to the TXD1 line from the D-Asic.
Receive RXD1. The receive signal is applied to the D-Asic via light sensitive diode H3401 and operational amplifier N3401B.

When no light is received, H3401 does not conduct. Pin 6 of N3401B is at ground level and pin 5 at approx. +0.25 V: so the RXD1 line is H.
When light is received, H3401 conducts. The voltage at the anode of V3401B is directly applied to inverting input pin 6. The non-inverting input (pin 5) is at a lower voltage resulting in RXD1 being L.

Supply voltage +3V3SADC is present if the Analyzer is turned on, or if the Power Adapter is connected (or both). If the Power Adapter is connected limited RS232 communication is possible, even when the Analyzer is off. In this way the Analyzer can e.g. be turned on by means of a RS232 command.

LCD Backlight Converter.
The LCD back light is provided by a small fluorescent lamp in LCD unit. The back light converter generates the 300-400 Vpp (!) supply voltage. The circuit consist of:
- A Pulse Width Modulated (PWM) buck regulator to generate a variable, regulated voltage (V4200, V4202, L4200, C4210).
- A Zero Voltage Switched (ZVS) resonant push-pull converter to transform the variable, regulated voltage into a high voltage AC output (V4201, T4200).

The PWM buck regulator consists of FET V4200, V4202, L4200, C4202, and a control circuit in N4200. FET V4200 is turned on and off by a square wave voltage on output COUT of N4200 (pin 14). By changing the duty cycle of this signal, the output on C4210 provides a variable, regulated voltage. The turn on edge of the COUT signal is synchronized with each zero detection.
Outputs AOUT and BOUT of N4200 provide complementary drive signals for the push-pull dual FET V4201. If V4201-2 conducts, the circuit consisting of the primary winding of transformer T4200 and C4211, will start oscillating at its resonance frequency. After half a cycle, a zero voltage is detected on pin 9 (ZO) of N4200, V4201-2 will be turned off, and V4201-1 is turned on. This process goes on each time a zero is detected. The secondary transformer current is sensed by R4201, and fed back to N4200 pin 7 and pin 4 for regulation of the PWM buck regulator output voltage.
If the TLON signal, from the D-Asic, goes H the backlight is turned on (N4200 pin 13

ENABLE is high).
Feedback of the lamp current is established by sensing the voltage across R4202 on N4200 pin 7. If the voltage drops below approximately 1.5V an ‘open lamp’ is detected and the converter is turned off. Soft start input N4200 pin 5 and R4207/C4201 allow time for the lamp to strike and conduct the programmed level of current before enabling the ‘open lamp’ detection.
The BACKBRIG signal supplied by the D-Asic provides a pulse width modulated (variable duty cycle) square wave. By changing the duty cycle of this signal, the average on-resistance of V4210 can be changed. This will change the secondary current, and thus the back light intensity. The voltage on the ‘cold’ side of the lamp is limited by V4204 and V4203A. This limits the emission of electrical interference.

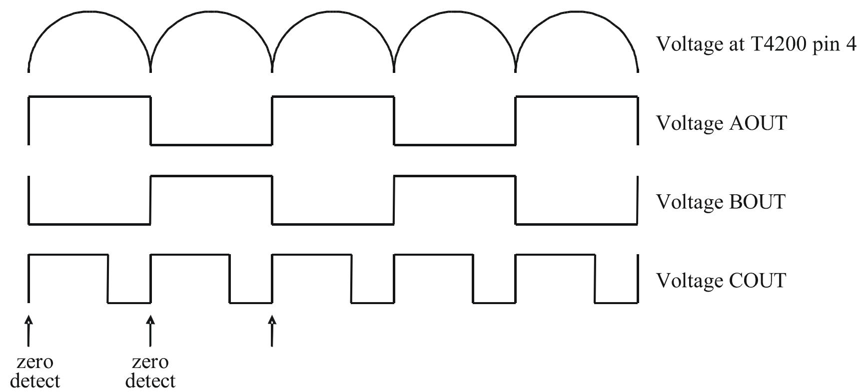


Figure 3-3. Back Light Converter Voltages

3.4.7 Battery Charger

See circuit diagram Figure 9-10.

The charger is formed by N502 and surrounding components. It is a switched mode supply working at 250 kHz approx. (determined by C520 at pin 6). The input for the supply is 18 V / 0.8 A from the BC430 power adapter that is applied to X501 and EMC filters L506, L507, Z500. The negative conductor is connected to ground. The positive conductor is connected via V500 (reverse polarity protection) and V502 (to block leakage current from the battery in power off mode via V501-1 into pin 1 of N502) to the switched regulator. The regulator is controlled by the N502 outputs DRVH (pin 23) and DRVL (pin 20). The regulator consists of V501-1, V501-2 / V508, L501, and C511. If V501-1 is on, current runs through L501 into the battery and C511. This current rises linearly with the time. At a certain moment V501-1 switches off and V501-2 switches on. The current in L501 now runs via V501-2 (and partly V508) into the battery and C511. The amount of current is monitored via sensing resistor R516 and operational amplifier N501 resulting in signal BATCURR (at output pin 1).
BATCURR is applied to an input of the Slow-ADC: the voltage range is between 0 ... 3 V (0 mA results in 1.67 V). Current regulation is achieved by controlling the duty cycle of V501-1 and V501-2.

Other circuit details:
- V509, C516, R517. Circuit to protect N502 from spikes on supply voltage that can occur e.g. when the plug of the power adapter is inserted.
- Diode V508. This diode is in parallel with switching FET V501-2. V508 reduces dissipation in V501-2 at high currents (Analyzer on and full charging current).
- MAINVAL. This signal is H when the power adapter voltage is present: comes from

comparator N500/pin 1 and is applied to an input of the D-Asic. It signals that sufficient power is available for battery charging.
- CHARCUR. Signal with variable duty cycle from D-Asic to control the charging current. Via inverter V550 the signal is applied to input ISET (pin 16) of N502. ISET at 0 V results in a low charging current; 2.5 V results in a high charging current.
- CHAOFF, V505, V507. Signal from D-Asic: turns charger off when H. V505, V507 are N-channel inverters.
- N503. Linear supply that makes an accurate +3.3 V for the Slow-ADC (diagram 9-9) and for REFPWM (REFeference voltage for Pulse Width Modulator) signal applied to D-Asic.
- BAT, BATSEL (N502, pin 14 and 15). Both signals are interconnected so that R520 and R526 form a voltage divider that is part of a feedback loop.
- BATIDENT. A resistor inside the battery pack (0 Ω for NiMH) is sensed by an input of the D-Asic and by the Slow-ADC. Because of this the proper charge/discharge current can be applied.
- BATTEMP. An NTC resistor inside the battery pack measures temperature. This signal is applied to an input of the Slow-ADC. It is also applied to the circuit with N504A/B, V510 that directly reduces charging current in case of a too high temperature.

3.4.8 Power Supplies

See circuit diagram Figure 9-11.

This section incorporates a number of power IC's that generate and control the supply voltages that are used in the Analyzer. All supply IC's are controlled by control signal POWERON (and its inverse POWERON#) that comes from the D-Asic. During power on the signal is H.
Refer to the Block Diagram for an overview on how the power IC's are interconnected.

N603 forms a switched mode power supply working at 1.1 MHz. It is supplied by the battery voltage Vbat and makes +5 VAnalog that is used for the analog input circuits (operational amplifiers, ADC's). This voltage is accurate to assure high measuring accuracy. The switching FET inside N603 is between pin 1 (SW) and pin 2 (GND) and output regulation is achieved by varying the duty cycle. With the related components L613, C605, L614, and diode V616 a combined step-up / step-down supply is formed. The step-down mode is active at normal battery voltage. With a battery almost empty (Vbat under 5.5 V) the circuit works as a step-up converter.

The supply works as follows: in the starting situation the FET inside N603 is off. The voltage on the junction L614/C605 is 0 V and C605 is charged to Vbat. When the FET switches on, voltage across L613 is minus the voltage across L614 and equal to Vbat. The current in both coils will rise linearly with the time. When the FET switches off, the current in both coils will continue: as a result the polarity of both voltages will change. The current from both coils will reach the output circuit C633 via diode V616. Voltage across L614 is minus the voltage across L613 and equals the output voltage + voltage across V616. The current in both coils now sinks linearly with the time till the moment that the FET switches on again. The on-time of the FET will increase at a higher load and or when Vbat gets lower.

N601 forms a dual supply working at a 1.1 MHz switching frequency. Voltage regulation is achieved by varying the duty cycle of the switching transistors inside the IC. N601 is supplied with +5 V. One half of N601 generates -6 V for the analog input circuits. The switching FET inside N601 is between SW1 (pin 10) and ground (pin 9). The output voltage is generated via L603, C627, V601, V602, and C602. Additional filtering is achieved via L602, C630. Output voltage stabilization is achieved via feedback loop R627, R628, C634 and N601/pin 1.

The other half of N601 makes +30 V that is used as a bias for the LCD. The switching FET inside N601 is between SW2 (pin 6) and ground (pin 7). The output voltage is generated via L604, V603, and C603. Additional filtering is achieved via L605, C631. Output voltage stabilization is achieved via feedback loop R629, R630, C635 and N601/pin 5.

N602 is a dual supply working at a 1.1 MHz switching frequency and capable of supplying high currents. Voltage regulation is achieved by varying the duty cycle of the switching transistors inside the IC. N602 is supplied with Vbatt.
One half of N601 generates + 1.8 V. The switching FET inside N602 is between SW2 (pin 7) and positive supply voltage (pin 3, 4). The output voltage is generated via V606, L607, C607, and C608. Current usage is between 0.4 and 0.9 A. Feedback is achieved via R609, R617.
The other half of N601 generates + 3.3 V which is e.g. used to supply all circuits during power-on. The switching FET inside N602 is between SW1 (pin 2) and positive supply voltage (pin 5, 6). The output voltage is generated via V608, L608, C614, and C613. Feedback is achieved via R614, R619, and R620.

N604 is a linear power IC that supplies 3.3 V during power-off as a backup for the SRAM, Video RAM, Flash memories, and D-Asic in power-off mode. N604 is switched on directly at power off via V615 and inverter V611 (N-channel FET); at power on N604 is switched off (pin 8 low) with 1 ms delay via R632, C619. N602 takes over the supply.

Power switch V612, V613. V613 is a N-channel FET that works as an inverter. It converts POWERON to POWERON#. V612 is a P-channel FET that conducts if power is on.

V612 supplies 3.3 V (+3V3_MAIN) to circuits that only require power during the on-state of the Analyzer: the ADC’s (D5707, D5708), NAND D5701, Flip-flop D5703, DSP D701, SDRAM memory D3701, FIFO memory D2701.

Circuits that are always supplied with 3.3 V (+3V3) are D-Asic D3500 and CPLD D3550, Flash memories D3301, D3302, D3303, D3304, and SRAM D3305, D3306, and Video RAM D3502.

Chapter 4
Performance Verification

Title	Page

4.1 Introduction

Warning

Procedures in this chapter should be performed by qualified service personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

The Fluke 433/434 Power Quality Analyzer (referred to as Analyzer) should be calibrated and in operating condition when you receive it.

The following performance tests are provided to ensure that the Analyzer is in a proper operating condition. If the Analyzer fails any of the performance tests, calibration adjustment (see Chapter 5) and/or repair (see Chapter 7) is necessary.

The Performance Verification Procedure is based on the specifications, listed in Chapter 2 of this Service Manual. The values given here are valid for ambient temperatures between 15 °C and 35 °C.

Analyzer performance can be checked with single phase 50 and 60 Hz test signals such as generated by a standard Calibrator (e.g. Fluke 5500A).

The tests mainly verify accuracy and offset of voltage and current inputs.

Tests indicated with (*) are optional. They can be done to check if the Analyzer's hardware (analog input channels) is OK. Bear in mind that the outcome of these checks is rather influenced by hardware sanity than by Calibration Adjustment.

Accuracy of all other Analyzer functions is linked to input accuracy and is embedded in the software. This link is tested extensively for each new software release.

Tests are done in V/A/Hz mode (unless indicated otherwise).

All indicated voltages and currents are rms values.

The Performance Verification Procedure is a quick way to check most of the Analyzer's specifications. Because of the highly integrated design of the Analyzer, it is not always necessary to check all features separately.

Always put the Analyzer in STBY (Stand By) mode before changing test leads.

Important: during all tests, signal must be applied to voltage channel A/L1. A/L1 is the reference channel.

The verification procedure assumes that the test engineer is familiar with the operation of Analyzer and Calibrator.

4.2 Equipment Required For Verification

The primary source instrument used in the verification procedures is the Fluke 5500A. If a 5500A is not available, you can substitute another Calibrator as long as it meets the minimum test requirements.

- Fluke 5500A Multi Product Calibrator.
- Stackable Test Leads (4x), as supplied with the 5500A.
- Extra set of stackable test leads capable to withstand 1000 V rms: 4 leads (black, red, yellow, white) are supplied with the 5500A Calibrator. A separate test lead set can be ordered as 5500/LEADS.

Note: for good recognition it is recommended to use a black lead between the Calibrator's LO and the Analyzer's Ground banana input.

- 50Ω Coax Cables (3 pieces required), Fluke PM9092 (0.5m, set of 3).
- Male BNC to Dual Female BNC adapter (3 pieces required), Fluke PM9093.
- Dual Banana Jack to female to male BNC (1 piece required), Fluke PM9082.
- 50Ω feed through termination (4 pieces required): Fluke PM9585.
- Battery Charger / Power Adapter, BC430.

4.3 General Instructions

Follow these general instructions for all tests:

- For all tests, power the Analyzer with the BC430 power adapter/battery charger. The battery pack must be installed and charged sufficiently.
- Allow the 5500A to satisfy its specified warm-up period.
- For each test point , wait for the 5500A to settle.
- Allow the Analyzer a minimum of 30 minutes to warm up.
- One division on the LCD consists of 25 pixels (1 pixel = 0.04 division).

4.4 Operating Instructions

4.4.1 Resetting the Analyzer

Proceed as follows to reset the Analyzer:

- Press to turn the Analyzer off.
- Press and hold SAVE SCREEN.
- Press and release to turn the Analyzer on.
- Wait until the Analyzer has **beeped twice**, and then release SAVE SCREEN. When the Analyzer has beeped twice, the RESET was successful.

4.4.2 Preparation

Proceed as follows:

- Reset the Analyzer.
- Press SETUP. Set the Analyzer to 3-phase WYE, 60 Hz, 120 V. Set Clamp for Phase and Neutral to 1 mV/A, 400 A, 1:1.
- Set the Analyzer in DEMO mode: press SETUP, press F3 - FUNCTION PREF, and select DEMO ON with F1. Demo mode gives increased sensitivity at the voltage inputs. Input voltage must **not exceed 2 V rms in Demo mode!**

4.5 Display And Backlight Test

Proceed as follows to test the display and the backlight:

1. Press to turn the Analyzer on.
2. Remove the BC430 adapter power, and verify that the backlight is dimmed.

3. Apply the BC430 adapter power and verify that the backlight brightness increases.
4. Press and hold (Brightness), then press and release F5 (Function key F5).

   The Analyzer shows the calibration menu in the bottom of the display.

   - Do not press F3 now! If you did, turn the Analyzer off and on, and start at 4.
5. Press F1 **PREVIOUS** three times. The Analyzer shows **Contrast (CL 0100):**
6. Press F3 **CALIBRATE** .

   The Analyzer shows a dark display; the test pattern as shown in Figure 4-1 may be not visible or hardly visible.
   Observe the display closely, and verify that the display shows no abnormalities, as for example very light pixels or lines.

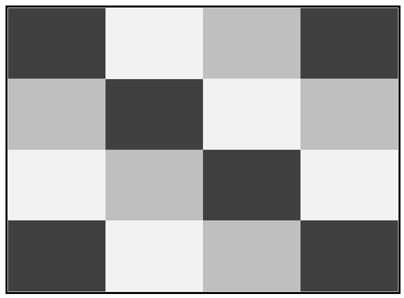


Figure 4-1. Display Pixel Test Pattern

7. Press F2 .
   The test pattern is removed; the Analyzer shows **Contrast (CL 0100):**
8. Press F2 again to do the next step **Contrast (CL 0110):**
9. Press F3 **CALIBRATE**
   The Analyzer shows the display test pattern shown in Figure 4-1, at default contrast. Observe the display closely, and verify that the display shows no abnormalities. Also verify that the contrast of the upper left and upper right square of the test pattern is equal.
10. Press F2 .
    The test pattern is removed; the Analyzer shows **Contrast (CL 0110):**
11. Press F2 again to do the next step **Contrast (CL 0120):**
12. Press F3 **CALIBRATE**
    The Analyzer shows a light display; the test pattern as shown in Figure 4-1 may not be visible or hardly visible.
    Observe the display closely, and verify that the display shows no abnormalities.
13. Turn the Analyzer OFF and ON to exit the calibration menu and to return to the normal operating mode.

If the maximum, minimum, or default display contrast is not OK, then you can set these items without performing a complete calibration adjustment; refer to Section 5 for detailed information.

4.6. Verification Of Current Inputs

4.6.1 Accuracy

Proceed as follows:

1. Must be checked for all phases A/L1, B/L2, C/L3, and N(eutral).
2. Set the Calibrator to 1 V, 60 Hz and STBY.
3. Connect the LO output (black) with the Ground (green) input of the Analyzer. Connect the HI output (red) with all current (BNC) inputs and the A/L1, B/L2, C/L3, and N voltage banana inputs of the Analyzer. Refer to Figure 4.2.

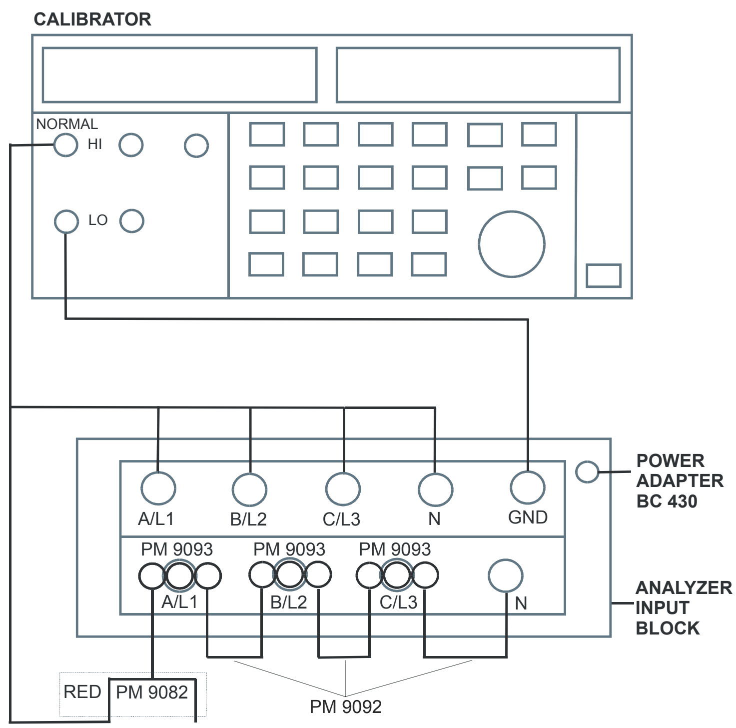


Figure 4-2. verification of Current Inputs

4. Set the Calibrator to OPR (Operate, indicated by a green LED is the OPR key).
5. On the Analyzer press MENU, select Volts/Amps/Hertz, press F5 – OK to enter the function.
6. Check for a current readout A rms between 985 ... 1015 A (tolerance 10 + 5 A = 15 A).
   (Voltage readout V rms must be approx. 0 V at A/L1, B/L2, C/L3 and 172 V at N inputs, frequency approx. 60.00 Hz, Analyzer in DEMO mode).
7. Set the Calibrator to 0 Hz, 0 V and then to OPR.
8. On the Analyzer check for a current readout A rms between 0 ... 5 A.

4.6.2 Bandwidth check of current channels (*)

Is an optional test. Proceed as follows:

1. Set the Calibrator to 1 V, 60 Hz and OPR.
2. The current channels must be checked one by one. Use the Calibrator's edit field function to adjust a readout of 1000 A for the current channel to be checked.
3. Increase the frequency to 3 kHz. Check for a readout of 948 A or more.

Table 4-1. Bandwidth Check of Current Channels

Current Channel to be verified	Readout at 60 Hz (adjust Calibrator with EDIT FIELD)	Readout at 3 kHz
A/L1	1000 A	948 A or more
B/L2	1000 A	948 A or more
C/L3	1000 A	948 A or more
N	1000 A	948 A or more

4. Set the Calibrator to STBY.
5. Disconnect the leads from the current inputs.
6. Switch the Analyzer's DEMO mode to OFF.

4.7 Voltage Inputs

4.7.1 Introduction

WARNING

Dangerous voltages will be present on the calibration source and connecting cables during the following steps. Ensure that the Calibrator is in standby mode before making any connection between the Calibrator and the Analyzer.

Proceed as follows:

1. To check the A/L1, B/L2, C/L3 inputs, connect the N input to Ground (See Figure 4-3). N now will give zero reading.

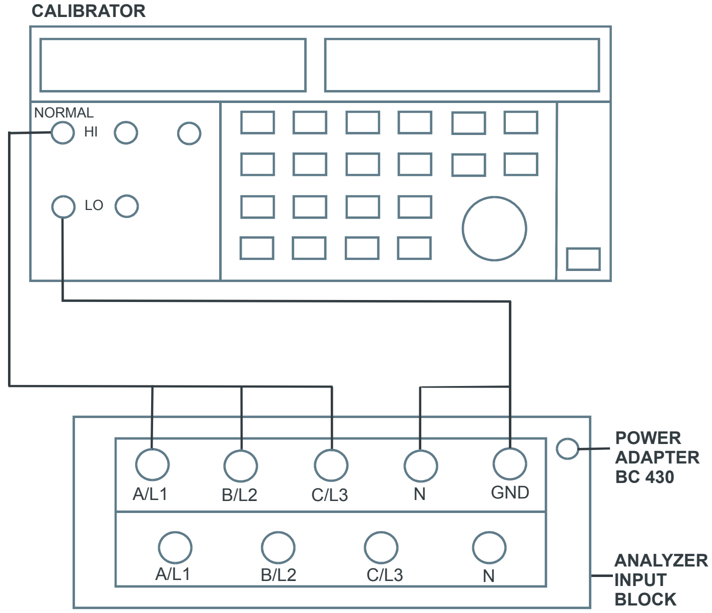


Figure 4-3. Checking the A/L1, B/L2, and C/L3 voltage inputs

2. To check the N input, connect the N input with the adjacent C/L3 input. A/L1, B/L2, C/L3 now will give zero reading. Refer to Figure 4-4.

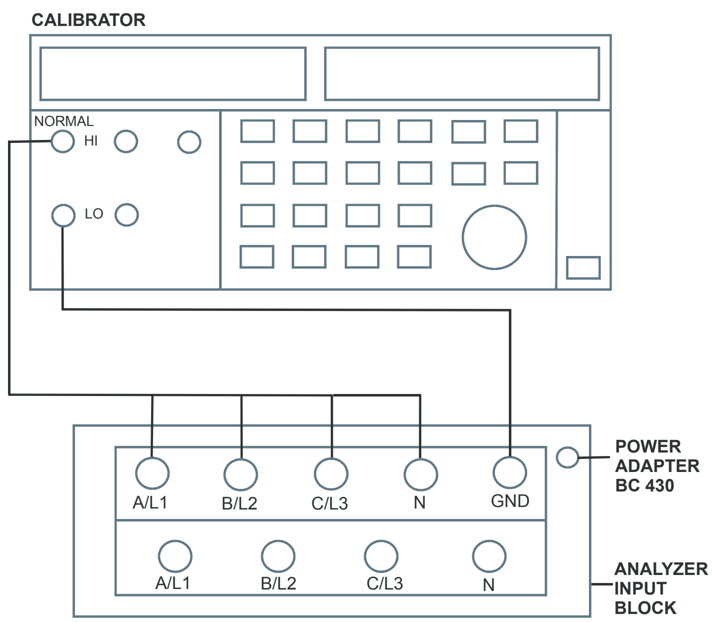


Figure 4-4. Checking the N (Neutral) voltage input

4.7.2 Verification of voltage inputs in 120 V range

Accuracy Check of Channel A/L1, B/L2, C/L3:

1. Set the Analyzer to 120 V, 60 Hz nominal (SETUP menu, arrow and ENTER keys). Press MENU, select Volts/Amps/Hertz, press F5 - OK.
2. To check the A/L1, B/L2, C/L3 inputs: connect the N input to Ground (See Figure 4-3).
3. Set the Calibrator to 0 Hz, 0 V and then to OPR.
4. Check for a voltage readout V rms between 0 ... 0.6 V.
5. Check the 120 V range according to the table below.

Table 4-2. Accuracy Check of Voltage Channels A/L1, B/L2, C/L3

Set Calibrator to	Readout at Voltage Channels
0 Hz, 0 V, OPR	0 ... 0.6 V
12 V, 60 Hz, OPR	11.4 ... 12.6 V
120 V, 60 Hz, OPR	119.4 ... 120.6 V, 59.94 ... 60.06 Hz
240 V, 60 Hz, OPR	239.4 ... 240.6 V, 59.94 ... 60.06 Hz

6. Set the Calibrator to STBY.

Optional Test. Bandwidth Check of Channel A/L1, B/L2, C/L3 (*):

7. Set the Calibrator to 120 V, 60 Hz and OPR.
8. Now check the voltage channels one by one. Use the Calibrator's field edit function to adjust the Calibrator to an Analyzer readout of 120.0 V.
9. Increase the frequency to 3 kHz. Check for a readout of 113.8 V or more. Check the channels according to the table below.

Table 4-3. Bandwidth Check of Voltage Channels A/L1, B/L2, C/L3

Voltage Channel to be verified	Readout at 60 Hz (adjust Calibrator with EDIT FIELD)	Readout at 3 kHz
A/L1	120.0 V	113.8 V or more
B/L2	120.0 V	113.8 V or more
C/L3	120.0 V	113.8 V or more

10. Set the Calibrator to STBY.

Accuracy Check of Channel N (Neutral):

11. Connect the N input with the C/L3 input (See Figure 4-4). A/L1, B/L2, C/L3 now give zero reading.
12. Set the Calibrator to 0 Hz / 0 V and then to OPR.

13. Check for a voltage readout V rms between 0 ... 0.6 V.
14. Check the 120 V range according to the table below.

Table 4-4. Accuracy Check of Voltage Channel N (Neutral)

Set Calibrator to	Readout at Voltage Channel N
0 Hz, 0 V, OPR	0 ... 0.6 V
12 V, 60 Hz, OPR	11.4 ... 12.6 V
120 V, 60 Hz, OPR	119.4 ... 120.6 V, 59.94 ... 60.06 Hz
240 V, 60 Hz, OPR	239.4 ... 240.6 V, 59.94 ... 60.06 Hz

15. Set the Calibrator to STBY.

Optional test. Bandwidth Check of Channel N (*):

16. Set the Calibrator to 120 V, 60 Hz and OPR.
17. Now check the voltage channel N. Use the Calibrator's field edit function to adjust the Calibrator to an Analyzer readout of 120.0 V.
18. Increase the frequency to 3 kHz. Check for a readout of 113.8 V or more.
19. Set the Calibrator to STBY.

4.7.3 Verification of voltage inputs in 230 V range

Accuracy Check of Channel A/L1, B/L2, C/L3:

1. Set the Analyzer to 230 V, 50 Hz nominal (SETUP menu, arrow and ENTER keys). Press MENU, select Volts/Amps/Hertz, press F5 - OK.
2. To check the A/L1, B/L2, C/L3 inputs: connect the N input to Ground (See Figure 4-3).
3. Set the Calibrator to 0 Hz, 0 V and then to OPR.
4. Check for a voltage readout V rms between 0 ... 1.2 V.
5. Check the 230 V range according to the table below.

Table 4-5. Accuracy Check of Voltage Channels A/L1, B/L2, C/L3

Set Calibrator to	Readout at Voltage Channels
0 Hz, 0 V, OPR	0 ... 1.2 V
23 V, 50 Hz, OPR	21.8 ... 24.2 V
230 V, 50 Hz, OPR	228.8 ... 231.2 V, 49.95 ... 50.05 Hz
460 V, 50 Hz, OPR	458.8 ... 461.2 V, 49.95 ... 50.05 Hz

6. Set the Calibrator to STBY.

Optional Test. Bandwidth Check of Channel A/L1, B/L2, C/L3 (*):

7. Set the Calibrator to 230 V, 50 Hz and OPR
8. Now check the voltage channels one by one. Use the Calibrator's field edit function to adjust the Calibrator to an Analyzer readout of 230.0 V
9. Increase the frequency to 3 kHz. Check for a readout of 218.3 V or more. Check the channels according to the table below.

Table 4-6. Bandwidth Check of Voltage Channels A/L1, B/L2, C/L3

Voltage Channel to be verified	Readout at 50 Hz (adjust Calibrator with EDIT FIELD)	Readout at 3 kHz
A/L1	230.0 V	218.3 V or more
B/L2	230.0 V	218.3 V or more
C/L3	230.0 V	218.3 V or more

10. Set the Calibrator to STBY.

Accuracy Check of Channel N (Neutral):

11. Connect the N input with the C/L3 input (See Figure 4-4). A/L1, B/L2, C/L3 now give zero reading.
12. Set the Calibrator to 0 Hz / 0 V and then to OPR.
13. Check for a voltage readout V rms between 0 ... 1.2 V.
14. Check the 230 V range according to the table below.

Table 4-7. Accuracy Check of Voltage Channel N (Neutral)

Set Calibrator to	Readout at Voltage Channel N
0 Hz, 0 V, OPR	0 ... 1.2 V
23 V, 50 Hz, OPR	21.8 ... 24.2 V
230 V, 50 Hz, OPR	228.8 ... 231.2 V, 49.95 ... 50.05 Hz
460 V, 50 Hz, OPR	458.8 ... 461.2 V, 49.95 ... 50.05 Hz

15. Set the Calibrator to STBY.

Optional Test. Bandwidth Check of Channel N (*):

16. Set the Calibrator to 230 V, 50 Hz and OPR.
17. Now check the voltage channel N. Use the Calibrator's field edit function to adjust the Calibrator to an Analyzer readout of 230.0 V.
18. Increase the frequency to 3 kHz. Check for a readout of 218.3 V or more.
19. Set the Calibrator to STBY.

4.7.4 Verification of voltage inputs in 400 V range

Accuracy Check of Channel A/L1, B/L2, C/L3:

1. Set the Analyzer to 400 V, 50 Hz nominal (SETUP menu, arrow and ENTER keys). Press MENU, select Volts/Amps/Hertz, press F5 - OK.
2. To check the A/L1, B/L2, C/L3 inputs: connect the N input to Ground (See Figure 4-3).
3. Set the Calibrator to 0 Hz, 0 V and then to OPR.
4. Check for a voltage readout V rms between 0 ... 2 V.
5. Check the 400 V range according to the table below.

Table 4-8. Accuracy Check of Voltage Channels A/L1, B/L2, C/L3

Set Calibrator to	Readout at Voltage Channels
0 Hz, 0 V, OPR	0 ... 2 V
40 V, 50 Hz, OPR	38 ... 42 V
400 V, 50 Hz, OPR	398 ... 402 V, 49.95 ... 50.05 Hz
800 V, 50 Hz, OPR	798 ... 802 V, 49.95 ... 50.05 Hz

6. Set the Calibrator to STBY.

Optional Test. Bandwidth Check of Channel A/L1, B/L2, C/L3 (*):

7. Set the Calibrator to 400 V, 50 Hz and OPR.
8. Now check the voltage channels one by one. Use the Calibrator's field edit function to adjust the Calibrator to an Analyzer readout of 400.0 V.
9. Increase the frequency to 3 kHz. Check for a readout of 379.8 V or more. Check the channels according to the table below.

Table 4-9. Bandwidth Check of Voltage Channels A/L1, B/L2, C/L3

Voltage Channel to be verified	Readout at 50 Hz (adjust Calibrator with EDIT FIELD)	Readout at 3 kHz
A/L1	400.0 V	379.8 V or more
B/L2	400.0 V	379.8 V or more
C/L3	400.0 V	379.8 V or more

10. Set the Calibrator to STBY.

Accuracy Check of Channel N (Neutral):

11. Connect the N input with the C/L3 input (See Figure 4-4). A/L1, B/L2, C/L3 now give zero reading.

12. Set the Calibrator to 0 Hz / 0 V and then to OPR.
13. Check for a voltage readout V rms between 0 ... 1.2 V.
14. Check the 400 V range according to the table below.

Table 4-10. Accuracy Check of Voltage Channel N (Neutral)

Set Calibrator to	Readout at Voltage Channel N
0 Hz, 0 V, OPR	0 ... 2 V
40 V, 50 Hz, OPR	38 ... 42 V
400 V, 50 Hz, OPR	398 ... 402 V, 49.95 ... 50.05 Hz
800 V, 50 Hz, OPR	798 ... 802 V, 49.95 ... 50.05 Hz

15. Set the Calibrator to STBY.

Optional Test. Bandwidth Check of Channel N (*):

16. Set the Calibrator to 400 V, 50 Hz and OPR.
17. Now check the voltage channel N. Use the Calibrator's field edit function to adjust the Calibrator to an Analyzer readout of 400.0 V.
18. Increase the frequency to 3 kHz. Check for a readout of 379.8 V or more.
19. Set the Calibrator to STBY.

4.7.5 Verification of voltage inputs in 6 kV range (Transients)

Set the Analyzer to Transients mode (Analyzer remains in 400 V, 50 Hz nominal).

Press MENU, select Transients, then F5 – OK, then START.

In the START screen: Voltage Swell must be on; the other 4 functions must be off.

Accuracy Check of Channel A/L1, B/L2, C/L3:

1. To check the A/L1, B/L2, C/L3 inputs: connect the N input to Ground (See Figure 4-3).
2. Set the Calibrator to 0 Hz, 0 V and then to OPR.
3. Check for a voltage readout V rms between 0 ... 10 V in the screen header.
4. Check the 6 kV range according to the table below.

Table 4-11. Accuracy Check of Voltage Channels A/L1, B/L2, C/L3

Set Calibrator to	Readout at Voltage Channels
0 Hz, 0 V, OPR	0 ... 10 V
100 V, 50 Hz, OPR	90 ... 110 V
1000 V, 50 Hz, OPR	990 ... 1010 V, 49.95 ... 50.05 Hz

5. Set the Calibrator to STBY.

Optional Test. Bandwidth Check of Channel A/L1, B/L2, C/L3 (*):

6. Set the Calibrator to 400 V, 50 Hz and OPR.
7. Now check the voltage channels one by one. Use the Calibrator's field edit function to adjust the Calibrator to an Analyzer readout of 400 V.
8. Increase the frequency to 3 kHz. Check for a readout of 378 V or more. Check the channels according to the table below.

Table 4-12. Bandwidth Check of Voltage Channels A/L1, B/L2, C/L3

Voltage Channel to be verified	Readout at 50 Hz (adjust Calibrator with EDIT FIELD)	Readout at 3 kHz
A/L1	400 V	378 V or more
B/L2	400 V	378 V or more
C/L3	400 V	378 V or more

9. Set the Calibrator to STBY.

Accuracy Check of Channel N (Neutral):

10. Connect the N input with the C/L3 input (See Figure 4-4). A/L1, B/L2, C/L3 now give zero reading.
11. Set the Calibrator to 0 Hz / 0 V and then to OPR.
12. Check for a voltage readout V rms between 0 ... 1.2 V.
13. Check the 6 kV range according to the table below.

Table 4-13. Accuracy Check of Voltage Channel N (Neutral)

Set Calibrator to	Readout at Voltage Channels N
0 Hz, 0 V, OPR	0 ... 10 V
100 V, 50 Hz, OPR	90 ... 110 V
1000 V, 50 Hz, OPR	990 ... 1010 V, 49.95 ... 50.05 Hz

14. Set the Calibrator to STBY.

Optional Test. Bandwidth Check of Channel N (*):

15. Set the Calibrator to 400 V, 50 Hz and OPR.
16. Now check the voltage channel N. Use the Calibrator’s field edit function to adjust the Calibrator to an Analyzer readout of 400 V.
17. Increase the frequency to 3 kHz. Check for a readout of 378 V or more.
18. Set the Calibrator to STBY.

Note: bandwidth will be slightly higher than in V/A/Hz mode because a low pass filter in the analog input channel is off during Transients mode.

4.8 Channel Isolation (*)

This optional test verifies cross talk from voltage channels to current channels. Voltage channels normally get high voltages while the current channels have a sensitivity of a couple of volts. This way of testing verifies the most critical situation.

Proceed as follows:

1. Connect the Analyzer’s A/L1, B/L2, C/L3, and N voltage inputs with the HI output of the Calibrator.
   Connect the Analyzer’s GND input with the LO output of the Calibrator.
2. Set all current channels to 1 mV/A, 400 A, 1:1 (SETUP menu, arrow and ENTER keys).
   Put the Analyzer in 3-phase WYE, 50 Hz, 400V, and V/A/Hz mode.
3. Short-circuit the four current inputs with a termination piece of 50 Ω or lower. Refer to Figure 4-5.
4. Set the Calibrator to 800 V, 50 Hz, and OPR.
5. Check that the readout on all current channels does not exceed 19 A (this includes the 5 A basic error of the current channels).
6. Set the Calibrator to STBY.
7. Disconnect all test leads.

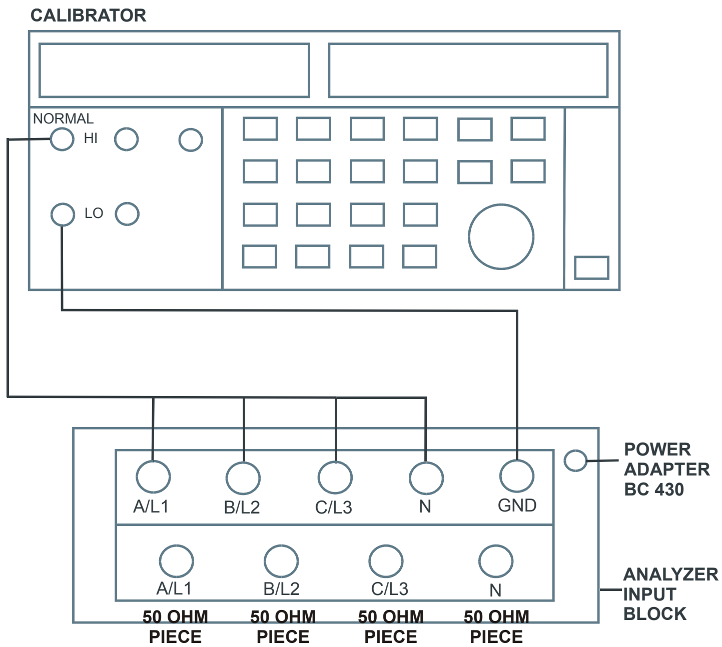


Figure 4-5. Checking the Channel isolation.

Chapter 5
Calibration Adjustment

Title	Page

5.1 General

5.1.1 Introduction

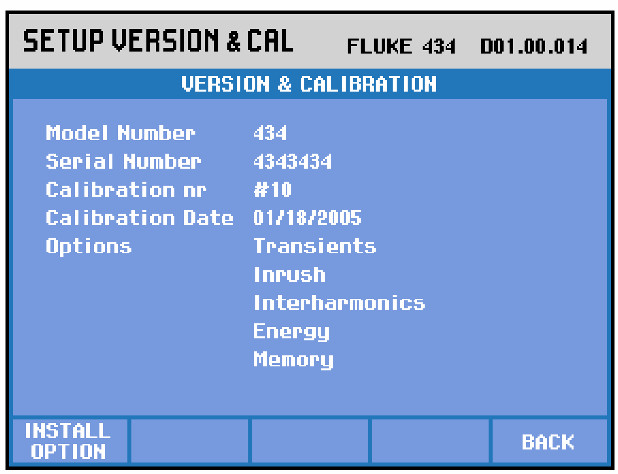
The following information, provides the complete Calibration Adjustment procedure for the Fluke 433/434 Power Quality Analyzer (referred to as Analyzer). The Analyzer allows closed-case calibration using known reference sources. It measures the reference signals, calculates the correction factors, and stores the correction factors in RAM. After completing the calibration, the correction factors can be stored in FlashROM.

The Analyzer should be calibrated after repair, or if it fails the performance test. The Analyzer has a normal calibration cycle of one year.

5.1.2 Calibration number and date

When storing valid calibration data in FlashROM after performing the calibration adjustment procedure, the calibration date is set to the actual Analyzer date, and calibration number is raised by one. To display the calibration date and - number:

1. Press SETUP, then press F2 to see the Version & Calibration data (see Figure 5.1).
2. Press F5 to return to exit the Version & Calibration screen.



version-cal-screen.bmp

Figure 5-1. Version & Calibration Data

Note:

The calibration date and calibration number will not be changed if only the Contrast Calibration Adjustment is changed

5.1.3 General instructions

Follow these general instructions for all-calibration steps:

- Allow the 5500A to satisfy its specified warm-up period. After each change of output conditions, wait for the 5500A to settle. This may take a couple of seconds.

- The required warm up period for the Analyzer is included in the Warming Up period (Calibration step CL 0200).
- Ensure that the Analyzer battery is charged sufficiently.
- Power the Analyzer via the BC430 Battery Charger/Power Adapter

5.1.4 Equipment required for calibration

The primary source instrument used in the calibration procedures is the Fluke 5500A. If a 5500A is not available, you can substitute another Calibrator as long as it meets the minimum test requirements.

- Fluke 5500A Multi Product Calibrator.
- Stackable Test Leads (4x), supplied with the 5500A.
- Extra set of stackable test leads capable to withstand 1000 V rms: 4 leads (black, red, yellow, white) are supplied with the 5500A Calibrator. A separate test lead set can be ordered as 5500/LEADS.
  Note: for good recognition it is advised to use a black lead between the Calibrator's LO output and the Analyzer's Ground banana input.
- 50Ω Coax Cables (3 pieces required): Fluke PM9092 (0.5m, set of 3, 1 set required).
- Male BNC to Dual Female BNC adapter: Fluke PM9093 (3 pieces required).
- Dual Banana Jack to female to male BNC: Fluke PM9082 (1 piece required).
- Battery Charger / Power Adapter: BC430.

5.2 Calibration Procedure Steps

To do a **complete** calibration adjustment you must do all following steps:

1. Select the Calibration Mode, section 5.3
2. Do the Contrast Calibration Adjustment, section 5.4
3. Do the Warming Up, section 5.5
4. Do the Final Calibration, section 5.6
5. Save the Calibration Data and Exit the calibration mode, section 5.7

The following **partial** calibration is allowed:

- Contrast calibration, do the above-mentioned steps 1, 2, and 5.
  If during normal operation the display cannot be made dark or light enough, or if the display after a Analyzer reset is too light or too dark, you can do this calibration.

5.3 Starting The Calibration

Follow the steps below to start the calibration:

1. Power the Analyzer via the power adapter input using the BC430 power adapter.
2. Press SETUP and check the actual Analyzer date. If necessary adjust the date (the calibration date will become the Analyzer date when saving the calibration data):

- Operate to highlight the Date.
- Press to open the SETUP DATE menu.
- Operate to select in sequence Year, Month, and Day.
- Operate to adjust each selected item Year, Month, and Day.
- Press to leave the SETUP DATE menu.

3. Select the calibration mode.

   The Calibration Adjustment Procedure uses built-in calibration setups, that can be accessed in the calibration mode.

   To enter the calibration mode proceed as follows:

   - Press and hold , press and release , then release .

   The display shows the **CAL MODE** (Calibration Adjustment) screen.

   The display shows the calibration step **Warming Up (CL 0200)** , the calibration status **:IDLE (valid)** or **:IDLE (invalid)** , and the soft key menu.

Continue as indicated in section 5.2.

You can leave the calibration mode without changing the calibration data by turning the Analyzer off.

Explanation of screen messages and key functions.

When the Analyzer is in the calibration Mode, only the to soft keys, the and the key can be operated, unless otherwise stated.

The calibration adjustment screen shows the actual calibration step (name and number) and its status: **Cal Name (CL nnnn) :Status (...)**

Cal Name — Name of the selected calibration step, e.g. **Warming Up**

(CL nnnn) — Number of the calibration step

Status (...) can be:

IDLE (valid) — After (re)entering this step, the calibration process is not started. The calibration data of this step are valid. This means that the last time this step was done, the calibration was successful. It does not necessarily mean that the unit meets the specifications related to this step!

IDLE (invalid) — After (re)entering this step, the calibration process is not started. The calibration data are invalid. This means that the last time this step was done, the calibration was not successful. Most probably the unit will not meet the specifications if the actual calibration data are saved.

BUSY aaa% bbb% — Calibration adjustment step in progress; progress % for Input A and Input B. During Warming Up the elapsed time is shown.

READY — Calibration adjustment step finished.

Functions of the keys F1-F4 are:

F1	**PREV**	select the previous step
F2	**NEXT**	select the next step
F3	**CAL**	start the calibration adjustment of the actual step
F5	**EXIT**	leave the calibration mode

5.4 Contrast Calibration Adjustment

After entering the calibration mode the display shows:

WarmingUp (CL 0200):IDLE (valid)

Do not press F3 now! If you did, turn the Analyzer off and on, and enter the calibration mode again.

Proceed as follows to adjust the maximum display darkness (CL 0100), the default contrast (CL 0110) , and the maximum display brightness (CL 0120).

1. Press F1 three times to select maximum darkness calibration **Contrast (CL 0100):**
2. Press F3 **CALIBRATE** . The display will show a dark test pattern, see Figure 5-2
3. Using ▲ ▼ adjust the display to the maximum darkness at which the test pattern is only just visible.
4. Press F2 to return to the soft key menu.
5. Press F2 to select default contrast calibration **Contrast (CL 0110):**
6. Press F3 **CALIBRATE**. The display shows the test pattern at default contrast.
7. Using ▲ ▼ set the display to optimal (becomes default) contrast.
8. Press F2 to return to the soft key menu.
9. Press F2 to select maximum brightness calibration **Contrast (CL 0120):**
10. Press F3 **CALIBRATE**. The display shows a bright test pattern.
11. Using ▲ ▼ adjust the display to the maximum brightness, at which the test pattern is only just visible.
12. Press F2 to return to the soft key menu.
13. Now you can either
    - Exit, if only the Contrast had to be adjusted. Continue at Section 5.7.

    or

    - Do the complete calibration. Press F2 to select the next step (Warming Up), and continue at Section 5.5.

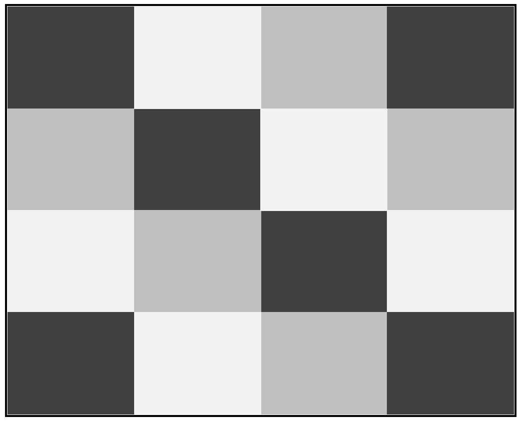


Figure 5-2. Display Test Pattern

Note: After having left calibration step CL 0120 in instruments with V01.00 software, the display contrast stays in the state as adjusted for maximum brightness. Because of this, menu visibility is insufficient. For instruments where this occurs it is recommended to save calibration data and exit as explained in Chapter 5.7. Then select calibration mode again and continue with calibration step CL 0200 (WarmingUp).

5.5 Warming Up

The Warming Up state will be entered after entering the calibration mode (section 5.3), or after selecting the next step if you have done the Contrast Calibration step CL 120 (section 5.4). The display will show
WarmingUp (CL 0200):IDLE (valid) or **(invalid)**.

Unless you want to calibrate the display contrast only, you must always start the calibration adjustment at the **Warming Up (CL 0200)** step. Starting at another step will make the calibration invalid!

The Warming Up consists of a 30 minutes warming-up period.

Proceed as follows to do the Warming Up:

1. Remove all input connections from the Analyzer.
2. Press F3 to start the Warming-Up.
   The display shows the calibration step in progress, and its status.
   The display shows **WarmingUp (CL 0200) :BUSY 00:29:59 .** The warming-up period is counted down from 00:29:59 to 00:00:00
3. Wait until the display shows **Warmingup: READY**
   If you turn off the Analyzer now by accident, turn it on again immediately; now you can select the calibration mode, and continue with step 4 below (press F2 **NEXT** several times, see 5.6).
   If you turn off the instrument now, and you do not turn on immediately, the Analyzer has cooled down, and you must repeat the Warming Up (select the calibration mode and start at CL 0200).
4. Press F2 **NEXT** and continue at Section 5.6.

5.6 Final Calibration

Before starting the final calibration you must have done the Warming Up (section 5.5)!

The final calibration is simple and straightforward and consists of the following elements:

- Offset adjustment of voltage and current inputs (0 V input signal).
- Low voltage adjustment of voltage and current inputs (0.67 V rms, 50 Hz input signal).
- Voltage gain adjustment of voltage inputs (120/230/480/600 V rms, 50 Hz input).

The final calibration requires input conditions that will be described in each step. You must always start the Final Calibration at the first step, see Section 5.6.1. Starting at another step will make the calibration invalid!

If you proceeded to calibration step N (for example step CL 0320), then return to a previous step (for example step CL 0310) , and then calibrate this step, the complete final calibration becomes invalid; then you must repeat the calibration starting at 5.6.1.

It is allowed to repeat a step that shows the status **:READY** by pressing F3 again.

5.6.1 Offset adjustment

Proceed as follows to do the Offset adjustment of all inputs:

1. Connect the Analyzer to the 5500A as shown in Figure 5-3.

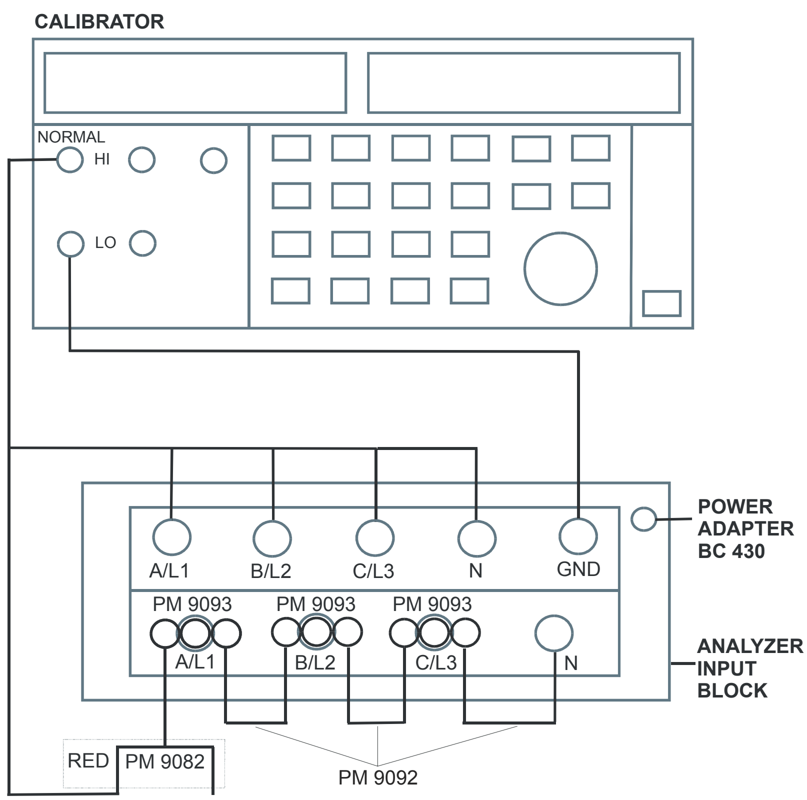


Figure 5-3. Offset, Low Voltage, and Current Gain Adjustment

2. The display must show step CL 0300.
   If it does not, then press F1 or F2 to select the first calibration step in Table 5-1.
3. Set the 5500A output to source the signal 0 Hz, 0 V required for the calibration steps in Table 5-1.
4. Set the 5500A in operate (OPR) or standby (STBY) as indicated.
5. Press F3 to start the calibration.
6. Wait until the display shows calibration status **:READY** .
7. Press F2 to select the next calibration step, and start the calibration.
   Continue through all calibration points of Table 5-1.
8. When you are finished, set the 5500A to Standby (STBY).
9. Continue at Section 5.6.2.

Table 5-1. Offset Adjustment of all Inputs

Cal step	Description	5500A Setting
CL 0300	OffsetLowVolt	0 V, 0 Hz, OPR
CL 0310	Offset125Volt	0 V, 0 Hz, OPR
CL 0320	Offset250Volt	0 V, 0 Hz, OPR
CL 0330	Offset500Volt	0 V, 0 Hz, OPR
CL 0340	Offset6KVolt	0 V, 0 Hz, OPR
---	---	STBY

5.6.2 Low voltage and current gain adjustment

Proceed as follows to do the Low Voltage and Current Gain Adjustment:

1. Press F2 to select calibration step CL 0400.
2. Keep the Analyzer connected to the 5500A as shown in Figure 5-3.
3. Set the 5500A Calibrator to source 0.67 V, 50 Hz .
4. Set the 5500A Calibrator to operate (OPR).
5. Press F3 to start the calibration.
6. Wait until the display shows calibration status **:READY** .
7. Set the 5500A Calibrator to Standby (STBY).

5.6.3 Voltage gain adjustment

Proceed as follows to do the Voltage gain Adjustment.

1. Press F2 to select the first calibration step in Table 5-2 (CL 0410).
2. Connect the Analyzer to the 5500A as shown in Figure 5-4.

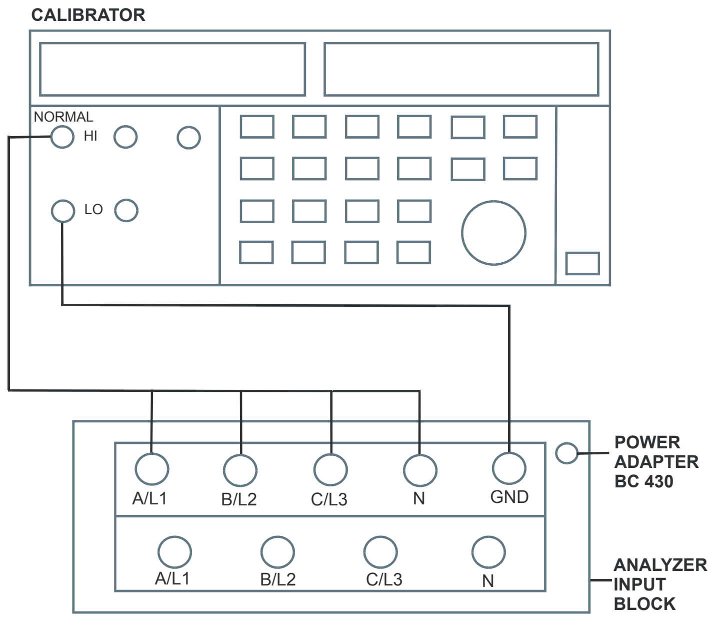


Figure 5-4. Voltage Gain Adjustment

3. Set the 5500A to supply 120 V, 50 Hz.

⚠ Warning

Dangerous voltages will be present on the calibration source and connection cables during the following steps. Ensure that the Calibrator is in standby (STBY) mode before making any connection between the Calibrator and the Analyzer.

4. Set the 5500A to operate (OPR).
5. Press F3 to start the calibration.
6. Wait until the display shows calibration status **:READY**.
7. Press F2 to select the next calibration step, set the 5500A to the next calibration point, and start the calibration. Continue through all calibration points of Table 5-2.
8. Set the 5500A to STBY (Standby).

Table 5-2. Voltage Gain Adjustment

Cal step	Description	5500A Setting
CL 0410	Gain125Volt	120 V, 50 Hz, OPR
CL 0420	Gain250Volt	230 V, 50 Hz, OPR
CL 0430	Gain500Volt	480 V, 50 Hz, OPR
CL 0440	Gain6KVolt	600 V, 50 Hz, OPR
---	---	STBY

9. Continue at section 5.7

5.7 Save Calibration Data And Exit

Proceed as follows to save the calibration data, and to exit the Maintenance mode:

1. Remove all test leads from the Analyzer inputs.
2. Press F5 **EXIT**. The Analyzer will display:

Calibration data valid.
Save data and exit maintenance mode?

Note

Calibration data valid indicates that the calibration adjustment procedure is performed correctly. It does not necessarily mean that the Analyzer meets the characteristics listed in Chapter 2.

3. Press F5 **YES** to save and exit.

Note 1

After saving the calibration data, the calibration number and - date will be updated if the calibration data have been changed and the data are valid.
The calibration number and - date will not change if:
- the calibration mode is entered and left without doing a calibration adjustment.
- only the contrast calibration adjustment (5.4) and/or the probe calibration is done.

Note 2

If you press F4 **NO** *,the Analyzer returns to the calibration mode. You can either calibrate the Analyzer again, or press* F5 **EXIT** *,* F5 **YES** *to save and exit.*

Possible error messages.

The following messages can be shown on the Analyzer display:

WARNING: Calibration data not valid.
Save data and exit maintenance mode?

Proceed as follows:

- If you did the Warming Up and Pre-Calibration successfully (section 5.5), and you want to store the Pre-Calibration data before continuing with the Final Calibration:

  ⇒ Press F5 **YES**.

  When turning the Analyzer off and on again, it will show the message:

  The instrument needs calibration.
  Please contact your service center.

The calibration date and number will not be updated. You must continue with the Final Calibration!

- To return to the Maintenance mode, if you want to repeat the complete calibration:

  ⇒ Press F4 **NO**.

  Now press F1 until the display shows **Warming Up (CL 0200):IDLE**, and calibrate the Analyzer, starting at section 5.5.

- If you want to exit and maintain the old calibration data:

Turn the Analyzer off.

Chapter 6
Disassembling the Analyzer

Title	Page

6.1. Introduction

This section provides the required disassembling procedures. The printed circuit assembly removed from the Analyzer must be adequately protected against damage.

Warning

To avoid electric shock, disconnect test leads, probes and power supply from any live source and from the Analyzer itself. Always remove the battery pack before completely disassembling the Analyzer. Only qualified personnel using customary precautions against electric shock should work on a disassembled unit with power on

6.2. Disassembly & Reassembly Procedures

6.2.1 Required Tools

To access all the assemblies, you need the following:

- Static-free work surface, and anti-static wrist wrap.
- #10 Torx screwdriver.
- Cotton gloves (to avoid contaminating the lens, PCA, and flat cable contacts).

6.2.2 Removing the Tilt Stand & Hang Strap

Use the following procedure to remove the tilt stand and hang strap (Figure 6-6, item 15 and item 10).

1. Set the tilt stand to a 45-degree position respective to the Analyzer bottom.
2. The hinge consists of a circular raised rim in the tilt stand that is located over a circular lowering in the bottom case. Pull sideward on the front edge of the tilt stand until the hinge releases. Then rotate the stand to the rear to remove it.
3. The figure below shows how to remove and install the hang strap.

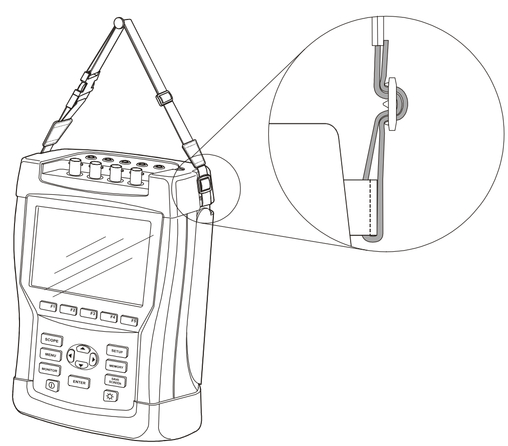


Figure 6-1. How to remove and fix the hang strap

6.2.3 Replacing the Side-Strap, Changing the Side-Strap Position

The side-strap (figure 6-6, item 16) can be attached at the right or left side of the Analyzer. Use the following procedure to replace the strap, or to change the strap position.

1. To remove the strap, unfold the strap ends (provided with Velcro tape), and pull the ends out of the strap holders (item 17).
2. To change the strap position open the Analyzer (see Section 6.2.4), remove the strap with the strap holders, attach them to the other side, and reassemble the Analyzer.

6.2.4 Opening the Analyzer, Removing the Battery

Use the following procedure to open the Analyzer, and to remove the battery:

1. Loosen the two M3 Torx screws that secure the input cover (Figure 6-2).
   Note: fix the screws firmly when installing the input cover again. This assures that the housing is closed sufficiently.
2. Loosen the two M3 Torx screws that secure the bottom holster (Figure 6-3).
3. Pull off the input cover and the bottom holster (Figure 6-4).
4. Unscrew the two screws that lock the bottom case.
5. Lift the bottom case at the lower side to remove it.
6. Unplug and lift out the battery pack (Figure 6-5).
7. Unplug the cable leading to the Main PCA (pull the cable gently backwards).

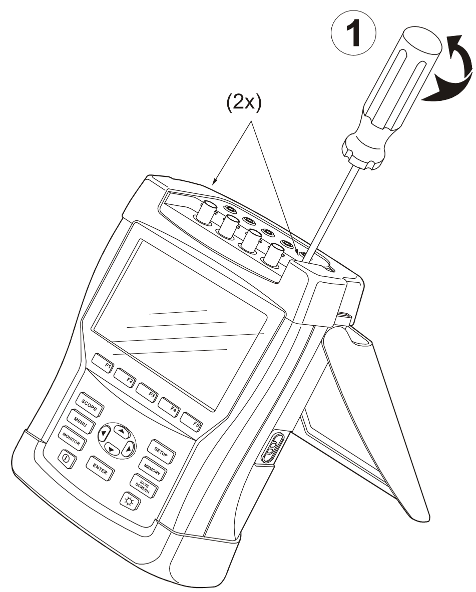


Figure 6-2. Loosen 2 Input Cover Screws

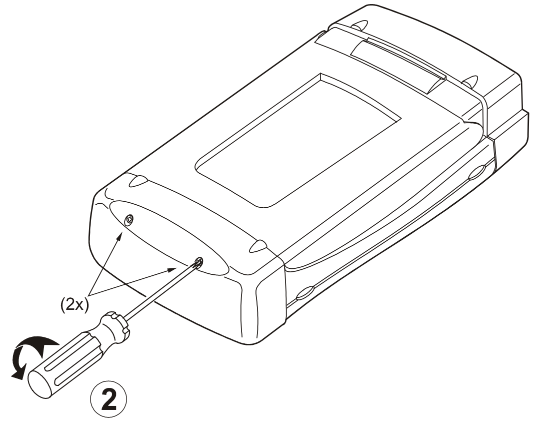


Figure 6-3. Loosen 2 Bottom Holster Screws

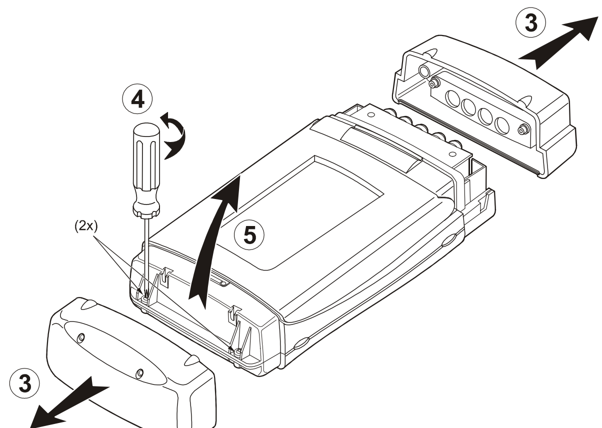


Figure 6-4. Opening the Analyzer

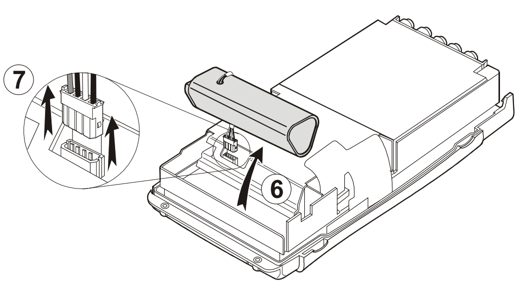


Figure 6-5. Removing the Battery Pack

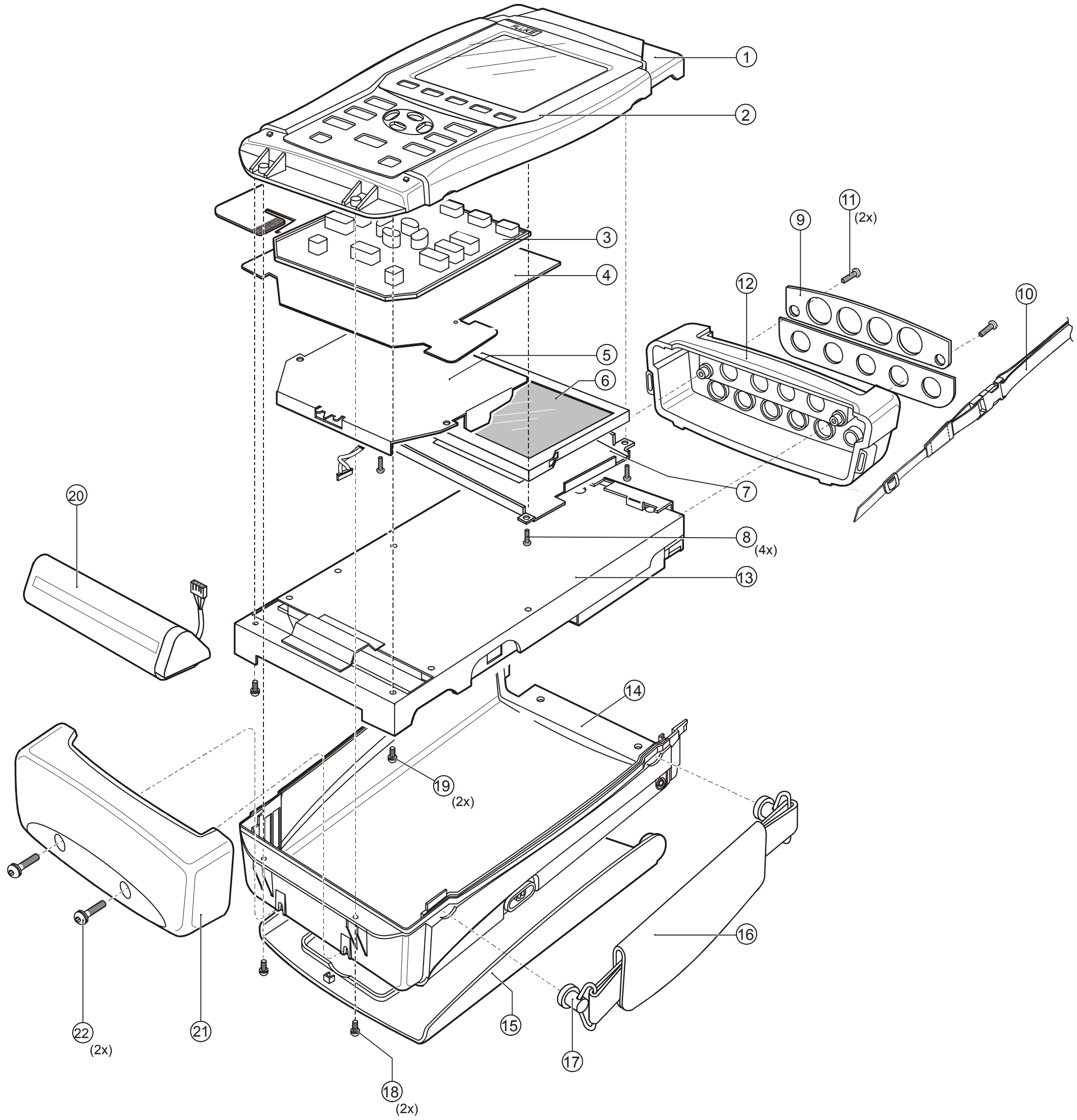


Figure 6-6. Final Assembly Details

6.2.5 Removing the Main PCA Unit

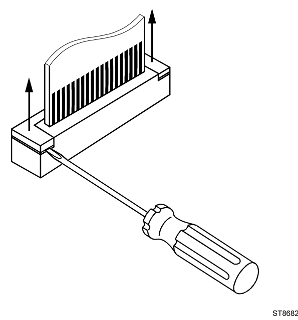
Caution

To avoid contaminating the flex cable contacts with oil from your fingers, do not touch the contacts (or wear gloves). Contaminated contacts may not cause immediate instrument failure in controlled environments. Failures typically show up when contaminated units are operated in humid areas.

Referring to Figure 6-6, use the following procedure to remove the main PCA unit.

1. Open the Analyzer (see Section 6.2.4).
2. Disconnect the blue keypad foil (item 4) flat cable, and the white LCD (item 6) flex cable. Unlock each cable by lifting the connector latch at the left and right edge

using a small screw-driver, see Figure 6-7. The latch remains attached to the connector body.



ST8682.WMF

Figure 6-7. Flex Cable Connectors

3. Unplug the two-wire backlight cable.

Warning

If the battery pack or the power adapter is connected, the LCD backlight voltage on the wire cable is 400V ! (when the Analyzer is on).

4. Remove the two screws (item 19) that secure the Main PCA unit to the top case.
5. Gently unlock the flaps of the keypad foil (item 4) that are stuck on to the metal shielding box.
6. Unlock the plastic clamps at the inputs side and remove the Main PCA unit.

6.2.6 Removing the Display Assembly

There are no serviceable parts in the display assembly. Referring to Figure 6-6, use the following procedure to remove the display assembly.

1. Remove the main PCA unit (see Section 6.2.5).
2. Unscrew the four screws item 8.
3. Remove the display assembly (item 6) with its mounting frame (item 7).
   To prevent finger contamination, wear cotton gloves, or handle the display assembly by its edges.
4. Remove the display from the mounting frame.

6.2.7 Replacing the LCD Window/Decal

The LCD window/decal (Figure 6-6, item 2) is glued on the top cover. To replace it do the following:

1. From the inside of the top cover push the window outwards until it comes of.
2. Carefully remove remains of glue from the top cover. The bulk of the glue can be removed with sticky tape. This action must be completed by cleaning the surface with alcohol. A clean surface assures a well-closed cabinet after installation of the new window.
   This is an important safety issue!
3. Remove the protection foil from the new window
4. Firmly press the new window on the top cover.

6.2.8 Removing the Keypad and Keypad Foil

Caution

To avoid contaminating the keypad contacts, and the keypad foil contacts with oil from your fingers, do not touch the contacts (or wear gloves). Contaminated contacts may not cause immediate instrument failure in controlled environments. Failures typically show up when contaminated units are operated in humid areas.

Referring to Figure 6-6, use the following procedure to remove the keypad and the keypad foil.

1. Remove the display assembly (see Section 6.2.6).
2. Remove the keypad support plate item 5.
3. Remove the keypad foil item 4. Notice the keypad foil positioning pins in the top case when reassembling.
4. Remove the keypad item 3.

6.2.9 Disassembling the Main PCA Unit

Caution

To avoid contaminating the main PCA with oil from your fingers, do not touch the contacts (or wear gloves). A contaminated PCA may not cause immediate instrument failure in controlled environments. Failures typically show up when contaminated units are operated in humid areas.

Referring to Figure 6-8, use the following procedure disassemble the main PCA unit.

1. Unscrew the seven M3x8 Torx screws (items 8,10) that secure the shielding covers (item 7 and 9), and remove the shielding covers. The covers are interlocking
2. Unscrew four M3x16 standoffs (item 4) and one M3x12 standoff (item 3) that secure the PCA to the shielding box item 2.
3. Remove the PCA from the shielding box.

4. To separate the Input block (item 1) from the PCA, unsolder 5 + 8 leads from the PCA. Then separate the input block from the PCA. The input block is locked with 4 studs that fit into 2 holes in the PCA and 2 holes in the bottom case.

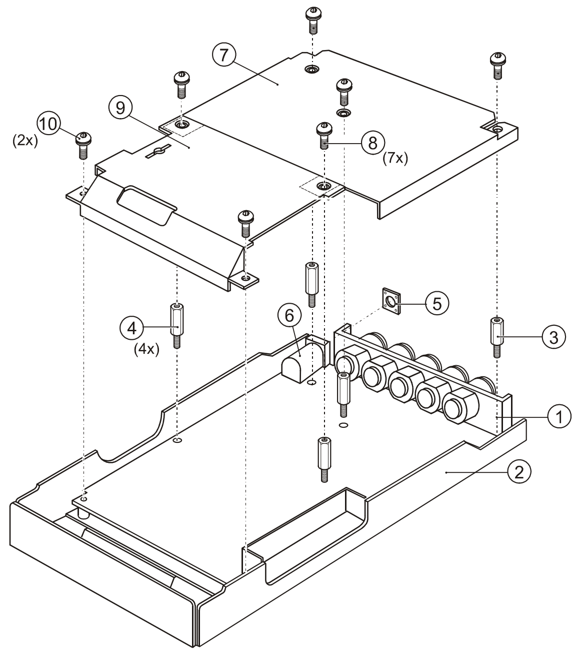


Figure 6-8. PCA Unit Assembly

6.2.10 Reassembling the Main PCA Unit

Reassembling the main PCA unit is the reverse of disassembly (see figure 6.8). However you must follow special precautions when reassembling the main PCA unit.

1. Put the PCA in the shielding box, and fasten the 5 hexagonal standoffs (item 3,4).
2. Lock the shielding covers (item 7 and 9) and fix them with 7 M3x8 Torx screws. Ensure that the small optical gate PCA mounted on the main PCA sticks through the slot in the shielding cover (item 9).
3. Ensure that the rubber sealing ring (item 5) for the power connector is present .

6.2.11 Reassembling the Analyzer

Reassembling the Analyzer is the reverse of disassembly. However you must follow special precautions when reassembling the Analyzer. Refer to figure 6-6.

Reassembling procedure for a completely disassembled unit:

1. Clean the inside of the lens with a moist soft cloth if necessary. Keep the lens free of dust and grease.
2. Install the keypad item 3. Press the edges of the keypad into the sealing groove of the top case. Ensure that the keypad lays flat in the top case, and that all keys are correctly seated.

3. Install the keypad foil item 4. Align the positioning holes in the keypad foil to the positioning pins in the top case.
4. Install the keypad support plate item 5.
5. Clean the display glass with a moist soft cloth if necessary. Install the display assembly and its mounting frame, and fasten the 4 screws (item 8).
6. Slide the Main PCA unit into the Top Case. Lock the plastic clamps at the inputs side on to the Top Case. Fasten with the 2 screws (item 19).
7. Stick the flaps of the keypad foil (item 4) to the metal shielding box
8. Verify that the backlight wires are twisted to minimize interference voltages. Reattach the backlight cable. Reattach the LCD flex cable, secure that cable in the connector with the connector latch.
9. The keypad foil is provided with a grounded shielding flap that covers the backlight cable. This decreases the electromagnetic emission. The flap should cover the cable connection area and lay over the PCA shield. Reattach the keypad flex cable, secure the flat cable in the connector with the connector latch.
10. Install the battery pack, and re-attach the cable.
11. Install the bottom case with the strap holders and strap (take care of correct position), and fasten the 2 screws item 18.
12. Fix the bottom holster (item 21) with 2 screws (item 22).
13. Slide the input cover on and fasten with the 2 M3 Torx screws (item 11). The screws must be tightened firmly to assure that the cabinet is well closed.
    This is an important safety issue!
14. Calibrate the display contrast (see section 5.4) if you replaced the display.

Chapter 7
Corrective Maintenance

Title **Page**

7.1 Introduction

This chapter describes signals to be measured in the Analyzer and procedures to be used to isolate problems.

This description gives an overview of signals that can be measured throughout the circuit. Read also the circuit description for additional information on signal conditions and functioning of the circuit.

To perform these tests effectively it is assumed that the service technician:
- knows how to operate the Analyzer.
- has read the description of the circuit part to be investigated (Chapter 3).

Indicated voltages are representing an average instrument.

Voltages have been measured with a Fluke 199C Scope Meter via a well adjusted 10:1 probe VP200. You also may use an equivalent Test Instrument.

The description below describes the major signals to be measured in the circuits. If a certain circuit is suspected, it is advised to also check other nodes such as supply voltages.

The location of each measuring point on top or bottom side of the PCA is given (e.g. B1, top). Refer to Fig. 9-12 Main PCA Top View and Fig. 9-13 Main PCA Bottom View.

⚠Warning

Opening the case may expose hazardous voltages. For example, the voltage for the LCD back light fluorescent lamp is >400V! Always disconnect the Analyzer from all voltage sources and remove the battery before opening the case. If repair of the disassembled Analyzer under voltage is required, it shall be carried out only by qualified personnel using customary precautions against electric shock.

- If the Analyzer fails, first verify that you are operating it correctly by reviewing the operating instructions in the User Documentation.
- Use the wire between the green Ground banana input and the PCA as ground when making measurements for fault finding. Also the PCB lands around the hexagonal standoffs that fix the PCA on to the shielding box assembly can be used.
  The Ground banana input and all circuitry grounds are interconnected in this Analyzer.
- Many of the diagnostic measurements can be done at the top side of the PCA. To access the top side of the Main PCA for measurements, proceed as follows:
  1. Open the Analyzer as described in paragraph 6.2.4.
  2. Remove 2 shielding covers from the top of the PCA.
  3. Power the PCA via the Power Adapter and/or battery pack. Watch out for short-circuiting due to metal parts on your desk! Refer to Figure 7-1.
- To access the bottom side of the PCA, remove 5 hexagonal standoffs. refer to Figure 7-2.

Caution

Do not power the unit when the LCD backlight cable is disconnected. The output voltage of the backlight voltage converter possibly can cause damage to the Main PCA when no load is connected for more than some minutes.

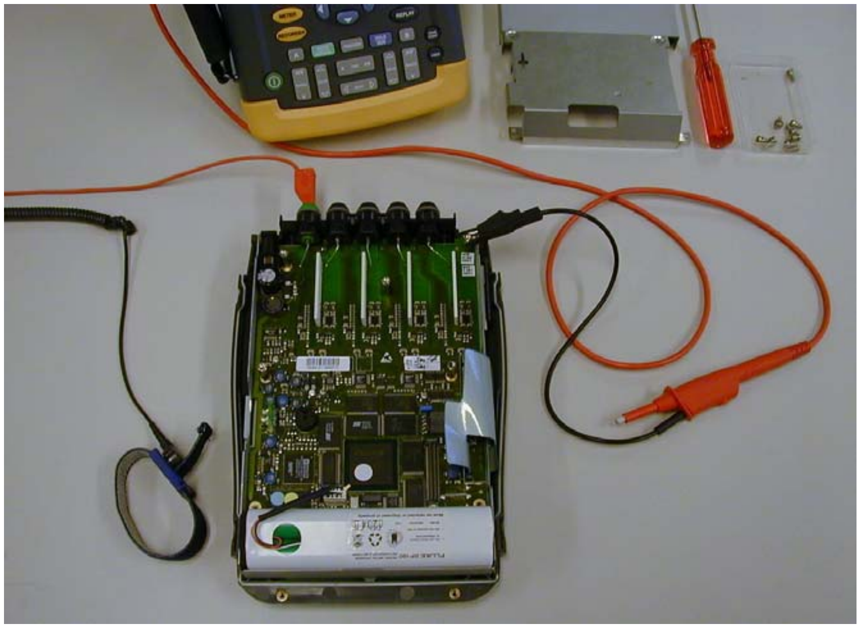


Figure 7-1. Operative Analyzer, Measuring on Top Side

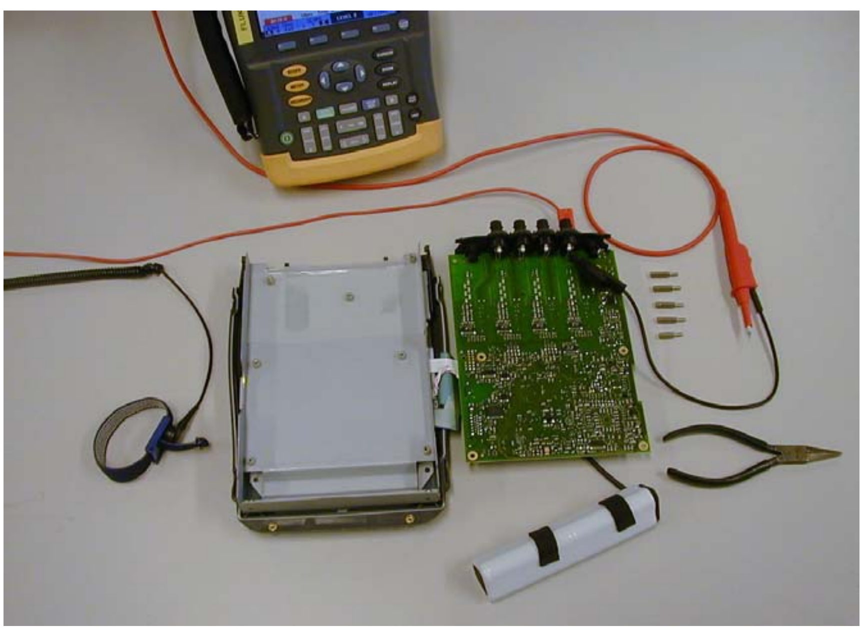


Figure 7-2. Operative Analyzer, Measuring on Bottom Side

7.2 Starting Fault Finding.

After each step, continue with the next step, unless stated otherwise.

Power the Analyzer by the battery pack only, then by the power adapter only.

1. The Analyzer operates with the power adapter, but not with the battery only: install a charged battery (VBAT = 7.2 V nominal), and check the connections between the battery and the Analyzer at the measuring points MS501 (+) and MS502 (-) (B1, bottom) or at 0.1 Ω sense resistor R516 (A4, bottom).
2. The Analyzer operates with the battery pack, but not with the power adapter only, and the battery pack is not charged by the Analyzer: continue at 7.3 Charger Circuit.
3. The Analyzer operates neither with the battery pack, nor with the power adapter: continue at 7.4 Starting with a Dead Analyzer.
4. Particular functions are wrong: continue at 7.5 Miscellaneous Functions.

Table 7-1. Starting Fault Finding

	Power adapter	Battery Pack	Check
1	OK	NOT OK	Battery pack, connector, sense resistor
2	NOT OK	OK	See Section 7.3 Charger Circuit
3	NOT OK	NOT OK	See Section 7.4 Starting with a Dead Analyzer
4	Partly OK	Partly OK	See Section 7.5 Miscellaneous Functions

7.3 Charger Circuit

See circuit diagram Figure 9-10.

1. Power the Analyzer by the power adapter only. Do not switch on.
2. Check for approx. 18.5 Vdc at V500/anode (A5, top) and approx. 18 Vdc at V502/cathode (A4, top). If wrong, check the power adapter input circuit at L506 (+), L507 (-), C508 (+ and -) (all in A5, top).
3. Check VBAT (MS501, B1, bottom) for about 11 V; if correct go to step 4.
4. Connect a charged battery. VBAT (MS501, B1, bottom) must be now about 8 V.
5. Check MAINVAL N500/pin 1 (A3, top) for about +3.3 V.

   The MAINVAL signal indicates to the D-ASIC that a correct power adapter voltage is connected.

If correct, continue at step 6.

If wrong, then:

   a. Check at N502/pin 6 (A4, top). Check for a triangular voltage 1.5 Vpp / 250 kHz superimposed on 1.75Vdc. C520 determines the switching frequency.

   b. Check the Switching regulator: at the ‘hot’ side of L501 (A4, top) there must be a square wave between 0 ... 18 V / 250 kHz.

6. Check auxiliary functions in the Charger circuit:

a. CHARCUR: determines the charging current for the Battery. Signal with variable duty cycle consisting of pulses 0 ... 3.3 V with 10 us repetition rate. Measure across R524 (A3, bottom).

b. BATCURR (battery current). Measures the voltage across current sensing resistor R516. BATCURR is applied to an input of the Slow-ADC: the voltage range is between 0 ... 3 V (0 mA results in 1.67 V). Measure at N501/pin 1 (A3, top).

c. +3V3SADC: Supply voltage for Slow ADC (present if the Analyzer is turned on). Measure across C523 (A3, top). Possible cause: defective N503.

d. REFPWM: accurate and stable 3.3 Vdc signal, to be checked at R529 (A3, top). Possible cause: defective N503.

7.4 Starting with a Dead Analyzer

If the Analyzer cannot be turned on, when powered by a charged battery pack, or by the power adapter, follow the steps below to locate the fault.

1. Connect a power adapter and a charged battery pack.
2. Turn the Analyzer on and listen if you hear a beep.
   a. If you hear no beep, continue at 7.4.1 Analyzer Completely Dead.
   b. If you hear a weak beep, continue at 7.4.2 Analyzer Software Does not Run.
   c. If you hear a “normal” beep, the software runs, but obviously the Analyzer is not operative. Continue at 7.4.3 Software Runs, Analyzer not Operative.

7.4.1 Analyzer Completely Dead

1. Turn the Analyzer off. Keep the keys  and  pressed, and turn the Analyzer on again. This will start up the mask software.
   If you still hear no beep, continue at step 2.
   If you hear a weak beep now, continue at Section 7.4.2.
2. Check Keyboard ROW1 (MS3603, D1, bottom) for a 3.3 V, 500 kHz signal.
   To see the signal you must load the test point with 1 MΩ, for example connect it directly to a Scope Meter input (use e.g. a 1:1 probe, but no 10:1 probe!)
   If wrong, continue at step 3.
   If correct, the mask software runs, but the buzzer circuit does not function. Check the buzzer function (Section 7.5.9), and then continue at Section 7.4.2.
3. Check Charger IC N502/pin 1 (A4, top) >17 V (A4, top). If wrong check R515 (A4, bottom), and connections to the battery pack.
4. Check the Power ON/OFF function, see section 7.5.11.
5. Check X-tal signals on:
   B3501/pin 2 (C1/bottom: sine wave 32 kHz, 3.1 Vpp),
   B3502/pin 1 (B1, top: sine wave 50 MHz, 3Vpp),
   B3500/pin 2 (B1/C1, top: 3.68 MHz, 2.4 Vpp on 1.5 Vdc).
   If wrong check connections, replace X-tals, replace D3500. If the Analyzer is off AND not powered by the Battery Charger/Power Adapter, only the 32 kHz clock runs. If the 3.6864 MHz clock is present, then continue at Section 7.4.3.

7.4.2 Analyzer Software Does not Run.

1. Turn the Analyzer OFF and ON again.
2. Check Keyboard ROW1 (MS3603, D1, bottom) for a 3.3 V, 500 kHz signal.
   To see the signal you must load the test point with 1 MΩ, for example connect it directly to a Scope Meter input (no 10:1 probe!)
   If not present, but you heard a weak beep, the Analyzer software runs, but the buzzer circuit does not function correctly. Go to Section 7.5.9 to check the buzzer circuit, then continue at Section 7.4.3 to see why the Analyzer cannot be operated.
   If a 416.5 kHz signal is present, the MASK software runs. Continue at step 3.
3. Do the RAM test, see Section 7.5.10.
4. Load new software to see if the loaded software is corrupted. See Section 7.7.

5. Check for badly soldered address/data lines and IC pins.
6. Replace the Flash-ROM's D3301, D3302, D3303, D3304 and/or SRAM D3305, D3306, and/or Video-RAM D3502.

7.4.3 Software Runs, Analyzer not Operative

1. Check the Display and Backlight function, see Section 7.5.1
2. Check the Power Supply section, see Section 7.5.2
3. Check the Keyboard function, see Section 7.5.4.

7.5 Miscellaneous Functions

7.5.1 Display, Back Light, and Supply Voltages

Warning

The voltage for the LCD back light fluorescent lamp is >250V!

See circuit diagram Figure 9-8 (LCD control) and 9-9 (Backlight control).

1. Connect another LCD unit to see if the problem is caused by the LCD unit. The unit is not repairable.
2. Check the LCD control signals on measurement spots MS3501...MS3533 (location D3, unless indicated otherwise. All spots on bottom side).

MS3501	+30 V	+30 V from N601 (meas. spot in B2)
MS3502	REFPWM	+3.3 V from N503 (meas. spot in B1)
MS3504	+1V8_CPLD	+1.8 V from N3500 (meas. spot in C1)
MS3505	+3V3	+3.3 V from N602 (meas. spot in B2)
MS3506	+5 V	+5 V from N603 (meas. spot in A3)
MS3507	+1V8_SHARC	+1.8 V from N602 (meas. spot in A1)
MS3508	M_ENABL_C	pulses with 2.2 ms period
MS3509	+3V3_SP	+3.3 V for D3500 (meas. spot in B1)
MS3510	FRAME_C	60 µs pulses, period ≅15 ms
MS3511	LINECLK_C	75 ns pulses, period 65 µs
MS3512	+2.5Vref_ADC	+2.5 V from D5704 (meas. spot in C3)
MS3513	LCDD0_C	pulses
MS3514	LCDD1_C	pulses
MS3516	LCDD2_C	pulses
MS3517	LCDD3_C	pulses
MS3519	DATACLK_C	pulse bursts with 65 µs period
MS3520	GROUND	0 V (meas. spot in B2/B3)
MS3521	LCDON_C	+5 V
MS3522	+3V3_MAIN	+3.3 V from V612 (meas. spot in B2/B3)
MS3523	LCDD4_C	pulses
MS3524	LCDD5_C	pulses
MS3525	LCDD6_C	pulses
MS3526	LCDD7_C	pulses
MS3527	-6VAnalog	-6 V from N601 (meas. spot in B3)
MS3503	V0	+25 V *

MS3528	V1	+23.5 V *
MS3529	V2	+22 V *
MS3530	V3	+3.1 V *
MS3531	V4	+1.5 V and spikes with 7 V top level *
MS3532	+5VAnalog	+5 V from N603 (meas. spot in A3)
MS3533	-REF5V	+5 V from N401 (meas. spot in B3)

** these voltages depend on the actual contrast setting. Their mutual relation should not change.*

3. Bad contrast.
   a. Check the voltage on R3604 (CONTRAST, C2, bottom) for a voltage between +1 to +3.5 V, depending on the LCD contrast setting. Verify that the voltage changes if the contrast is changed.
   If wrong check PWM circuit (in Section 7.5.8, D-Asic REFPWM).
   b. Check the supply voltages V0...V4, see step 2.

4. Defective backlight (TL converter), see circuit diagram Figure 9-9:
   The voltage at the hot side of the lamp (X4200/pin 1, MS4200 meas. spot location D2, bottom) must be **350...400 Vrms,** 70 kHz .
   a. Check VBAT on the battery connector pin 1 for >7 V
   b. Turn the Analyzer on, and monitor the voltage on T4200:3 (D2, top) or 5 for a 12 Vpp, 70 kHz, half-rectified sine wave. If not present on both pin 3 and pin 5 continue, else go to step c. If a half rectified sine wave, with an increasing amplitude, is present for about 0.2 second directly after power on, then the secondary circuit is defective:
   - check the resistance between T4200:6 and 10 for ≅300Ω
   - check V4203, V4204.
   - install a new LCD unit.
   c. Check T4200:3 and 5 for a 12 Vpp, 70 kHz, half-rectified sine wave. If it is present only on pin 3 or only on pin 5, then replace V4201.
   d. Check V4201/4 (D2, bottom) and V4201/2 (D2, bottom) for a 10 Vpp, 70 kHz, square wave. If wrong then check N4200/13 (TLON, D2, bottom) for +3V3. If TLON is correct, then replace N4200.
   e. Check (replace) V4200, V4202.
   f. Required voltages on other test points:
   V4202/cathode (D1, top): 10 Vpp 140 kHz square wave.
   N4200/7 (D2, bottom), V4204/collector (D2, bottom): +1.5 Vdc.
   N4200/9 (D2, bottom): 12 Vpp rectified sine wave, 140 kHz (basic sine wave 70 kHz).
   V4200/4 (D1, top): 10 Vpp 140 kHz rectangular waveform, duty cycle about 30%.

5. Backlight brightness control wrong:
   Check the V4210/gate (D2, top, BACKBRIG, supplied by D-ASIC)
   - For low brightness: 20 kHz , 3.3 V pulses, pulse width 50 ns
   - For medium brightness: 20 kHz, 3.3 V pulses , pulse width 14 μs
   - For high brightness: 20 kHz, 3.3 V pulses , pulse width 30 μs
   Check V4204/collector (D2, bottom: pulses 70 kHz between 0 ... 4 V.
   Check V4210, R4203.

7.5.2 Power Supply

See circuit diagram Figure 9-11. The Power Supply consists of a number of supply IC's that generate the various voltages that are used in the Analyzer. Some of them are switched mode IC's, others are linear types. Refer to the Analyzer's Block diagram (Fig. 3-1) to see how the supply IC's are interconnected. Measuring points are located at top side of PCA (unless otherwise noted).

1. Signals to be checked in supply section N603 that converts VBAT to +5 V and +5 VAnalog for analog circuits:
   a. VBAT input voltage: measure at 'cold' side of L613 (A3, connected with N603/5): 8 V with battery Charger connected, slightly lower when running on battery power.
   b. Switching FET inside N603 (pin 1): measure at 'hot' side of L613 (A3): sq. wave 18 Vpp, frequency 1.1 MHz approx.
   c. +5 V or +5 VAnalog: measure 5V at both nodes of L612 (A3), +5VAnalog also available across C601 (A3).
2. Signals to be checked in the part of N601 that coverts +5 V to -6 V for analog circuits).
   a. +5 V input voltage: measure at N601/8 or at both nodes of L601 (A2).
   b. Switching FET inside N601 (pin 10): measure at 'hot'side of L603 (A3): frequency bursts with a frequency of about 1.1 MHz and sq. wave of about 8 Vpp.
   c. -6 V output voltage: measure across C630 or on L602 (A3).
3. Signals to be checked in the part of N601 that coverts +5 V to +30 V for LCD biasing:
   a. +5 V input voltage: measure at N601/8 or at both nodes of L601 (A2).
   b. Switching FET inside N601 (pin 6): measure at V603/anode (A2/B2): frequency bursts with a frequency of about 1.1 MHz and signal amplitude reaching about 40 Vpp.
   c. +30 V output voltage: measure at V603/cathode (A2/B2).
4. Signals to be checked in the part of N602 that coverts VBAT to +1.8 V supply voltage:
   a. VBAT input voltage: measure at both nodes of L606 (A1): 8 V with battery Charger connected, slightly lower when running on battery power.
   b. Switching FET inside N602 (pin 7): measure at V606/cathode (A1): asymmetrical sq. wave 10 Vpp and 1.1 MHz.
   c. +1.8 V output voltage: measure at 'cold' side of L607 (A1): +1.8 V.

5. Signals to be checked in the part of N602 that coverts VBAT to +3.3 V supply during power-on:
   a. VBAT input voltage: measure at both nodes of L606 (A1): 8 V with battery Charger connected, slightly lower when running on battery power.
   b. Switching FET inside N602 (pin 2): measure at V608/cathode (A2): asymmetrical sq. wave 10 Vpp and 1.1 MHz.
   c. +3.3 V output voltage: measure at ‘cold’ side of L608 (A2): +3.3 V.
6. N604 is a linear power IC that supplies 3.3 V during power-off as a backup for the D-Asic, SRAM, Video RAM, and Flash memories:
   a. VBAT input voltage: measure at PCA track between N604/pin 4 and R623 (A2): 8 V with battery Charger connected, slightly lower when running on battery power.
   b. Output voltage +3.3 V: measure at measuring spot adjacent to N604/pin 5,6 (A2): +3.3 V both during power-on and power-off.
   c. Switching signal at N604/pin 8: measure at measuring spot adjacent to N604/pin 8 (A2): L at power-on, H at power-off.

7.5.3 Slow ADC, +3V3SADC

See circuit diagram Figures 9-9 and 9-10.

Check the following signals:

1. +3V3SADC (supplied by linear power IC N503, Charger circuit) must be +3.3V. To be measured at D4300/pin 16 (B1, bottom). If the unit can be turned on and +3V3SADC is not OK, the line is shorted to ground or N503 or R528 is defective.
2. BATCUR (D4300, B1, bottom):12 from N501 in Charger circuit, must be in the range 0 ... 3 V.
   Battery current is sensed across R516 (0.1 Ω). If wrong, replace N501 (A3, top) or related components.
3. BATVOLT is derived from VBAT in the charger circuit. VBAT is the voltage at the battery connector X4100/pin 1. BATTVOLT must be **(0.3 x VBAT)** Volt. To measured at D4300/pin 14 (B1, bottom).
4. BATTEMP. Voltage from a NTC resistor (10 k Ω nominal) inside the Battery Pack with respect to – of battery. BATTEMP must be +1.6 V approx.. To be measured at D4300/pin 15 (B1, bottom).
5. LCDCONTROL (D4300/pin 5, B1, bottom) from PTC V4205, must be about 1.8V at room temperature.
6. BATIDENT (D4300:13) senses the battery type identification resistor in the battery pack. Must be about 0 V for the NiMH Battery Pack.
7. +2.5Vref_ADC (D4300:1) must be 2.5 V
8. MBVRSIND (D4300:4) must be about 0 V (R4304 not placed). The voltage can be changed by installing different resistors R4304 and R4305 to identify a different Mainboard PCB version: to be used for future extensions.
9. Check the multiplexer control lines (coming from the D-ASIC)
   SELMUX0 (D4300/pin 11): positive pulses, duty cycle 75%, period 1200 ms
   SELMUX1 (D4300/pin 10): positive pulses, duty cycle 50%, period 600 ms

SELMUX2 (D4300/pin 9): positive pulses, duty cycle 25%, period 1200 ms
D4300 location: B1, bottom.

10. Check D4300/pin 3 (output). If the instrument is on, it must alternately show the voltage levels on D4300 pins 5, 12, 14 , and 15; if at a fixed level, then replace D4300. When starting up, also the other inputs are sensed once.
11. Check signal SADLEV. Voltage varies continuously between 0 ... 3 V at a low rate. Measure at R4300 (B1, top). In 300 ms the voltage levels successively approximate the values measured on D4300/pin 3: if wrong, trace the signal to the PWM circuit on the Digital Control part (Figure 9-6).
12. Check signal SLOWADC. Is a sq. wave between 0 ... 3.3 V with variable duty cycle. To be measured at D4300/pin 1 (B1, top).

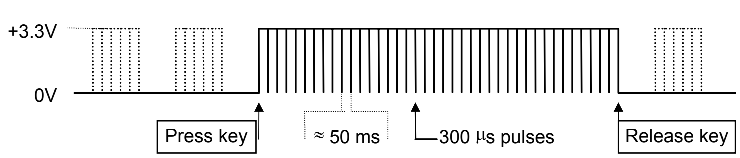
7.5.4 Keyboard

Proceed as follows if one or more keys cannot be operated. Table 7-2 shows how the keys are connected to the rows and columns. Test points are located in D1, bottom. For the ON/OFF key see Section 7.5.11.

Table 7-2. Analyzer Key Matrix

COL↓	ROW → test spot	0 MS3602	1 MS3603	2 MS3604	3 MS3605	4 MS3606	(5) (MS3607)
(0)	(MS3608)						
1	MS3609	F4	F5	▼		▲	
2	MS3610	F3	SAVE SCREEN	☼	MENU	►	
3	MS3611	F2	SETUP	◄	MONITOR		
4	MS3612	F1	MEMORY	ENTER	SCOPE		
(5)	(MS3613)						

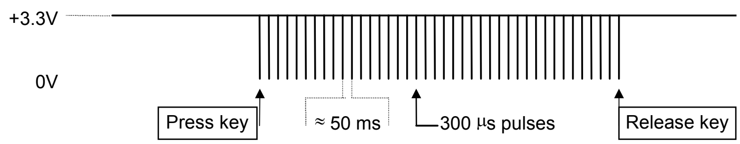
1. Try a new keypad, and keypad foil to see if this cures the problem.
2. Press a key, and check ROW0...4 (measure spots MS3602..MS3606) for the signal shown below :



When a battery is installed, and no key is pressed the ROW lines are low.
When no battery is installed and no key is pressed (mains adapter supply), the ROW

lines show 300 ms pulse bursts (dotted lines in the above figure).
During the time a key is pressed, the ROW lines show continuously pulses.

3. Check COL1...4 (measure spots MS3609...MS3612) for a +3.3V level. Then press and hold a key, and check the matching COL line for the signal shown below:



If wrong, check the connections from X3600 to D3500.

7.5.5 Optical Port (Serial RS232 Interface)

See circuit diagram Figure 9-9.

Receive (RXD1)

1. Check the voltage on X3400/pin 4 (A2, top) for about ± 3.3 V
2. Check the voltage on X3400/pin 3:
   dark: +0 V
   light (shine with a lamp in the optical port diode H3401): + 2.5 V.

Send (TXD1).

1. Check the voltage TXD on X3400/pin 1 (A2, top) for +3.3V.
2. Press MEMORY , and then press F4 PRINT to start the Analyzer print data output.
3. Check the line TXD on X3400/pin 2 for a burst of pulses (pulses from +2.3 V to +3.3 V). The length of the burst and the pulses depends on the selected baud rate.

7.5.6 Voltage and Current Channel Measurements

See circuit diagram Figure 9-1 and 9-2.

On this diagram you will find the analog input circuits for voltage and current measurement. Diagram 2 shows the voltage and current channels for phase A/L1. Phases B/L2, C/L3, and N (Neutral) have identical circuitry, but with a different numbering range for the components. The voltage input has 5 ranges that can be selected in the SETUP menu.

The input circuitry can be checked by applying a 50 or 60 Hz test signal from e.g. a Calibrator. Applying high input voltages (to check the ranges 1000 V, 400 V, 230 V, 120 V) is only necessary to test the ranges of the voltage input circuits consisting of N1/D1, N101/D101, N201/D201, N301/D301. It is therefore recommended only to use high input voltages if this cannot be avoided! This has to be done by a qualified technician who is aware of the dangers involved.

All other tests can be done with the Analyzer under test in DEMO mode. DEMO mode can be activated via SETUP and the F3 – FUNCTION PREFerence. Sufficient signal amplitudes can be measured throughout the circuits if you apply 0.67 Vrms (2 Vpp) 50 or 60 Hz in DEMO mode to voltage and current inputs,

Voltage input circuit ranges: check output voltage at N1A/pin 1. Range selection is done by a 4-position multiplexer.

Table 7-3. Checking Voltage Channels and Ranges

Analyzer Range	Set Analyzer to	Apply signal from calibrator	Measure at N1/ pin1 (D4, top)	Control signals at A0, A1, EN (D4, top)
2 V	DEMO	0.67 Vrms	2.4 Vpp	EN = L
120 V	120 Vnom	120 Vrms	2.1 Vpp	L, L, H
230 V	230 Vnom	230 Vrms	2.1 Vpp	H, L, H
400 V	400 Vnom	400 Vrms	1.9 Vpp	L, H, H
1 kV	Transients (*)	1 kVrms	1.2 Vpp	H, H, H

(*): attainable via MENU.

When ready, set the input signal to 0.67 V / 50 Hz and the Analyzer to DEMO. Check other nodes in the circuit:
- N1/pin 7 (D4, top): 2 Vpp.
- N2/pin 1 (D4, top): 2 Vpp superimposed on 2.5 Vdc (to match input range of ADC).

Current channels. Set all current channels to 1mV/A, 400 A, and 1:1. Apply 0.67 V / 50 Hz to current channel to be checked:
- N3/pin 1 (D4, top): 0.8 Vpp.
- N4/pin 1 (D4, top): 0.8 Vpp superimposed on 2.5 Vdc (to match input range of ADC).

The voltage and current channels B/L2, C/L3, and N can be checked in the same way.

General hint: check supply voltages at suspected circuit parts.

7.5.7 ADC’s

See circuit diagram Figure 9-3.

The ADC circuit converts 8 analog input signals into digital data. For this purpose 2 ADC’s are used. Each ADC has 3 outputs (data, clock, and sync) to transfer data to the DSP.

The analog input signals can be checked in demo mode by applying 0.67 V / 50 Hz to the Analyzer’s voltage and current inputs (with respect to the green banana input GND). Measuring spots are located at bottom side of PCA (locations B3, C3).

Table 7-4. Checking Analog Input Voltages

Input signal	ADC input	Measuring spot (location)	Signal to be measured
A/L1 voltage	D5707/pin 39	MS5704 (C3, bottom)	2 Vpp on 2.5 Vdc
A/L1 current	D5707/pin 41	MS5705 (C3, bottom)	0.8 Vpp on 2.5 Vdc
B/L2 voltage	D5707/pin 46	MS5702 (C3, bottom)	2 Vpp on 2.5 Vdc
B/L2 current	D5707/pin 44	MS5703 (C3, bottom)	0.8 Vpp on 2.5 Vdc
C/L3 voltage	D5708/pin 39	MS5708 (B3, bottom)	2 Vpp on 2.5 Vdc
C/L3 current	D5708/pin 41	MS5709 (B3, bottom)	0.8 Vpp on 2.5 Vdc
N voltage	D5708/pin 46	MS5706 (B3, bottom)	2 Vpp on 2.5 Vdc
N current	D5708/pin 44	MS5707 (B3, bottom)	0.8 Vpp on 2.5 Vdc

Remove the input signals from the Analyzer inputs since they do not contribute to a better diagnosis of the ADC outputs. Check the data outputs acc. to the table below.

Table 7-5. Checking Digital Output Voltages

ADC to be checked	Output signal	Measuring spot (*) (location)	Signal to be measured
D5707/21	Data	R5712 (C3, top)	Variable frequency + duty cycle data
D5707/22	Clock	R5713 (C3, top)	34 MHz bursts
D5707/23	Sync	R5715 (C3, top)	2x positive pulse, rep rate 400 kHz
D5708/21	Data	R5723 (B3, top)	Variable frequency + duty cycle data
D5708/22	Clock	R5716 (B3, top)	34 MHz bursts
D5708/23	Sync	R5719 (B3, top)	2x positive pulse, rep rate 400 kHz

(*): you can measure on the resistors present in the six signal lines. The resistors give a slight voltage loss so that voltage is a little higher at the ADC-side.

<u>Other nodes to be checked (located in C3, top unless indicated otherwise):</u>

- D5703/5,6 (flip-flop, C3, top): 200 kHz symmetrical square wave.
- D5701/1,2 (nand, C3, top): 400 kHz square wave.
- D5701/9,10 (nand, C3, top): 400 kHz positive going needle pulses (ACQ_START).
- D5701/12, 13 (nand, C3, top): positive going 13 ms pulse when switching to another measuring function.
- D5704 (B3, top): converts +5 V (pin 2) to +2.5 V (pin 6) reference voltage for ADC's.

7.5.8 DSP, D-Asic, and CPLD

DSP. Measuring points are located at bottom side of PCA (unless indicated otherwise).

Signals to be checked in circuit diagram Figure 9-4:
- MSO#: pulses with variable frequency and duty cycle, measure at R704 (A1).
- +3V3_SHARC: 3.3 V DSP supply, measure across C708 (B2, bottom) or C712 (B2, bottom) or V604/cathode (B2, top).
- +1V8_SHARC: 1.8 V DSP supply, measure across C721 (B1, bottom) or C722 (B1, bottom) or anode V604 (B2, top).
- +1V8 general supply voltage: measure across C713 (A1), C728 (A1).
- DSP_CLOCK: 25 MHz symmetrical sq. wave, measure at R4701 (B1).

Signals to be checked in circuit diagram Figure 9-5:
- FIFO_RST#: normally H, L during a period after power-on, measure at R2702 (B2).
- DSPCONTROL: normally H, pulses going L after change of measuring mode, measure at R3558 (C1).
- Some data and control lines incorporate small measuring spots where under normal working conditions data signals (L = 0 V, H = 3.3 V) can be measured

D-Asic. Measuring points located at bottom side of PCA (unless indicated otherwise).

Signals to be checked in circuit diagram Figure 9-6:

The D-Asic is a Ball Grid Array. The pins are under the IC and not directly accessible. It is therefore that measurements must be done at other components:
- Keyboard: 6 row signals and 6 column signals and the ONKEY signal can be measured at measuring spots (D1) that are indicated in the circuit diagram and the drawing of bottom side of PCA.
- Video RAM (D3502, C1, top): the spacing of the pins allows measuring address and data lines for data signals (L = 0 V, H = 3.3 V).
- LCD control lines: data signals and adjustable DC signals can be measured at measuring spots (D3) that are indicated in the circuit diagram and the drawing of bottom side of PCA.
- FAMD0 ... FAMD7: check for data signals (L = 0 V, H = 3.3 V) at pins of FIFO memory D2701 (B1, top). Spacing of the pins is small, but some have a small measuring spot.
- FIFO_RCLK: 25 MHz clock signal available at FIFO D2701/pin 32 or adjacent measuring spot (B1, top).
- DSP_CLOCK: 25 MHz symmetrical sq. wave, measure at R4701 (B1) in vicinity of DSP.
- ACQ_START: 400 kHz positive going needle pulses at D5701/pin 9, 10 (C3, top).
- FIFO_OR: data signal normally L, pulse H during 600 us, at FIFO D2701/pin 29 or adjacent measuring spot (B1, top).
- REFPWM: stable 3.3 Vdc signal, to be checked at R529 (A3, top).
- BACKBRIG: sq. wave with variable duty cycle (high duty; high intensity) to determine intensity of LCD backlight: measure at V4210/gate (D2, top).
- CONTRAST: voltage adjustable between 2.2 ... 2.6 Vdc with the arrow keys in USER PREF menu, measure across C3618 (D2).
- SADLEV: voltage continuously varying between 0 ... 3 V at a low rate: measure at R4300 (B1, top).
- CHARCUR: determines battery charging current, variable duty cycle signal with pulses with a repetition rate of 10 us, measure across R524 (A3, bottom).
- SLOWADC: sq. wave with variable duty cycle, between 0 ... 3.3 V: measure at N4300/pin 1 (B1, top).
- BATIDENT: battery identification signal, must be close to 0 V with battery pack BP190 connected: measure at R512 (B1, top).

- Input Range Control: applies 2 x 8 logic signals to control e.g. input range of voltage channels: measure at D401, D403 (D3, top). For logic levels refer to circuit description chapter 7.5.6.
- D-Asic Clock B3500 (B1/C1, top): measure sine wave 2.4 Vpp on 1.5 Vdc and 3.68 MHz at B3500/pin 1.
- D-Asic Clock: B3501/pin 2 (C1, bottom), measure a sine wave 3.1 Vpp and 32.8 kHz.
- D-Asic Clock B3502 (B1, top): measure sine wave 3 Vpp, 50 MHz at B3502/pin 1.
- SELMUX2/1/0 (D4300, B1): MUX0 (pin 11): sq. wave period time 1200 ms duty cycle 75%, MUX1 (pin 10): period time 600 ms duty cycle 50%, MUX2 (pin 9) period time 1200 ms duty cycle 25%.
- POWERON: H during power-on, measure e.g. at V613/gate (A2, top).
- MAINVAL: measure +3.3 V (H) at N500/pin 1 (A3, top). Signal is 0 V (L) with no Adapter power.
- TXD1: transmit signal for optical RS-232 interface: measure 3.3 Vdc at X3400/pin 1 and pulses between 2.2 and 3.3 V at X3400/pin 2 (A2, top).
- RXD1: receive signal for optical RS-232 interface: measure 3.3 Vdc at X3400/pin 4 and a voltage between 3.3 and 0 V at X3400/pin 3 (A2, top). Voltage is 0 V if a light source of sufficient strength is placed in front of the photodiode.
- DSPCONTROL: normally H, pulses going L after having changed the active measuring mode, measure at R3558 (C1, bottom).
- BEEPER: refer to 7.5.9.

CPLD. Measuring points located in C1 at topside of PCA (unless indicated otherwise). Refer to Figure 9-6.
- D3550/pin 22 (ENABLEMAIN): +3.3 V, 60 us low pulse when switched off.
- D3550/pin 21 (CPLD_OFF): +0.3 V, 80 us high pulse when switched off.
- D3550/pin 19: 32 kHz clock, 3.3 V level.
- D3550/pin 18: +3.3 V, 0 V when switched off.
- D3550/pin 48: 50 MHz clock, 3.3 V level, 0 V when switched off.
- D3550/pin 46 (VDDVAL): +3.3 V.

7.5.9 Buzzer Circuit

See circuit diagram Figure 9-6.

Check the following:
- measure a 80 ms burst 0 – 3.3 V at V4211/gate (e.g. at power-on).
- measure a 80 ms burst 0 – 30 V at V4211/drain (e.g. at power-on).
- measure a 80 ms burst 0 – 3 V at V4211/drain (e.g. at power-on in Mask mode).

7.5.12 RAM Test

You can use the Microsoft Windows Terminal program or MetCal to test the RAM.

To use the Microsoft Windows Terminal proceed as follows:

1. Connect the Analyzer to a PC via the Optical Interface Cable PM9080.
2. Start the Terminal program, and select the following Settings:

Terminal Emulation	TTY (Generic)	
Terminal Preferences	Terminal Modes	CR -> CR/LF
	☒Line Wrap	☒ Inbound
	☒Local Echo	☐ Outbound
	☒Sound	
Communications	Baud Rate	9600
	Data Bits	8
	Stop Bits	1
	Parity	None
	Flow Control	Xon/Xoff
	Connector	COMn

3. Turn the Analyzer off. Keep the keys and pressed, and turn the Analyzer on again. This will start up the mask software. You will hear a very weak beep now.
4. In the terminal program type CAPITAL characters X (no ENTER!). After a number of characters the Analyzer mask software will respond with an acknowledge 0 (zero). This indicates that the communication between the Terminal program and the Analyzer is accomplished.
5. Type `ID`
   and press [Enter]
   The Analyzer will return an acknowledge 0 (zero), and the string
   `Universal Host Mask software; UHM V3.0`
   If it does not, check the Terminal program settings, the interface connection, and the Analyzer Optical Port (Section 7.5.5).
6. To test Video RAM D3502:
   Type `EX11,#H20400000,#H80000`
   and press [Enter]
   The Analyzer will return one of the following acknowledges:
   0 RAM is OK.
   1 syntax error in the typed command
   6 the RAM does not properly function, replace one or two RAM's.
7. To test the SRAM D3305, D3306:
   Type WW10000000,2,00020002 and press [Enter] (= preparation)
   The Analyzer must return acknowledge 0 (zero)

   Type `EX12,#H44000000,#H100000` and press [Enter] (= test)
   The Analyzer will return one of the following acknowledges:
   0 RAM is OK.
   1 syntax error in the typed command
   6 the RAM does not properly function, replace one or two RAM's.

Note:

On the Terminal Screen, the Analyzer acknowledge overwrites the first character of the message that has been sent to the Analyzer.

You can use the following MetCal program to do the test:

```
1.001  PORT         [P1200,n,8,1,x]
1.002  PORT         em[13][i]
1.003  PORT         FLUKEUHM[13][i]
1.004  PORT         [d2000]
1.005  PORT         XXXXXXXXXX[i]
1.006  PORT         id[13][i][i$]
1.007  LABEL        repeat
1.008  PORT         [i$]
1.009  JMPL         repeat ZCMPI(mem2,"0")
1.010  PORT         ex11,#H20400000,#H80000[13][i]
1.011  JMPL         error1 mem > 0
1.012  DISP         Video RAM D3502 ok
1.013  PORT         WW10000000,2,00020002[13][1]
1.014  PORT         EX12,#H44000000,#H100000[13][i]
1.015  JMPL         error2 mem > 0
1.016  DISP         SRAM D3305, D3306 ok
1.017  JMPL         stop
1.018  LABEL        error1
1.019  DISP         Video RAM D3502 defective
1.020  JMPL         stop
1.021  LABEL        error2
1.022  DISP         SRAM D3305, D3306 defective
1.023  LABEL        stop
1.024  END
```

7.5.11 Power ON/OFF

Check MS3614 (D1, bottom side) for +3 V (supplied by D3500:F4). If the ON key is pressed, MS3614 must go low.
If wrong, do the Section 7.4.1. tests first!

7.5.12 Battery

Battery operating time does not meet the specification (7 hours):

1. Turn the Analyzer on (battery power only)
2. Check for a voltage across R516 (A4, bottom side) of about 55 mV. This corresponds with a current of about 0.55 A. If the current is much higher, the cause of the problem is not the battery, but too much current drain.

Battery is discharged when Analyzer is not used for some time (2 or 3 weeks)

1. Turn the Analyzer on (battery power only)
2. Check for a voltage across R516 (A1, bottom side) of about 0.1 mV (use a sensitive Digital Voltmeter). This corresponds with a current of about 1 mA. Turn the Analyzer off and on, and check the voltage again for 0.1 mV. Do this about 10 times. If one or more times a current of about 0.8 mV is measured (corresponds with 8 mA), the cause is a defective or not correctly programmed IC D3550. This IC takes care of a correct power state of D3500.
   As the 8 mA discharge current can have damaged the battery, you must check the battery capacity as described below.
3. If the current is much higher then 8 mA the cause of the problem is not or is not only D3550.

To check if the battery has a correct capacity:

1. Fully discharge the battery. For this set the Analyzer's Battery Save function to 'Disabled': SETUP, F4 – USER PREF, Battery save / Auto-OFF.
2. Disconnect the BC430 Battery Charger/Power Adapter.
3. Keep the Analyzer switched on in e.g. V/A/Hz Trend mode. The Analyzer will stay on till the battery is empty and keeps record of the elapsed time.

4. When the battery is discharged the Analyzer will shut down. Now connect the BC430, turn the power on and check the length of the Trend trace. For a new battery pack this should be about 7 hours. Depending on the number of applied charge cycles the battery capacity will decrease. If the Trend Plot trace has a length of 5.5 hours or less you may consider to replace the battery pack.

7.6 Configuration of CPLD-chip D3550-1.

The CPLD-Chip (D3550-1) must be programmed after being installed. CPLD is a programmable device. As a spare part it is supplied as a non-configured device. After CPLD has been soldered on to the Main PCA, it must be configured.

To configure, the Scope meter Loader Program must be used and dedicated Loader and Model files. This has to be done in an Authorized Fluke Service Centre.

After configuring, it must be checked if the CPLD configuration was successful:

The function of CPLD is to assure that battery current drain is almost zero (<1 mA) after the Analyzer has been switched off. The current can be checked with a sensitive Digital Voltmeter across R516 (0.1 Ω). This check must be done 10 times after power off and every time current should not exceed 1 mA (0.1 mV across R516) with the mains adapter disconnected.

A more direct check of correct CPLD-functioning is to check for a 60 us negative going pulse at power-off at the side of R3551 that is connected to D3550/pin 22 (B1, bottom, signal ENABLEMAIN.

7.7 Loading Software

To load a new software version in the Analyzer contact an authorized Fluke Service center, see section 8.3.

Chapter 8
List of Replaceable Parts

8.1 Introduction

This chapter contains an illustrated list of replaceable parts for the models 433 and 434 Power Quality Analyzer. Parts are listed by assembly; alphabetized by item number or reference designator. Each assembly is accompanied by an illustration showing the location of each part and its item number or reference designator. The parts list gives the following information:

- Item number / reference designator (for example: C20) and location (for example location D4, on top side of PCA)
- Description
- Ordering code

Caution

The above symbol indicates a component that may be damaged by static discharge. Especially the active components in this Analyzer are static sensitive. Always take the appropriate precautions for handling these components!

8.2 How to Obtain Parts

Contact an authorized Fluke service center, see section 8.3.

To locate an authorized service center refer to the second page of this manual (back of the title page).

In the event that the part ordered has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

To ensure prompt delivery of the correct part, include the following information when you place an order:

- Instrument model (for example Fluke-434), 12 digit instrument code (9444 ... .), and serial number (DM.......). The items are printed on the type plate on the bottom cover.
- Ordering code
- Item number / Reference designator
- Description
- Quantity

8.3 Service Centers

To locate an authorized service center, call Fluke using any of the phone numbers listed below, or visit on the World Wide Web: www.fluke.com

USA and Canada: 1-888-99-FLUKE (1-888-993-5853)
Europe: +31-40-2675200
Japan: +81-3-3434-0181
Singapore: +65-679 95588
Anywhere in the world: +1-425-446-5500

8.4 Final Assembly Parts

See Table 8-1 and Figure 8-1 for the Final Assembly parts.

Table 8-1. Final Assembly Parts

Item	Description	Ordering Code
1	Top case assembly Fluke 433, 434 (without LCD, without window/decal, incl. sealing strips)	4022 244 98511
2	Display window/decal Fluke 433	0040 243 00031
	Display window/decal Fluke 434	0040 243 00071
3	Keypad	0040 243 00022
4	Keypad foil	0040 245 00022
5	Keypad support assembly	4022 244 98521
6	Display unit Color	4022 244 93261
	Flat cable for display unit	4022 303 40111
7	Display mounting frame	4022 243 09773
	Rubber buffer (self-adhesive, 2 pcs. at rear side of mounting frame)	4022 110 00511
	Contact finger strip (self-adhesive, 1 pce. at rear of mounting frame)	4022 244 94751
8	EJOT Pt self tapping screw	4022 244 92551
9	Decal set for input sockets, colored	0040 241 00412
9	Decal set for input sockets, black & white	0040 241 00401
10	Hang strap	946769
11	Combiscrew (black) to fix input cover	4022 244 90862
12	Input cover	0040 243 00041
13	Main PCA unit for both models. Unit is provided with sticker 430 **Load appropriate 433/434 software and configure model 433 or model 434, then always calibrate the unit**!	0040 246 00041
14	Bottom case assembly, incl. isolation foil for optical RS232 port	4022 244 98501
15	Tilt stand (bail)	4022 244 98211
16	Strap	4022 244 98191
17	Strap holder (2 pcs per instrument)	4022 244 98201
18	Combi-screw Torx M3x10 (screw + split spring)	4022 244 91231
19	Combi-screw Torx M3x8	4022 325 42081
20	Battery Pack (see note below)	BP190
21	Bottom holster	4022 244 98221
22	Combi-screw Torx M3x10 (screw + flat washer)	4022 244 91231

Note

Ni MH

The Analyzer contains a NiMH battery (item 19). Do not mix with the solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler.

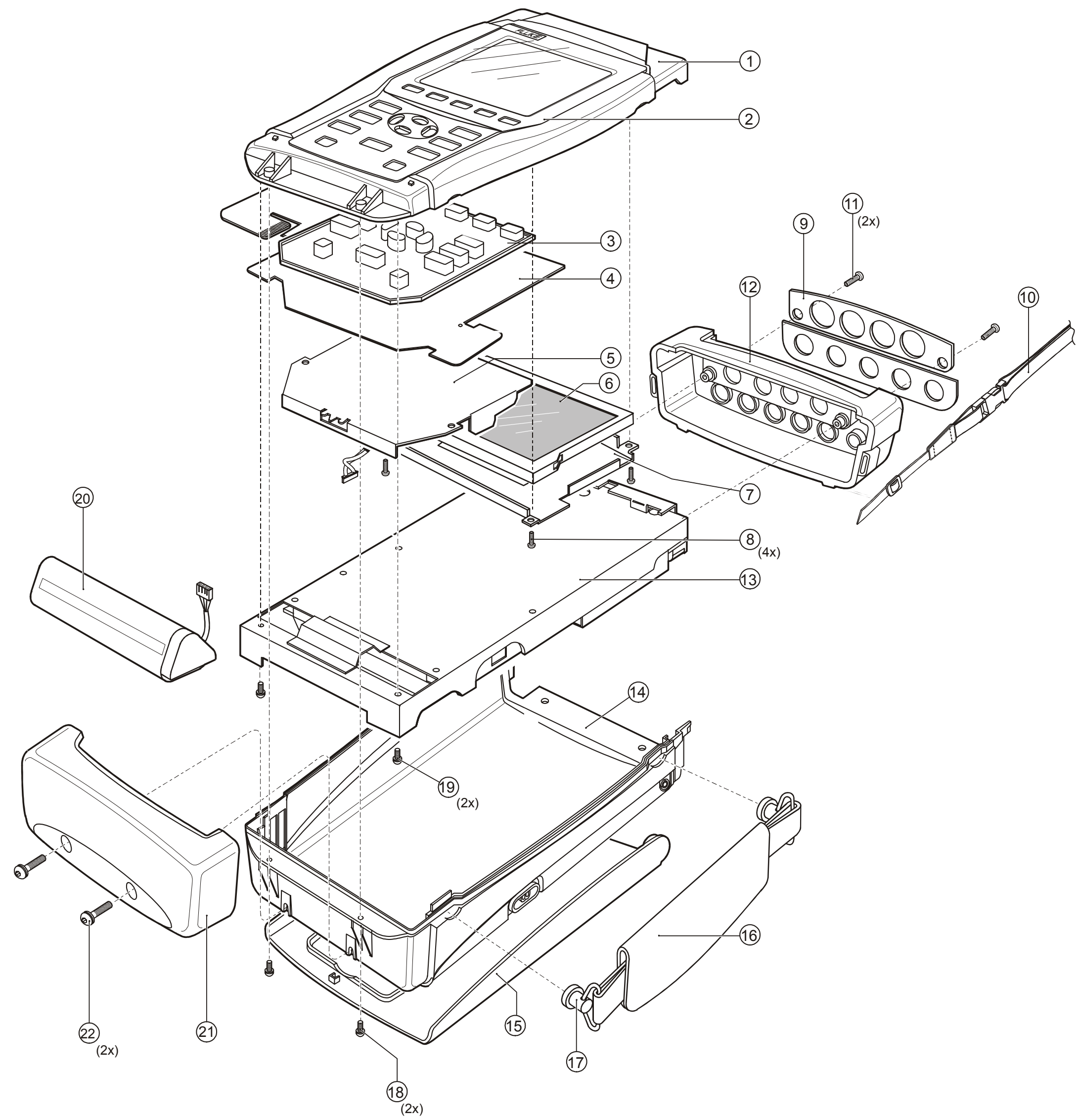


Figure 8-1. Final Assembly Details

8.5 Main PCA Unit Parts

See Table 8-2 and Figure 8-2 for the main PCA Unit parts.

Table 8-2. Main PCA Unit Parts

Item	Description	Ordering Code
1	Input block	0040 240 00011
2	Shielding box assy	0040 242 00022
3	Hexagonal standoff M3x12 (1 pce per instrument)	4022 108 00831
4	Hexagonal standoff M3x16 (4 pcs per instrument)	4022 108 00821
5	Sealing ring for power connector	4022 244 98331
6	Supply power input connector	4022 244 92561
7	Attenuator shielding complete	0040 242 00012
8	Combi screw M3x8	4022 325 42081
9	Shielding cover	4022 243 08933
10	Combi screw M3x8	4022 325 42081

Note 1

If the main PCA must be replaced, you must order the complete main PCA Unit.

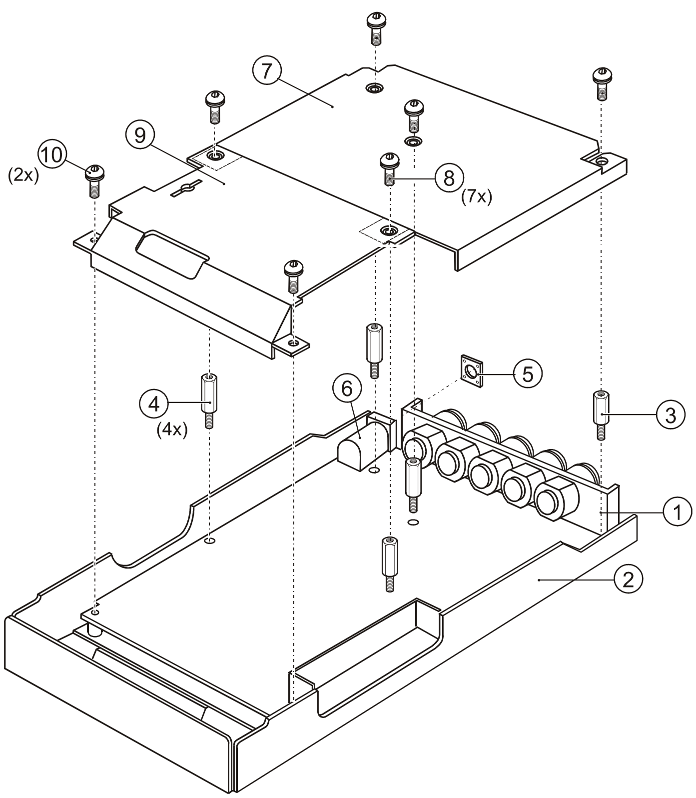


Figure 8-2. Main PCA Unit

8.6 Main PCA Parts

See Figure 9-12 and Figure 9-13 at the end of Chapter 9 for the main PCA reference designation views.

Table 8-3. Main PCA Parts

Item	Description	Location on Main PCA top	 bottom	Ordering Code
B3500	XTAL 3.68640MHZ ACT86SM	C1		4022 303 20811
B3501	WATCH CRYSTAL 32.768KHZ		C1	4022 303 20291
B3502	QUARTZ CRYSTAL 50MHZ AC	B1		4022 106 00021
C1	CAP 180PF 5% 50V	D3		4022 301 60321
C2	CAP 100NF 10% 50V	D4		4022 301 61331
C3	CAP 100NF 10% 50V	D4		4022 301 61331
C4	CAP 100NF 10% 50V	D4		4022 301 61331
C5	CAP 100NF 10% 50V	D4		4022 301 61331
C6	CAP 100NF 10% 50V	D4		4022 301 61331
C7	CAP 4.7PF 0.25PF 50V	D4		4022 301 60131
C8	CAP 22PF 5% 50V	D4		4022 301 60211
C10	CAP 33PF 5% 2kV		D4	4022 301 65421
C12	CAP 33PF 5% 2kV		D4	4022 301 65421
C13	CAP 33PF 5% 2kV		D4	4022 301 65421
C15	CAP 33PF 5% 2kV		D4	4022 301 65421
C16	CAP 33PF 5% 2kV		D5	4022 301 65421
C19	CAP 100NF 10% 50V	D3		4022 301 61331
C20	CAP 1NF 5% 50V	D4		4022 301 60411
C21	CAP 100NF 10% 50V	D4		4022 301 61331
C22	CAP 100NF 10% 50V	D4		4022 301 61331
C23	CAP 100NF 10% 50V	D4		4022 301 61331
C25	CAP 10UF 10% 6.3V	D3		4022 101 00011
C26	CAP 10UF 10% 6.3V	D3		4022 101 00011
C28	CAP 100NF 10% 50V	D4		4022 301 61331
C29	CAP 820PF 5% 50V	D3		4022 301 60401
C31	CAP 1.8NF 2% 50V		D4	4022 301 65101
C32	CAP 220PF 5% 50V		D4	4022 301 60331
C33	CAP 3.3NF 5% 50V		D4	4022 301 60921
C35	CAP 4.7NF 5% 50V		D4	4022 301 65161
C36	CAP 4.7NF 5% 50V		D4	4022 301 65161
C37	CAP 10NF 5% 25V		D4	4022 301 64671
C101	CAP 180PF 5% 50V	C3		4022 301 60321
C102	CAP 100NF 10% 50V	C4		4022 301 61331
C103	CAP 100NF 10% 50V	C4, D4		4022 301 61331
C104	CAP 100NF 10% 50V	D4		4022 301 61331
C105	CAP 100NF 10% 50V	C4		4022 301 61331
C106	CAP 100NF 10% 50V	C4		4022 301 61331

Item	Description	Location on Main PCA		Ordering Code
		top	bottom	
C107	CAP 4.7PF 0.25PF	C4		4022 301 60131
C108	CAP 22PF 5% 50V	C4		4022 301 60211
C110	CAP 33PF 5% 2kV		C4	4022 301 65421
C112	CAP 33PF 5% 2kV		C4	4022 301 65421
C113	CAP 33PF 5% 2kV		C4	4022 301 65421
C115	CAP 33PF 5% 2kV		C4	4022 301 65421
C116	CAP 33PF 5% 2kV		C5	4022 301 65421
C119	CAP 100NF 10% 50V	C3		4022 301 61331
C120	CAP 1NF 5% 50V	C4		4022 301 60411
C121	CAP 100NF 10% 50V	C4		4022 301 61331
C122	CAP 100NF 10% 50V	C4		4022 301 61331
C123	CAP 100NF 10% 50V	C4		4022 301 61331
C125	CAP 10UF 10% 6.3V	C3		4022 101 00011
C126	CAP 10UF 10% 6.3V	C3		4022 101 00011
C128	CAP 100NF 10% 50V	C4		4022 301 61331
C129	CAP 820PF 5% 50V	C3		4022 301 60401
C131	CAP 1.8NF 2% 50V		C4	4022 301 65101
C132	CAP 220PF 5% 50V		C4	4022 301 60331
C133	CAP 3.3NF 5% 50V		C4	4022 301 60921
C135	CAP 4.7NF 5% 50V		C4	4022 301 65161
C136	CAP 4.7NF 5% 50V		C4	4022 301 65161
C137	CAP 10NF 5% 25V		C4	4022 301 64671
C201	CAP 180PF 5% 50V	C3		4022 301 60321
C202	CAP 100NF 10% 50V	C4		4022 301 61331
C203	CAP 100NF 10% 50V	C4		4022 301 61331
C204	CAP 100NF 10% 50V	C4		4022 301 61331
C205	CAP 100NF 10% 50V	C5		4022 301 61331
C206	CAP 100NF 10% 50V	B4		4022 301 61331
C207	CAP 4.7PF 0.25PF 50V	C4		4022 301 60131
C208	CAP 22PF 5% 50V	C4		4022 301 60211
C210	CAP 33PF 5% 2kV		C4	4022 301 65421
C212	CAP 33PF 5% 2kV		C4	4022 301 65421
C213	CAP 33PF 5% 2kV		C4	4022 301 65421
C215	CAP 33PF 5% 2kV		B4, B5	4022 301 65421
C216	CAP 33PF 5% 2kV		C5	4022 301 65421
C219	CAP 100NF 10% 50V	B3		4022 301 61331
C220	CAP 1NF 5% 50V	B4		4022 301 60411
C221	CAP 100NF 10% 50V	B4		4022 301 61331
C222	CAP 100NF 10% 50V	B4		4022 301 61331
C223	CAP 100NF 10% 50V	B4		4022 301 61331
C225	CAP 10UF 10% 6.3V	B3		4022 101 00011
C226	CAP 10UF 10% 6.3V	C3		4022 101 00011
C228	CAP 100NF 10% 50V	B4		4022 301 61331
C229	CAP 820PF 5% 50V	C3		4022 301 60401
C231	CAP 1.8NF 2% 50V		C4	4022 301 65101
C232	CAP 220PF 5% 50V		C4	4022 301 60331
C233	CAP 3.3NF 5% 50V		C4	4022 301 60921
C235	CAP 4.7NF 5% 50V		C4	4022 301 65161

Item	Description	Location on Main PCA		Ordering Code
		top	bottom	
C236	CAP 4.7NF 5% 50V		C4	4022 301 65161
C237	CAP 10NF 5% 25V		C4	4022 301 64671
C301	CAP 180PF 5% 50V	B3		4022 301 60321
C302	CAP 100NF 10% 50V	B4		4022 301 61331
C303	CAP 100NF 10% 50V	B4		4022 301 61331
C304	CAP 100NF 10% 50V	B4		4022 301 61331
C305	CAP 100NF 10% 50V	B4		4022 301 61331
C306	CAP 100NF 10% 50V	B4		4022 301 61331
C307	CAP 4.7PF 0.25PF 50V	B4		4022 301 60131
C308	CAP 22PF 5% 50V	B4		4022 301 60211
C310	CAP 33PF 5% 2kV		B4	4022 301 65421
C312	CAP 33PF 5% 2kV		B4	4022 301 65421
C313	CAP 33PF 5% 2kV		B4	4022 301 65421
C315	CAP 33PF 5% 2kV		B5	4022 301 65421
C316	CAP 33PF 5% 2kV		B5	4022 301 65421
C319	CAP 100NF 10% 50V	B3		4022 301 61331
C320	CAP 1NF 5% 50V	A4		4022 301 60411
C321	CAP 100NF 10% 50V	A4		4022 301 61331
C322	CAP 100NF 10% 50V	A4		4022 301 61331
C323	CAP 100NF 10% 50V	A4		4022 301 61331
C325	CAP 10UF 10% 6.3V	A3, B3		4022 101 00011
C326	CAP 10UF 10% 6.3V	B3		4022 101 00011
C328	CAP 100NF 10% 50V	A4		4022 301 61331
C329	CAP 820PF 5% 50V	B3		4022 301 60401
C331	CAP 1.8NF 2% 50V		B4	4022 301 65101
C332	CAP 220PF 5% 50V		B4	4022 301 60331
C333	CAP 3.3NF 5% 50V		B4	4022 301 60921
C335	CAP 4.7NF 5% 50V		B4	4022 301 65161
C336	CAP 4.7NF 5% 50V		B4	4022 301 65161
C337	CAP 10NF 5% 25V		B4	4022 301 64671
C400	CAP 10UF 10% 6.3V		B3	4022 101 00011
C401	CAP 10UF 10% 6.3V	B3		4022 101 00011
C405	CAP 10NF 10% 50V		B3	4022 301 62961
C406	CAP 100NF 10% 50V	B3		4022 301 61331
C407	CAP 100NF 10% 50V	B3		4022 301 61331
C408	CAP 100NF 10% 50V		D3	4022 301 61331
C409	CAP 100NF 10% 50V		D3	4022 301 61331
C500	CAP 100NF 10% 50V	A3		4022 301 61331
C501	CAP 100NF 10% 50V		A3	4022 301 61331
C502	CAP 100NF 10% 50V	A3		4022 301 61331
C503	CAP 100NF 10% 50V	A3		4022 301 61331
C504	CAP 100NF 10% 50V		A3	4022 301 61331
C505	CAP 100NF 10% 50V	B1		4022 301 61331
C506	CAP 100NF 10% 50V		B1	4022 301 61331
C507	CAP 100NF 10% 50V	B1		4022 301 61331
C508	CAP 1UF +80/-20% 50V	A5		4022 301 64591
C509	ALCAP 470UF 20% 35V	A4, A5		4022 301 64681
C510	CAP 1UF +80/-20% 50V	A5		4022 301 64591

Item	Description	Location on Main PCA		Ordering Code
		top	bottom	
C511	CAP 10UF 10% 16V	A4		4022 301 63631
C512	CAP 100NF 10% 50V	B1		4022 301 61331
C513	CAP 100NF 10% 50V	B1		4022 301 61331
C514	CAP 1UF +80/-20% 50V		A3, A4	4022 301 64591
C515	CAP 100NF 10% 50V		A4	4022 301 61331
C516	CAP 10NF 10% 50V	A4		4022 301 62961
C517	CAP 100NF 10% 50V		A4	4022 301 61331
C518	CAP 100NF 10% 50V		A4	4022 301 61331
C519	CAP 330NF 10% 50V	A3		4022 101 00291
C520	CAP 180PF 5% 50V	A3		4022 301 60321
C521	CAP 100NF 10% 50V	A3		4022 301 61331
C522	CAP 1UF 10% 25V	A3		4022 301 64361
C523	ALCAP 4.7UF 20% 35V	A3		4022 301 65151
C524	CAP 10NF 10% 50V		A3	4022 301 62961
C525	CAP 10NF 10% 50V		A3	4022 301 62961
C526	CAP 100NF 10% 50V		A3	4022 301 61331
C601	CAP 10UF 10% 6.3V	A3		4022 101 00011
C602	CAP 10UF 10% 6.3V		A3	4022 101 00011
C603	ALCAP 4.7UF 20% 35V	B2, B3		4022 301 65151
C605	CAP 1UF 10% 25V		A2	4022 301 64361
C607	CAP 10UF 10% 6.3V		A1	4022 101 00011
C608	CAP 10UF 10% 6.3V		A1	4022 101 00011
C609	CAP 10UF 10% 6.3V		B1	4022 101 00011
C611	CAP 100NF 10% 50V		A1	4022 301 61331
C612	CAP 100NF 10% 50V		A1, A2	4022 301 61331
C613	CAP 10UF 10% 6.3V		A2	4022 101 00011
C614	CAP 10UF 10% 6.3V		A2	4022 101 00011
C615	CAP 220PF 5% 50V	A1		4022 301 60331
C617	CAP 10NF 10% 50V		B2	4022 301 62961
C618	CAP 220PF 5% 50V		A2	4022 301 60331
C619	CAP 10NF 10% 50V	B2		4022 301 62961
C620	CAP 10NF 10% 50V		A2	4022 301 62961
C627	CAP 100NF 10% 50V		A3	4022 301 61331
C630	CAP 10UF 10% 6.3V	A3		4022 101 00011
C631	ALCAP 4.7UF 20% 35V	B2, B3		4022 301 65151
C632	CAP 10UF 10% 6.3V		A2	4022 101 00011
C633	CAP 10UF 10% 6.3V		A3	4022 101 00011
C634	CAP 4.7PF 5% 50V		A3	4022 301 60631
C635	CAP 4.7PF 5% 50V		A2	4022 301 60631
C638	CAP 10UF 10% 16V		A2	4022 301 63631
C639	CAP 10UF 10% 16V		A1	4022 301 63631
C640	CAP 10UF 10% 16V	A1		4022 301 63631
C701	CAP 10NF 10% 50V		A1	4022 301 62961
C702	CAP 100PF 5% 50V		A1	4022 301 60291
C703	CAP 1UF 10% 25V		B2	4022 301 64361
C704	CAP 10NF 10% 50V		A1	4022 301 62961
C705	CAP 100PF 5% 50V		A1	4022 301 60291
C706	CAP 10NF 10% 50V		B1	4022 301 62961

Item	Description	Location on Main PCA top	 bottom	Ordering Code
C707	CAP 100PF 5% 50V		B1	4022 301 60291
C708	CAP 1UF 10% 25V		B2	4022 301 64361
C709	CAP 10NF 10% 50V		A1	4022 301 62961
C710	CAP 100PF 5% 50V		A1	4022 301 60291
C711	CAP 10NF 10% 50V		B1	4022 301 62961
C712	CAP 10NF 10% 50V		B2	4022 301 62961
C713	CAP 10NF 10% 50V		A1	4022 301 62961
C715	CAP 10NF 10% 50V		A1	4022 301 62961
C716	CAP 100PF 5% 50V		A1	4022 301 60291
C717	CAP 10NF 10% 50V		A1	4022 301 62961
C718	CAP 100PF 5% 50V		A1	4022 301 60291
C719	CAP 10NF 10% 50V		A1	4022 301 62961
C720	CAP 1UF 10% 25V	A1		4022 301 64361
C721	CAP 10NF 10% 50V		B1	4022 301 62961
C722	CAP 1UF 10% 25V		B1	4022 301 64361
C723	CAP 100PF 5% 50V		A1	4022 301 60291
C725	CAP 10NF 10% 50V		A1	4022 301 62961
C726	CAP 100PF 5% 50V		B1	4022 301 60291
C727	CAP 10NF 10% 50V		B1	4022 301 62961
C728	CAP 100PF 5% 50V		B1	4022 301 60291
C2701	CAP 10NF 10% 50V		B1	4022 301 62961
C2702	CAP 10NF 10% 50V		B1	4022 301 62961
C2703	CAP 10NF 10% 50V		B1	4022 301 62961
C2707	CAP 10UF 10% 6.3V	B1		4022 101 00011
C3301	CAP 100NF 10% 50V		B2	4022 301 61331
C3302	CAP 100NF 10% 50V		C1	4022 301 61331
C3303	CAP 100NF 10% 50V		C2	4022 301 61331
C3304	CAP 100NF 10% 50V		C2	4022 301 61331
C3305	CAP 100NF 10% 50V		C2	4022 301 61331
C3306	CAP 100NF 10% 50V		B2	4022 301 61331
C3307	CAP 100NF 10% 50V		B2	4022 301 61331
C3308	CAP 100NF 10% 50V		C2	4022 301 61331
C3309	CAP 100NF 10% 50V		C1	4022 301 61331
C3310	CAP 100NF 10% 50V		C1	4022 301 61331
C3311	CAP 100NF 10% 50V		B1	4022 301 61331
C3312	CAP 100NF 10% 50V		B1	4022 301 61331
C3313	CAP 100NF 10% 50V		C2	4022 301 61331
C3401	CAP 100NF 10% 50V	A2		4022 301 61331
C3402	CAP 100NF 10% 50V	A2		4022 301 61331
C3403	CAP 47PF 5% 50V		A2	4022 301 60251
C3500	CAP 100NF 10% 50V		C1	4022 301 61331
C3501	CAP 100NF 10% 50V		C1	4022 301 61331
C3502	CAP 100NF 10% 50V		C1	4022 301 61331
C3503	CAP 1UF 10% 25V		C1	4022 301 64361
C3504	CAP 100NF 10% 50V		B1	4022 301 61331
C3505	CAP 100NF 10% 50V		B1	4022 301 61331
C3506	CAP 100NF 10% 50V		C2	4022 301 61331
C3507	CAP 100NF 10% 50V		B1	4022 301 61331

Item	Description	Location on Main PCA top	bottom	Ordering Code
C3509	CAP 100NF 10% 50V		B1	4022 301 61331
C3510	CAP 100NF 10% 50V		C1	4022 301 61331
C3511	CAP 100NF 10% 50V		C1	4022 301 61331
C3512	CAP 100NF 10% 50V		C2	4022 301 61331
C3519	CAP 22NF 10% 50V	D1		4022 301 60491
C3533	CAP 100NF 10% 50V		B1	4022 301 61331
C3540	CAP 18PF 5% 50V		B1	4022 301 60201
C3541	CAP 18PF 5% 50V	B1		4022 301 60201
C3542	CAP 180PF 5% 50V		B1	4022 301 60321
C3543	CAP 18PF 5% 50V		C1	4022 301 60201
C3544	CAP 18PF 5% 50V		B1	4022 301 60201
C3546	CAP 4.7PF 5% 50V		C1, C2	4022 301 60631
C3550	CAP 100NF 10% 50V		C1	4022 301 61331
C3551	CAP 100NF 10% 50V		C1	4022 301 61331
C3552	CAP 100NF 10% 50V		C1	4022 301 61331
C3553	CAP 100NF 10% 50V	C1		4022 301 61331
C3600	CAP 100NF 10% 50V	D2		4022 301 61331
C3611	CAP 100NF 10% 50V		D2	4022 301 61331
C3612	CAP 100NF 10% 50V		D2	4022 301 61331
C3613	CAP 100NF 10% 50V		D3	4022 301 61331
C3614	CAP 100NF 10% 50V		D2	4022 301 61331
C3615	CAP 100NF 10% 50V		D2	4022 301 61331
C3616	CAP 100NF 10% 50V		D3	4022 301 61331
C3617	CAP 100NF 10% 50V		C2	4022 301 61331
C3618	CAP 100NF 10% 50V		D2	4022 301 61331
C3619	ALCAP 4.7UF 20% 35V	C2		4022 301 65151
C3621	CAP 100NF 10% 50V	D3		4022 301 61331
C3622	CAP 100NF 10% 50V	D3		4022 301 61331
C3623	CAP 22NF 10% 50V	D3		4022 301 60491
C3701	CAP 10NF 10% 50V		A1	4022 301 62961
C3702	CAP 10NF 10% 50V		A1	4022 301 62961
C3703	CAP 10NF 10% 50V		A1	4022 301 62961
C3704	CAP 10NF 10% 50V		A1	4022 301 62961
C3705	CAP 10NF 10% 50V		A1	4022 301 62961
C3706	CAP 10NF 10% 50V		A1	4022 301 62961
C3707	CAP 10NF 10% 50V		A1	4022 301 62961
C3708	CAP 10NF 10% 50V		A1	4022 301 62961
C3709	CAP 10NF 10% 50V		A1	4022 301 62961
C3710	CAP 10NF 10% 50V		A1	4022 301 62961
C3711	CAP 1UF 10% 25V		A1	4022 301 64361
C3712	CAP 1UF 10% 25V		A1	4022 301 64361
C3713	CAP 10NF 10% 50V		A1	4022 301 62961
C4200	CAP 100NF 10% 50V		D2	4022 301 61331
C4201	CAP 1UF 10% 25V		D2	4022 301 64361
C4202	CAP 680PF 5% 50V		D2	4022 301 60391
C4203	CAP 100NF 10% 50V		D1	4022 301 61331
C4204	CAP 10NF 10% 50V	D1		4022 301 62961
C4206	TACAP 10UF 20% 10V		C1	4022 301 61881

Item	Description	Location on Main PCA		Ordering Code
		top	bottom	
C4210	CAP 47NF 10% 25V	D2		4022 301 60551
C4211	CAP 100NF 10% 63V	D2		4022 301 65141
C4212	CAP 33PF 5% 2KV	D2		2020 558 90468
C4213	CAP 1UF 10% 25V		D1	4022 301 64361
C4214	CAP 10UF 10% 16V		D1	4022 301 63631
C4221	CAP 1NF 5% 50V	D2		4022 301 60411
C4222	CAP 100NF 10% 50V		D1	4022 301 61331
C4223	CAP 100NF 10% 50V	D2		4022 301 61331
C4303	CAP 100NF 10% 50V	B1		4022 301 61331
C4304	CAP 100NF 10% 50V	B1		4022 301 61331
C4310	CAP 22NF 10% 50V	B1		4022 301 60491
C5701	CAP 100NF 10% 50V		C3	4022 301 61331
C5702	CAP 10UF 10% 6.3V		C3	4022 101 00011
C5704	CAP 2.2NF 10% 50V		C3	4022 301 60431
C5705	CAP 2.2NF 10% 50V		C3	4022 301 60431
C5706	CAP 2.2NF 10% 50V		C3	4022 301 60431
C5707	CAP 2.2NF 10% 50V		C3	4022 301 60431
C5708	CAP 100NF 10% 50V		B3	4022 301 61331
C5709	CAP 10UF 10% 6.3V		C3	4022 101 00011
C5711	CAP 2.2NF 10% 50V		B3	4022 301 60431
C5712	CAP 2.2NF 10% 50V		B3	4022 301 60431
C5713	CAP 2.2NF 10% 50V		B3	4022 301 60431
C5714	CAP 2.2NF 10% 50V		B3	4022 301 60431
C5715	CAP 10UF 10% 6.3V		C3	4022 101 00011
C5716	CAP 10UF 10% 6.3V		B3	4022 101 00011
C5717	CAP 10UF 10% 6.3V		B3	4022 101 00011
C5718	CAP 10UF 10% 6.3V		C3	4022 101 00011
C5719	CAP 10NF 10% 50V		C3	4022 301 62961
C5720	CAP 10NF 10% 50V		B3, C3	4022 301 62961
C5723	CAP 100NF 10% 50V		C3	4022 301 61331
C5724	CAP 100NF 10% 50V	C3		4022 301 61331
C5725	CAP 100NF 10% 50V		B3	4022 301 61331
C5726	CAP 100NF 10% 50V		C3	4022 301 61331
C5727	CAP 100NF 10% 50V	C3		4022 301 61331
C5728	CAP 100NF 10% 50V		C3	4022 301 61331
C5729	CAP 100NF 10% 50V	B3		4022 301 61331
C5730	CAP 100NF 10% 50V	B3		4022 301 61331
C5731	CAP 100NF 10% 50V		C3	4022 301 61331
D1	MUX 2X4CH-ANA DG409DQ	D4		4022 103 04031
D101	MUX 2X4CH-ANA DG409DQ	C4		4022 103 04031
D201	MUX 2X4CH-ANA DG409DQ	C4		4022 103 04031
D301	MUX 2X4CH-ANA DG409DQ	B4		4022 103 04031
D401	SHIFTREG 8B 74HC595PW	D3		4022 103 03541
D403	SHIFTREG 8B 74HC595PW	D3		4022 103 03541
D701	DSP ADSP-21161NKCA-100	A1		4022 103 02761
D2701	MEM SN74ALVC7805-40DLR	B1		4022 103 02741
D3301	FEPROM 32MB SST39VF3201	B2		4022 103 04201

Item	Description	Location on Main PCA top	bottom	Ordering Code
D3302	FEPROM 32MB SST39VF3201	B2		4022 103 04201
D3303	FEPROM 8M M29W800DB70N6	C1		4022 103 03561
D3304	FEPROM 8M M29W800DB70N6	C2		4022 103 03561
D3305	4MBIT SRAM 256X16 TSOP2	C2		4022 304 13241
D3306	4MBIT SRAM 256X16 TSOP2	B2		4022 304 13241
D3500	Digital Asic Spider	C1		4022 304 11551
D3502	4MBIT SRAM 256X16 TSOP2	C1		4022 304 13241
D3550	CPLD LC4032ZC-5T48C	C1		4022 103 03571
D3553	BUFFER DUAL NC7WZ07P6X		B2	4022 103 02371
D3601	74HCT541PW	D2		4022 304 11561
D3602	74HCT541PW	D2		4022 304 11561
D3701	DRAM MT48LC4M32B2TG-7	A1		4022 103 01271
D4300	8-INP MUX 74HC4051		B1	9337 148 20653
D5701	4 X 2-INP NAND 74LVC00A	C3		4022 304 10971
D5703	2 X D-FF 74LVC74A	C3		4022 304 10961
D5704	VOLTREF 2.5V ADR421AR	B3		4022 103 02781
D5707	ADC 4CH 16B AD7655AST	C3		4022 103 02771
D5708	ADC 4CH 16B AD7655AST	B3		4022 103 02771
D5710	PROC SUPERVISOR TPS3823	B1		4022 103 03641
L1	FILTER EMI 1000E		D5	4022 104 00301
L101	FILTER EMI 1000E		C5	4022 104 00301
L201	FILTER EMI 1000E		C5	4022 104 00301
L301	FILTER EMI 1000E		B5	4022 104 00301
L501	INDUCT 100UH 20% DS5022P-104	A4		4022 104 00991
L502	FILTER EMI 1000E	B1		4022 104 00301
L503	FILTER EMI 1000E	B1		4022 104 00301
L504	FILTER EMI 600E		B1	4022 104 00961
L505	FILTER EMI 600E		B1	4022 104 00961
L506	FILTER EMI 600E	A5		4022 104 00961
L507	FILTER EMI 600E	A5		4022 104 00961
L601	IND 3.3UH 20% SLF7032T	A2		4022 104 00841
L602	INDUCT 2.2UH 5% NL32252	A3		4022 104 00821
L603	IND 10UH 20% SLF7032T	A3		4022 104 00831
L604	IND 10UH 20% SLF7032T	A2		4022 104 00831
L605	CHIP INDUCTOR 47UH 10%		B2	2411 531 15141
L606	INDUCTOR 2.2UH 5% NL32252	A1		4022 104 00821
L607	IND 3.3UH 20% SLF7032T	A1		4022 104 00841
L608	IND 3.3UH 20% SLF7032T	A2		4022 104 00841
L609	INDUCT 2.2UH 5% NL32252		A2	4022 104 00821
L612	IND 3.3UH 20% SLF7032T	A3		4022 104 00841
L613	IND 10UH 20% SLF7032T	A3		4022 104 00831
L614	IND 10UH 20% SLF7032T	A2		4022 104 00831
L701	FILTER EMI 1000E	B2		4022 104 00301
L703	FILTER EMI 1000E		A1	4022 104 00301
L704	FILTER EMI 600E	B1		4022 104 00961
L2701	INDUCT 2.2UH 5% NL32252	B1		4022 104 00821
L3500	CHIP INDUCT. 1UH 5%	C1		2422 535 96505

Item	Description	Location on Main PCA top	bottom	Ordering Code
L3701	FILTER EMI 600E 1206		A1	4022 104 00961
L4200	INDUCT 150UH 20%	D2		4022 301 92341
L4201	INDUCT 100UH 20%	D1		4022 301 92351
L5701	FILTER EMI 1000E		C3	4022 104 00301
L5702	FILTER EMI 1000E	B3		4022 104 00301
L5703	FILTER EMI 1000E	C3		4022 104 00301
L5704	FILTER EMI 1000E	C3		4022 104 00301
N1	OPAMP DUAL TLV2372IDGK	D4		4022 103 03581
N2	OPAMP R-R OPA353NA	D4		4022 103 04121
N3	OPAMP R-R TLV2371IDBV	D4		4022 103 03591
N4	OPAMP R-R OPA353NA	D4		4022 103 04121
N101	OPAMP DUA TLV2372IDGK	C4		4022 103 03581
N102	OPAMP R-R OPA353NA	C4		4022 103 04121
N103	OPAMP R-R TLV2371IDBV	C4		4022 103 03591
N104	OPAMP R-R OPA353NA	C4		4022 103 04121
N201	OPAMP DUA TLV2372IDGK	C4		4022 103 03581
N202	OPAMP R-R OPA353NA	B4, C4		4022 103 04121
N203	OPAMP R-R TLV2371IDBV	B4		4022 103 03591
N204	OPAMP R-R OPA353NA	B4		4022 103 04121
N301	OPAMP DUA TLV2372IDGK	B4		4022 103 03581
N302	OPAMP R-R OPA353NA	B4		4022 103 04121
N303	OPAMP R-R TLV2371IDBV	A4		4022 103 03591
N304	OPAMP R-R OPA353NA	A4		4022 103 04121
N401	OPAMP R-R TLV2371IDBV	B3		4022 103 03591
N500	COMP RR-IN LMC7211AIM5	A3		4022 103 02541
N501	OPAMP CMOS OPA336NA	A3		4022 103 04091
N502	BAT-CHARG ADP3806JRU	A4		4022 103 03601
N503	V-REG 3.3V LP2951ACMX-3.3		A3	4022 304 13361
N504	OPAMP DUA TLV2372IDGK	A3		4022 103 03581
N601	CONV DC/DC LT1945EMS	A3		4022 103 03611
N602	VOLTREG SW LT1940EFE	A1		4022 103 02921
N603	CONV DC/DC LT1930ES5		A2, A3	4022 103 04111
N604	V-REG 3.3V LP2986ILD-3	A2		4022 103 03621
N3401	COMP DUAL LM393M		A2	4022 103 01291
N3500	V-REG LP3984IMF-1.8		C1	4022 103 03631
N3552	NC7WZ17-UHS		C1	4022 304 11691
N3600	MC33171D		C2, D2	4022 304 11571
N3601	OPAMP QUAD BIPOL MC3317		D2	4022 304 11431
N4200	LAMP CNTRLLR UC3872DW		D1,D2	9322 095 09682
N4300	OPAMP R-R TLV2371IDBV	B1		4022 103 03591
R1	RES NETW R_T1794-605	D4, D5		0040 102 00021
R101	RES NETW R_T1794-605	C4, C5		0040 102 00021
R201	RES NETW R_T1794-605	B4, B5		0040 102 00021
R301	RES NETW R_T1794-605	B4, B5		0040 102 00021
R2	RES 8X10K 1%		D3, D4	4022 102 00201
R4	RES 1E 1% .125W	D3		4022 301 21291

Item	Description	Location on Main PCA		Ordering Code
		top	bottom	
R5	RES 4E64 1% .125W		D3	4022 301 21331
R6	RES 1E 1% .125W	D3		4022 301 21291
R7	RES 10E 1% .125W		D3	4022 301 21351
R8	RES 4E64 1% .125W		D3	4022 301 21331
R9	RES 10E 1% .125W		D3	4022 301 21351
R10	RES 10E 1% .125W		D3	4022 301 21351
R11	RES 10E 1% .125W		D3	4022 301 21351
R12	RES 1K 1% .125W	D4		4022 301 24841
R13	RES 10K 1% 0.1W	D4		4022 301 22071
R14	RES 10K 1% 0.1W	D4		4022 301 22071
R15	RES 10K 1% 0.1W	D4		4022 301 22071
R16	RES 10K 1% 0.1W	D4		4022 301 22071
R17	RES 10K 1% 0.1W	D4		4022 301 22071
R18	RES 10K 1% 0.1W	D4		4022 301 22071
R19	RES 10K 1% 0.1W	D4		4022 301 22071
R20	RES 10K 1% 0.1W	D4		4022 301 22071
R21	RES 10K 1% 0.1W	D4		4022 301 22071
R22	RES 4M7 1% 0.125W	D4		4022 301 33811
R23	RES 10K 1% 0.1W	D4		4022 301 22071
R24	RES 10K 1% 0.1W	D3		4022 301 22071
R25	RES 1M 1% 0.1W	D4		4022 301 22441
R26	RES 10K 1% 0.25W		D5	4022 301 20831
R102	RES 8X10K 1%		C3, C4	4022 102 00201
R104	RES 1E 1% .125W	C3		4022 301 21291
R105	RES 4E64 1% .125W		C3	4022 301 21331
R106	RES 1E 1% .125W	C3		4022 301 21291
R107	RES 10E 1% .125W		C3	4022 301 21351
R108	RES 4E64 1% .125W		C3	4022 301 21331
R109	RES 10E 1% .125W		C3	4022 301 21351
R110	RES 10E 1% .125W		C3	4022 301 21351
R111	RES 10E 1% .125W		C3	4022 301 21351
R112	RES 1K 1% .125W	D4		4022 301 24841
R113	RES 10K 1% 0.1W	C4		4022 301 22071
R114	RES 10K 1% 0.1W	C4		4022 301 22071
R115	RES 10K 1% 0.1W	C4		4022 301 22071
R116	RES 10K 1% 0.1W	C4		4022 301 22071
R117	RES 10K 1% 0.1W	C4		4022 301 22071
R118	RES 10K 1% 0.1W	C4		4022 301 22071
R119	RES 10K 1% 0.1W	C4		4022 301 22071
R120	RES 10K 1% 0.1W	C4		4022 301 22071
R121	RES 10K 1% 0.1W	C4		4022 301 22071
R122	RES 4M7 1% 0.125W	C4, D4		4022 301 33811
R123	RES 10K 1% 0.1W	C4		4022 301 22071
R124	RES 10K 1% 0.1W	C3		4022 301 22071
R125	RES 1M 1% 0.1W	C4		4022 301 22441
R126	RES 10K 1% 0.25W		C5	4022 301 20831
R202	RES 8X10K 1%		C3, C4	4022 102 00201
R204	RES 1E 1% .125W	B3		4022 301 21291

Item	Description	Location on Main PCA top	Location on Main PCA bottom	Ordering Code
R205	RES 4E64 1% .125W		B3	4022 301 21331
R206	RES 1E 1% .125W	C3		4022 301 21291
R207	RES 10E 1% .125W		B3	4022 301 21351
R208	RES 4E64 1% .125W		B3	4022 301 21331
R209	RES 10E 1% .125W		B3	4022 301 21351
R210	RES 10E 1% .125W		B3	4022 301 21351
R211	RES 10E 1% .125W		C3	4022 301 21351
R212	RES 1K 1% .125W	C4		4022 301 24841
R213	RES 10K 1% 0.1W	B4		4022 301 22071
R214	RES 10K 1% 0.1W	B4		4022 301 22071
R215	RES 10K 1% 0.1W	B4		4022 301 22071
R216	RES 10K 1% 0.1W	B4		4022 301 22071
R217	RES 10K 1% 0.1W	B4		4022 301 22071
R218	RES 10K 1% 0.1W	B4		4022 301 22071
R219	RES 10K 1% 0.1W	B4		4022 301 22071
R220	RES 10K 1% 0.1W	B4		4022 301 22071
R221	RES 10K 1% 0.1W	B4		4022 301 22071
R222	RES 4M7 1% 0.125W	C4		4022 301 33811
R223	RES 10K 1% 0.1W	B4		4022 301 22071
R224	RES 10K 1% 0.1W	B3		4022 301 22071
R225	RES 1M 1% 0.1W	C4		4022 301 22441
R226	RES 10K 1% 0.25W		B5	4022 301 20831
R302	RES 8X10K 1%		B3, B4	4022 102 00201
R304	RES 1E 1% .125W	A3		4022 301 21291
R305	RES 4E64 1% .125W		A3	4022 301 21331
R306	RES 1E 1% .125W	B3		4022 301 21291
R307	RES 10E 1% .125W		B3	4022 301 21351
R308	RES 4E64 1% .125W		A3	4022 301 21331
R309	RES 10E 1% .125W		B3	4022 301 21351
R310	RES 10E 1% .125W		B3	4022 301 21351
R311	RES 10E 1% .125W		B3	4022 301 21351
R312	RES 1K 1% .125W	B4		4022 301 24841
R313	RES 10K 1% 0.1W	A4		4022 301 22071
R314	RES 10K 1% 0.1W	A4		4022 301 22071
R315	RES 10K 1% 0.1W	A4		4022 301 22071
R316	RES 10K 1% 0.1W	A4		4022 301 22071
R317	RES 10K 1% 0.1W	A4		4022 301 22071
R318	RES 10K 1% 0.1W	A4		4022 301 22071
R319	RES 10K 1% 0.1W	A4		4022 301 22071
R320	RES 10K 1% 0.1W	A4		4022 301 22071
R321	RES 10K 1% 0.1W	A4		4022 301 22071
R322	RES 4M7 1% 0.125W	B4		4022 301 33811
R323	RES 10K 1% 0.1W	A4		4022 301 22071
R324	RES 10K 1% 0.1W	A3		4022 301 22071
R325	RES 1M 1% 0.1W	B4		4022 301 22441
R326	RES 10K 1% 0.25W		B5	4022 301 20831
R403	RES 10E 1% .125W	B3		4022 301 21351
R404	RES 10E 1% .125W	B3		4022 301 21351

Item	Description	Location on Main PCA top	bottom	Ordering Code
R405	RES 10E 1% .125W	B3		4022 301 21351
R406	RES 10E 1% .125W	B3		4022 301 21351
R407	RES 8X10K 1%		B3	4022 102 00201
R408	RES 1E 1% .125W		D3	4022 301 21291
R500	RES 681K 1% .125W	A3		4022 301 22411
R501	RES 4M7 1% 0.125W	A3		4022 301 33811
R502	RES 21K5 1% 0.125W	A3		4022 301 29501
R503	RES 100K 1% .125W	A3		4022 102 20361
R504	RES 330K 1% .125W		A3	4022 301 23161
R505	RES 2K15 1% .125W	A3		4022 301 21911
R506	RES 56K2 1% .125W	A3		4022 301 22251
R507	RES 316K 1% .125W		A3	4022 301 22371
R508	RES 21K5 1% 0.125W		A3	4022 301 29501
R509	RES 100K 1% .125W		A3	4022 102 20361
R510	RES 330K 1% .125W		A3	4022 301 23161
R511	RES 10K 1% .125W	B1		4022 301 23091
R512	RES 10K 1% .125W	B1		4022 301 23091
R513	RES 316K 1% .125W	B1		4022 301 22371
R514	RES 100K 1% .125W	B1		4022 102 20361
R515	RES 10E 1% .125W		A4	4022 301 21351
R516	RES 0E1 5% 0.25W		A4	4022 301 21251
R517	RES 162E 1% .125W		A4	4022 301 21641
R518	RES 10E 1% .125W		A4	4022 301 21351
R519	RES 10E 1% .125W		A4	4022 301 21351
R520	RES 330K 1% .125W		A4	4022 301 23161
R521	RES 100E 1% .125W		A4	4022 301 21591
R522	RES 100K 1% .125W		A4	4022 102 20361
R523	RES 51K1 1% .125W		A4	4022 301 22241
R524	RES 100K 1% .125W		A3	4022 102 20361
R525	RES 100K 1% .125W		A3	4022 102 20361
R526	RES 100K 1% .125W		A4	4022 102 20361
R527	RES 51E1 1% .125	A3		4022 301 21521
R528	RES 10E 1% .125W	A3		4022 301 21351
R529	RES 10E 1% .125W	A3		4022 301 21351
R530	RES 100E 1% .125W		A4	4022 301 21591
R531	RES 51K1 1% .125W		A4	4022 301 22241
R532	RES 1M 1% .125W		A3	4022 301 25301
R533	RES 1M 1% .125W	A3		4022 301 25301
R534	RES 1M 1% .125W	A3		4022 301 25301
R535	RES 1M 1% .125W		A3	4022 301 25301
R536	RES 1M 1% .125W	A3		4022 301 25301
R537	RES 16K2 1% .125W		A3	4022 301 22121
R538	RES 100K 1% .125W	A3		4022 102 20361
R602	RES 26K1 0.1% 0.125W		A3	4022 301 22721
R603	RES 2K4 1% .125W		A3	4022 301 30501
R604	RES 9K31 0.1% .125W		A3	4022 102 00101
R606	RES 10E 1% .125W		A2	4022 301 21351
R607	RES 10E 1% .125W		A2	4022 301 21351

Item	Description	Location on Main PCA		Ordering Code
		top	bottom	
R608	RES 100K 1% .125W		A1	4022 102 20361
R609	RES 10K 1% .125W		A1	4022 301 23091
R610	RES 10K 1% .125W		A1	4022 301 23091
R611	RES 10K 1% .125W		A2	4022 301 23091
R612	RES 100K 1% .125W		A2	4022 102 20361
R613	RES 10K 1% .125W		A1	4022 301 23091
R614	RES 10K 1% .125W		A1, A2	4022 301 23091
R615	RES 100K 1% .125W		A1	4022 102 20361
R616	RES 0E1 5% 0.25W	A2		4022 301 21251
R617	RES 22K 1% .125W		A1	4022 301 24881
R618	RES 0E 2A 0805		A2	4022 301 21281
R619	RES 162E 1% .125W	A1, A2		4022 301 21641
R620	RES 16K2 1% .125W	A2		4022 301 22121
R621	RES 0E 2A 0805		A1	4022 301 21281
R622	RES 121K 1% .125W		A2	4022 301 22321
R623	RES 100K 1% .125W	A2		4022 102 20361
R624	RES 0E 2A 0805		A3	4022 301 21281
R625	RES 0E 2A 0805		B2	4022 301 21281
R626	RES 10E 1% .125W	A1		4022 301 21351
R627	RES 38K3 1% .125W		A3	4022 301 22211
R628	RES 10K 1% .125W	A3		4022 301 23091
R629	RES 237K 1% 0.1W		A2	4022 301 25751
R630	RES 10K 1% .125W		A2	4022 301 23091
R631	RES 100K 1% .125W	A3		4022 102 20361
R632	RES 100K 1% .125W		B2	4022 102 20361
R633	RES 100K 1% .125W	A2		4022 102 20361
R702	RES 10K 1% .125W		A2	4022 301 23091
R703	RES 10K 1% .125W		A2	4022 301 23091
R704	RES 10K 1% .125W		A1	4022 301 23091
R1701	RES 10K 1% .125W		B2	4022 301 23091
R1702	RES 10K 1% .125W		B1	4022 301 23091
R2701	RES 10K 1% .125W		B1	4022 301 23091
R2702	RES 10K 1% .125W		B2	4022 301 23091
R2707	RES 10K 1% .125W		A2	4022 301 23091
R3301	RES 10K 1% .125W		C2	4022 301 23091
R3303	RES 0E 2A 0805		B2	4022 301 21281
R3305	RES 1E 1% .125W		B2	4022 301 21291
R3306	RES 0E 2A 0805		C1	4022 301 21281
R3308	RES 1E 1% .125W		C1	4022 301 21291
R3310	RES 0E 2A 0805		B2	4022 301 21281
R3311	RES 0E 2A 0805		C2	4022 301 21281
R3313	RES 1E 1% .125W		C2	4022 301 21291
R3314	RES 1E 1% .125W		C2	4022 301 21291
R3315	RES 1E 1% .125W		C2	4022 301 21291
R3317	RES 1E 1% .125W		C2	4022 301 21291
R3319	RES 0E 2A 0805		B2	4022 301 21281
R3321	RES 0E 2A 0805		B2	4022 301 21281
R3327	RES 3K16 1% .125W		B1	4022 301 21951

Item	Description	Location on Main PCA top	bottom	Ordering Code
R3328	RES 26K1 1% .125W		B1	4022 301 22171
R3330	RES 1E 1% .125W		C1	4022 301 21291
R3331	RES 1E 1% .125W		C1	4022 301 21291
R3400	RES 162E 1% .125W	A2		4022 301 21641
R3401	RES 10E 1% .125W	A2		4022 301 21351
R3402	RES 14K7 1% .125W	A2		4022 301 22111
R3403	RES 511E 1% .125W	A2		4022 301 21761
R3404	RES 511E 1% .125W	A2		4022 301 21761
R3405	RES 100K 1% .125W	A2		4022 102 20361
R3406	RES 5K11 1% .125W	A2		4022 301 22001
R3407	RES 100E 1% .125W		A2	4022 301 21591
R3408	RES 14K7 1% .125W	A2		4022 301 22111
R3409	RES 21K5 1% 0.1W	A2		4022 301 22151
R3500	RES 0E 2A 0805		B2	4022 301 21281
R3501	RES 0E 2A 0805	B2		4022 301 21281
R3502	RES 1K 1% .125W		D1	4022 301 24841
R3503	RES 100K 1% .125W		D1	4022 102 20361
R3504	RES 100K 1% .125W		D1	4022 102 20361
R3508	RES 1K 1% .125W		B1	4022 301 24841
R3520	RES 0E 2A 0805		C2	4022 301 21281
R3521	RES 0E 2A 0805		C1	4022 301 21281
R3523	RES 3K16 1% .125W		A2	4022 301 21951
R3524	RES 3K16 1% .125W		A2	4022 301 21951
R3530	RES 1M 1% 0.1W		B1	4022 301 22441
R3531	RES 82E5 1% .125W		B1	4022 301 21571
R3532	RES 511E 1% .125W		C1	4022 301 21761
R3533	RES 1M 1% 0.1W		B1	4022 301 22441
R3534	RES 1M 1% 0.1W		B1	4022 301 22441
R3551	RES 100K 1% .125W		B1	4022 102 20361
R3552	RES 10K 1% .125W		C1	4022 301 23091
R3554	RES 100K 1% .125W		C1	4022 102 20361
R3556	RES 10K 1% .125W		B1	4022 301 23091
R3557	RES 1E 1% .125W		C1	4022 301 21291
R3558	RES 10K 1% .125W		C1	4022 301 23091
R3559	RES 10K 1% .125W		B2	4022 301 23091
R3601	RES 1E 1% .125W		C2	4022 301 21291
R3602	RES 1E 1% .125W	D3		4022 301 21291
R3603	RES 100K 1% .125W		C2	4022 102 20361
R3604	RES 26K1 1% .125W		C2	4022 301 22171
R3605	RES 1E 1% .125W	D3		4022 301 21291
R3606	RES 38K3 1% .125W		D2	4022 301 22211
R3607	RES 26K1 1% .125W		D2	4022 301 22171
R3608	RES 196K 1% 0.125W	C2, C3		4022 301 29491
R3609	RES 14E7 1% .125W	C3		4022 301 21391
R3611	RES 6K81 1% .125W		D2	4022 301 22031
R3612	RES 6K81 1% .125W		D2	4022 301 22031
R3613	RES 82K5 1% .125W		D3	4022 301 22291
R3614	RES 6K81 1% .125W		D3	4022 301 22031

Item	Description	Location on Main PCA		Ordering Code
		top	bottom	
R3615	RES 6K81 1% .125W		D3	4022 301 22031
R3621	RES 14E7 1% .125W		D2	4022 301 21391
R3622	RES 14E7 1% .125W		A2	4022 301 21391
R3623	RES 14E7 1% .125W		D3	4022 301 21391
R3624	RES 14E7 1% .125W		D3	4022 301 21391
R3631	RES 14E7 1% .125W		D2	4022 301 21391
R3632	RES 14E7 1% .125W		A2	4022 301 21391
R3633	RES 14E7 1% .125W		D3	4022 301 21391
R3634	RES 14E7 1% .125W		D2	4022 301 21391
R4200	RES 10K 1% .125W		D1	4022 301 23091
R4201	RES 100K 1% .125W	D2		4022 102 20361
R4202	RES 5K11 1% .125W		D2	4022 301 22001
R4203	RES 1K 1% .125W		D2	4022 301 24841
R4204	RES 51E1 1% .125		D1	4022 301 21521
R4205	RES 4E64 1% .125W		D1	4022 301 21331
R4206	RES 10K 1% .125W	D1		4022 301 23091
R4207	RES 6K19 1% .125W		D2	4022 301 22021
R4208	RES 10K 1% .125W	A2		4022 301 23091
R4209	RES 10E 1% .125W		D2	4022 301 21351
R4300	RES 21K5 1% 0.1W	B1		4022 301 22151
R4303	RES 100E 1% .125W	B1		4022 301 21591
R4305	RES 0E 2A 0805		B2	4022 301 21281
R4306	RES 2K15 1% .125W		B2	4022 301 21911
R4700	RES 26E1 1% MRS16T	A2		5322 117 10993
R4701	RES 33E 1% .125W		B1	4022 301 24941
R4702	RES 10K 1% .125W		B2	4022 301 23091
R4703	RES 10K 1% .125W		B2	4022 301 23091
R4704	RES 10K 1% .125W		B1	4022 301 23091
R4705	RES 0E 2A 0805		B1	4022 301 21281
R4706	RES 0E 2A 0805		B1	4022 301 21281
R4707	RES 0E 2A 0805		B2	4022 301 21281
R4708	RES 10K 1% .125W	A2		4022 301 23091
R4709	RES 10K 1% .125W		B2	4022 301 23091
R4710	RES 10K 1% .125W	A2		4022 301 23091
R4711	RES 0E 2A 0805	A2		4022 301 21281
R4712	RES 5K11 1% .125W	A2		4022 301 22001
R4713	RES 10K 1% .125W		A2	4022 301 23091
R5701	RES 1E 1% .125W		C3	4022 301 21291
R5702	RES 14E7 1% .125W		C3	4022 301 21391
R5703	RES 14E7 1% .125W		C3	4022 301 21391
R5704	RES 14E7 1% .125W		C3	4022 301 21391
R5705	RES 14E7 1% .125W		C3	4022 301 21391
R5706	RES 1E 1% .125W		B3	4022 301 21291
R5707	RES 14E7 1% .125W		B3	4022 301 21391
R5708	RES 14E7 1% .125W		B3	4022 301 21391
R5709	RES 14E7 1% .125W		B3	4022 301 21391
R5710	RES 14E7 1% .125W		B3	4022 301 21391
R5711	RES 10K 1% .125W		B1	4022 301 23091

Item	Description	Location on Main PCA top	bottom	Ordering Code
R5712	RES 100E 1% .125W	C3		4022 301 21591
R5713	RES 100E 1% .125W	C3		4022 301 21591
R5714	RES 10K 1% .125W	C3		4022 301 23091
R5715	RES 100E 1% .125W	C3		4022 301 21591
R5716	RES 100E 1% .125W	B3		4022 301 21591
R5717	RES 1E 1% .125W		B3	4022 301 21291
R5718	RES 1E 1% .125W		C3	4022 301 21291
R5719	RES 100E 1% .125W	B3		4022 301 21591
R5720	RES 1E 1% .125W		C3	4022 301 21291
R5723	RES 100E 1% .125W	B3		4022 301 21591
T4200	SMD TRNSFRMR 678XN-1081	D2		2722 171 18021
V1	N-CHAN. MOSFET BSS83	D4		5322 130 60502
V101	N-CHAN. MOSFET BSS83	C4		5322 130 60502
V201	N-CHAN. MOSFET BSS83	C4		5322 130 60502
V301	N-CHAN. MOSFET BSS83	B4		5322 130 60502
V500	DIODE SCHOTTKY MBRS340T	A5		4022 304 11251
V501	TMOS N-CH FET MMDF3N04		A4	4022 304 10221
V502	DIODE SCHOTTKY MBRS340T	A4		4022 304 11251
V503	DIODE SCHOTTKY BAT74		A4	9337 422 90215
V505	N-CHAN FET BSN20		A3	9340 125 00215
V506	DIODE SCHOTTKY BAT74		A3	9337 422 90215
V507	N-CHAN FET BSN20		A5	9340 125 00215
V508	DIODE 2X RECT MBRD630CT		A4	4022 103 04191
V509	SCHOTTKY DIODE BAT54S	A4		9339 763 80215
V510	N-CHAN FET BSN20		A4	9340 125 00215
V550	FET 2X N+P CH IRF5851TR		A4	4022 103 02471
V601	DIODE SCHOTTKY MBRS140T	A3		4022 103 00031
V602	DIODE SCHOTTKY MBRS140T	B3		4022 103 00031
V603	DIODE SCHOTTKY MBRS140T	B2		4022 103 00031
V604	SCHOTTKY DIODE BAT54S	B2		9339 763 80215
V605	DIODE SCHOTTKY MBRS140T		A1	4022 103 00031
V606	DIODE SCHOTTKY MBRS140T	A1		4022 103 00031
V607	DIODE SCHOTTKY MBRS140T		A2	4022 103 00031
V608	DIODE SCHOTTKY MBRS140T	A2		4022 103 00031
V610	LF TRANSISTOR BC848CLT		A2	4022 304 11011
V611	N-CHAN FET BSN20	A2		9340 125 00215
V612	MOSFET P-CH FDN340P	A2		4022 103 03651
V613	N-CHAN FET BSN20	A2		9340 125 00215
V614	SCHOTTKY DIODE BAT54S		A2	9339 763 80215
V615	SCHOTTKY DIODE BAT54S	B2		9339 763 80215
V616	DIODE SCHOTTKY MBRS140T		A2	4022 103 00031
V3401	SIL DIODE BAS28	A2		9336 791 70215
V3402	DIODE SCHOTTKY BAT74		B2	9337 422 90215
V3500	DIODE SCHOTTKY BAT74	B1		9337 422 90215
V3550	BFS19 TRANSISTOR SOT-23		B1	9330 835 01215
V4200	FET P-CH NTTS2P03R2 MIC	D1		4022 103 00051

Item	Description	Location on Main PCA top	Location on Main PCA bottom	Ordering Code
V4201	TMOS N-CH FET MMDF3N04		D2	4022 304 10221
V4202	DIODE SCHOTTKY MBRS140T	D1		4022 103 00031
V4203	SIL DIODE BAS28	D2		9336 791 70215
V4204	TRANS PNP BC858CLT1		D2	4022 304 11021
V4205	SENSOR TEMP KTY82-210 S	B2		4022 103 04161
V4210	N-CHAN FET BSN20	D2		9340 125 00215
V4211	N-CHAN FET BSN20		A2	9340 125 00215
X001	MALE HEADER 4-P SNG			4022 303 10111
X500	HEADER 4P-M STR 22-03-5	B1		4022 303 10071
X501	POWER CONNECTOR SP	A5		4022 244 92561
X3600	FLEX-PRINT CON 15-P	D1		2422 025 13792
X3601	FPC CON ZIF 22P 52559-2	D3		4022 303 10501
X4200	HEADER 2P-M RA HV-2P-HF	D2		4022 303 10581
Z500	FILT EMI 50V 10A BNX002	A5		5322 156 11139
H001	PHOTODIODE OP906 OP	A2		9322 108 00682
H002	LED IR OP266A 3MM OPTEK	A2		4022 103 01021
H3500	SOUNDER PE PKM13EPP-400	A2		2422 527 00499

8.7 Accessories

Table 8-4. Standard Accessories

Item	Ordering Code
Battery Charger /Power Adapter, available models: Universal 115/230 V, 50 and 60 Hz Japanese version 100 V, 50 and 60 Hz *To accommodate connection to various line power sockets, the BC430 Battery Charger / Power Adapter is equipped with a male plug that must be connected to a line plug adapter appropriate for local use. Since the Charger is isolated, you can use line plug adapters with or without a protective ground terminal.* *The 230 V rating of the BC430 is not for use in North America. A line plug adapter complying with the applicable National Requirements may be provided to alter the blade configurations for a specific country.*	 BC430 BC430/806
Test Lead Set 2.5 m including Alligator Clips (5 pieces of each item)	TLS430
AC Current Clamp Set (set of 4 pieces): 400 A (1 mV/A) and 40 A (10 mV/A) switcheable	i400s
Set with Color Coding Clips for Test Leads	0040 244 00071
Optical Cable for USB	OC4USB
Hard Case	C430

Table 8-5. Users Manuals

Item	Ordering Code
Getting Started Manual (English, French, Spanish, Portuguese)	4822 872 30755
Getting Started Manual (English)	4822 872 30756
Getting Started Manual (English, French, German, Spanish, Italian, and Norwegian safety text)	4822 872 30757
Getting Started Manual (English, Russian, Japanese, Chinese, Korean)	4822 872 30758
CD with Users Manuals and Getting Started Manuals (All languages)	0040 247 00021

Table 8-6. Optional Accessories

Item	Ordering Code
Advanced Functions for Fluke 433 (Interharmonics, Transients, Energy Usage, Inrush Currents, Extra Memory).	Fluke-433/AF
FlukeView Software for Fluke 433	SW43W (V3.0)
Upgrade Kit for Fluke 433 (Advanced Functions, FlukeView Software, Optical Cable for USB model OC4USB)	Fluke-433/UGK
Optical Isolated RS-232 Cable	PM9080
Print Adapter for Parallel Printers	PAC91
Optical Isolated Trigger Probe (For Fluke 434 to test energy meters)	
AC Current Clamp 200 A (10 mV/A) and 20 A (100 mV/A) switcheable.	i200s
AC Current Clamp 2000 A (1 mV/A) and 200 A (10 mV/A) switcheable, flexible.	i2000flex
AC Current Clamp 500 A (1 mV/A).	80i-500s
AC Current Clamp 1000 A (1 mV/A), 100 A (10 mV/A), and 10 A (100 mV/A) switcheable.	i1000s
AC Current Clamp 3000 A (0.1 mV/A), 300 A (1 mV/A), and 30 A (10 mV/A) switcheable.	i3000s
AC/DC Current Clamp 100 A (10 mV/A) and 10 A (100 mV/A) switcheable.	80i-110s
AC/DC Current Clamp 400 A (1 mV/A)	i410 and PM9082
AC/DC Current Clamp 600 A AC and 1000 A DC (1 mV/A)	i1010 and PM9082
Service Manual (English)	4822 872 05392

Chapter 9
Circuit Diagrams

9.1 Introduction

This chapter contains all circuit diagrams and reference designator views of the Analyzer. There are no serviceable parts on the LCD unit. Therefore no circuit diagrams and reference designator views of the LCD unit are provided.

9.2 Tracing signals in circuit diagrams

Signal lines ending with an arrowhead indicate that the signal goes from one circuit diagram to another. To trace these signals, you can use the coordinates on the edges of the diagrams.

For example: source signal ADC_A0 on circuit diagram 3 (Figure 9-3) has an outgoing arrow with the indication (5,B3). This means that the destination for signal ADC_A0 is located on circuit diagram 5 (Figure 9-5) and located in section B3.

9.3 Locating Parts & Test Points

Use Table 8-3 (Chapter 8) to locate parts on the reference designator views of the Main PCA Top View (Figure 9-12) and Bottom View (Figure 9-13). The drawings are provided with coordinates at the edges.

Use Table 9-1 to locate test points (MSxxxx) on the PCA Bottom Side indicated in Figure 9-13.

Table 9-1. Location of test Points on PCA Bottom Side

Measuring Point	Location	Measuring Point	Location	Measuring Point	Location
MS1	D5	MS3520	B2	MS3613	D1
MS101	C5	MS3521	D3	MS3614	D1
MS102	C4	MS3522	B2	MS401	A5
MS103	C4	MS3523	D3	MS4200	D2
MS2	D4	MS3524	D3	MS4201	D2
MS201	C5	MS3525	D3	MS4701	B1
MS202	B4	MS3526	D3	MS501	B1
MS203	B4	MS3527	B3	MS502	B1
MS3	D4	MS3528	D3	MS503	B1
MS301	B5	MS3529	D3	MS504	B1
MS302	A4	MS3530	D3	MS5701	C3
MS303	A4	MS3531	D3	MS5702	C3
MS3501	B2	MS3532	A3	MS5703	C3
MS3502	B1	MS3533	B3	MS5704	C3
MS3503	D3	MS3550	D1	MS5705	C3
MS3504	C1	MS3551	C1	MS5706	B3
MS3505	B2	MS3552	D1	MS5707	B3
MS3506	A3	MS3553	C1	MS5708	B3
MS3507	A1	MS3602	D1	MS5709	B3
MS3508	D3	MS3603	D1		
MS3509	B1	MS3604	D1		
MS3510	D3	MS3605	D1		
MS3511	D3	MS3606	D1		
MS3512	C3	MS3607	D1		
MS3513	D3	MS3608	D1		
MS3514	D3	MS3609	D1		
MS3516	D3	MS3610	D1		
MS3517	D3	MS3611	D1		
MS3519	D3	MS3612	D1		

9.4 Diagrams

See next pages for circuit diagrams and PCB layout drawings.

The table below shows the row/column matrix of the keypad. The keypad is connected to the D-ASIC via X3600 (Figure 9-6)

The On/Off key is not included in the keyboard layout matrix. It is directly connected to an input of the D-ASIC (ONKEY , pin F4)

Table 9-2. Keyboard Layout

COL↓	**ROW →** test spot	**0** MS3602	**1** MS3603	**2** MS3604	**3** MS3605	**4** MS3606	**(5)** (MS3607)
(0)	(MS3608)						
1	MS3609	F4	F5	▼		▲	
2	MS3610	F3	SAVE SCREEN	☼	MENU	▶	
3	MS3611	F2	SETUP	◀	MONITOR		
4	MS3612	F1	MEMORY	ENTER	SCOPE		
(5)	(MS3613)						

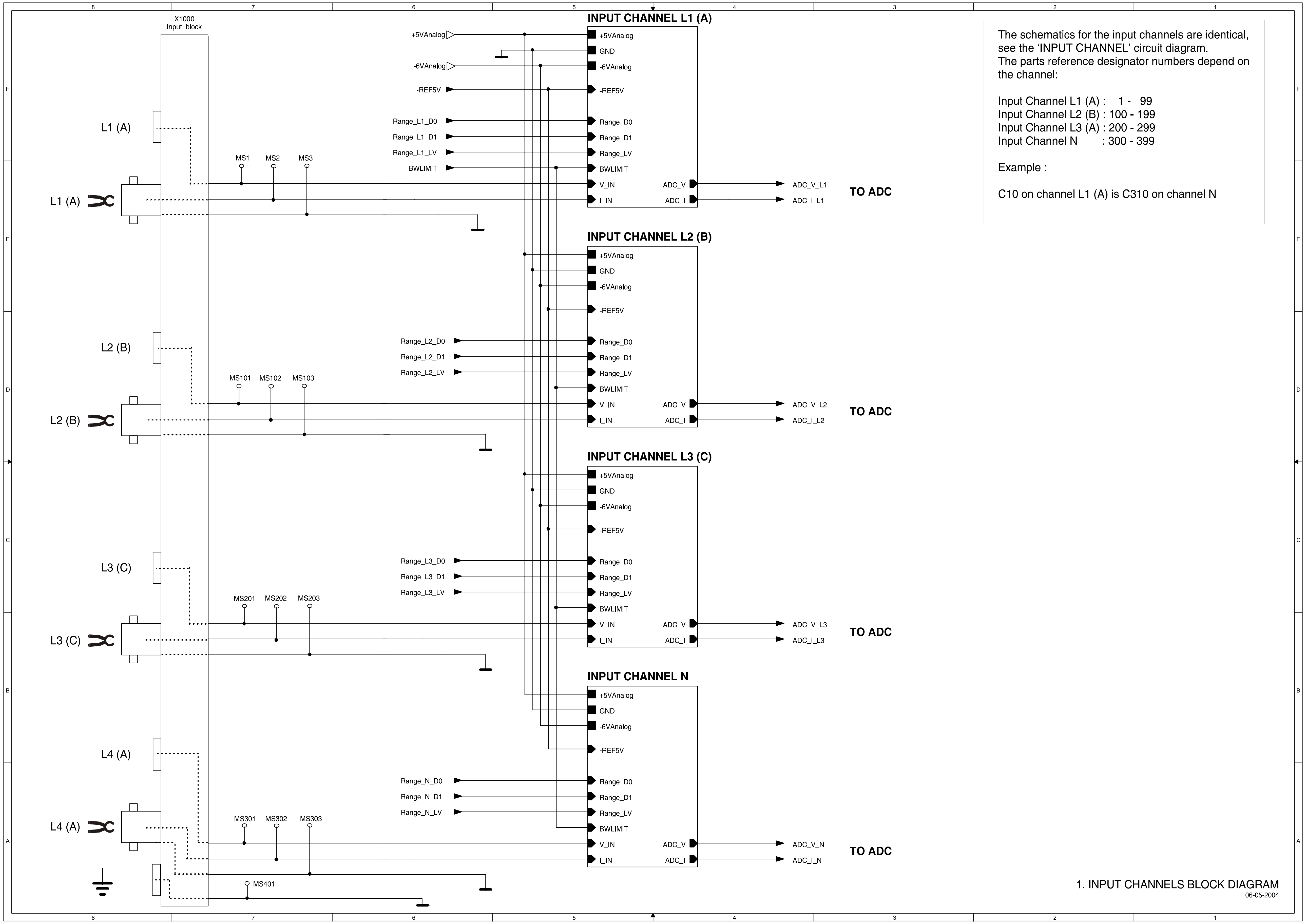


Figure 9-1. Overview of Input Channels

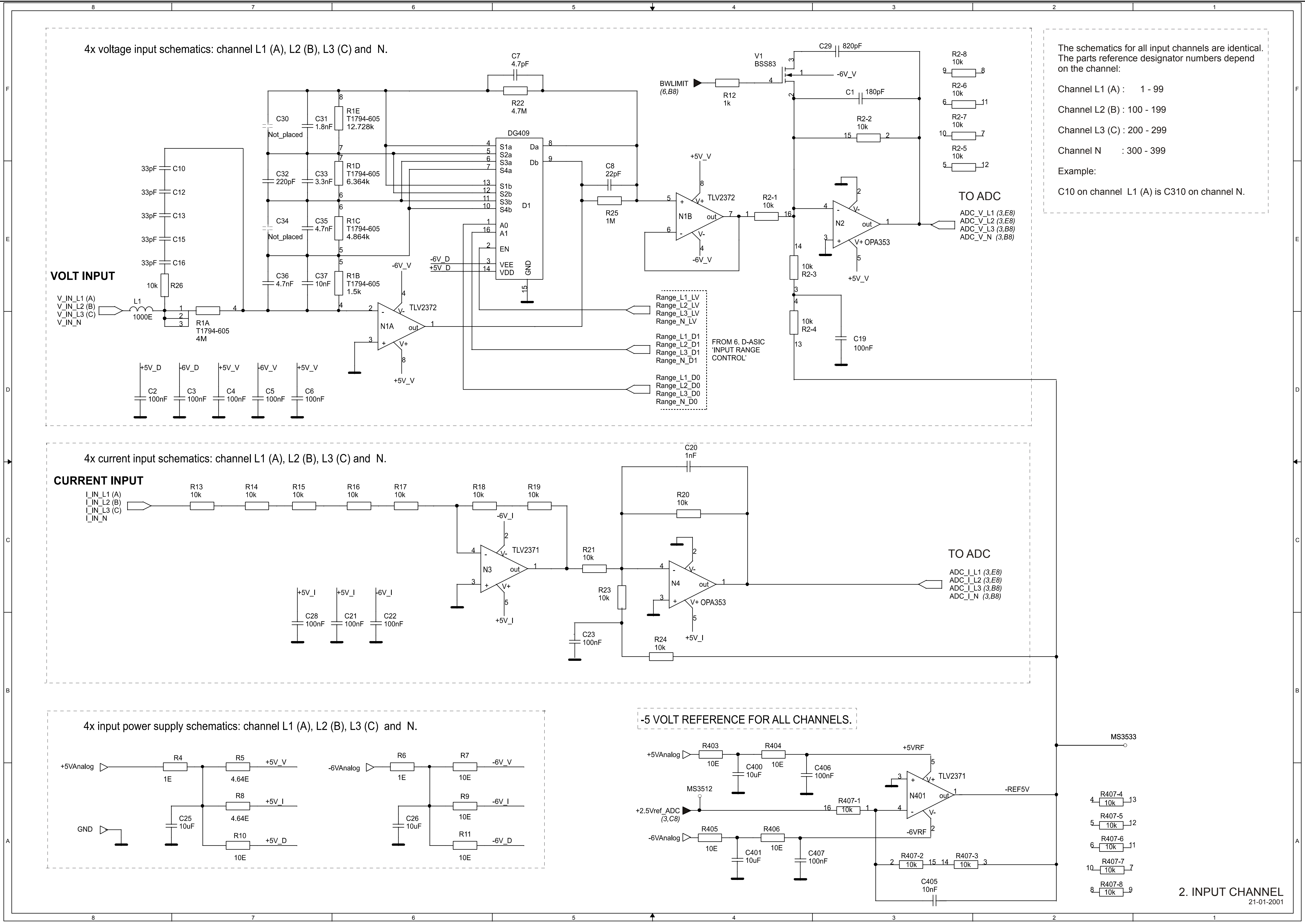


Figure 9-2. Volt and Current Channels A/L1 (B/L2, C/L3, and N are identical)

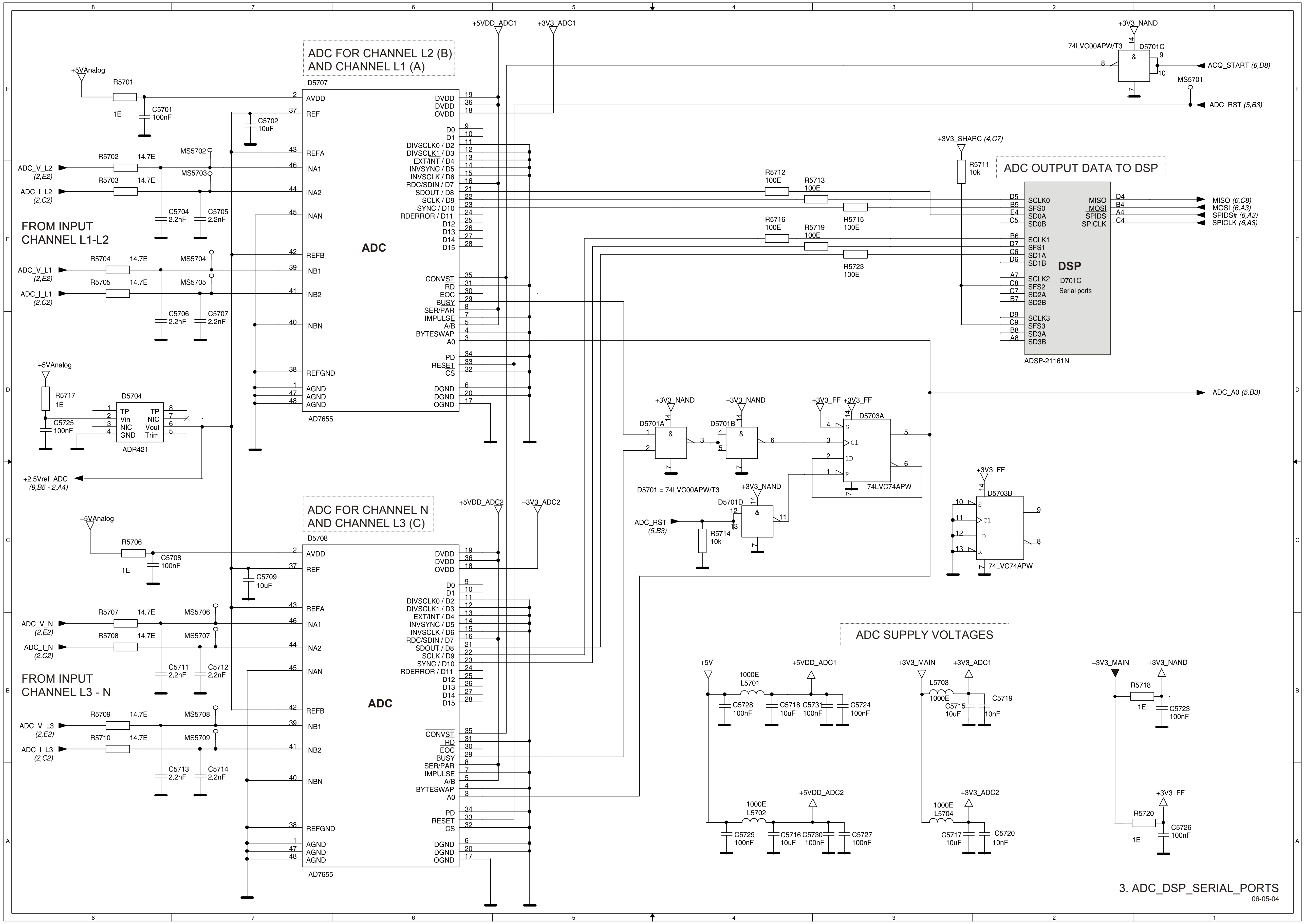


Figure 9-3. ADC - Analog to Digital Conversion

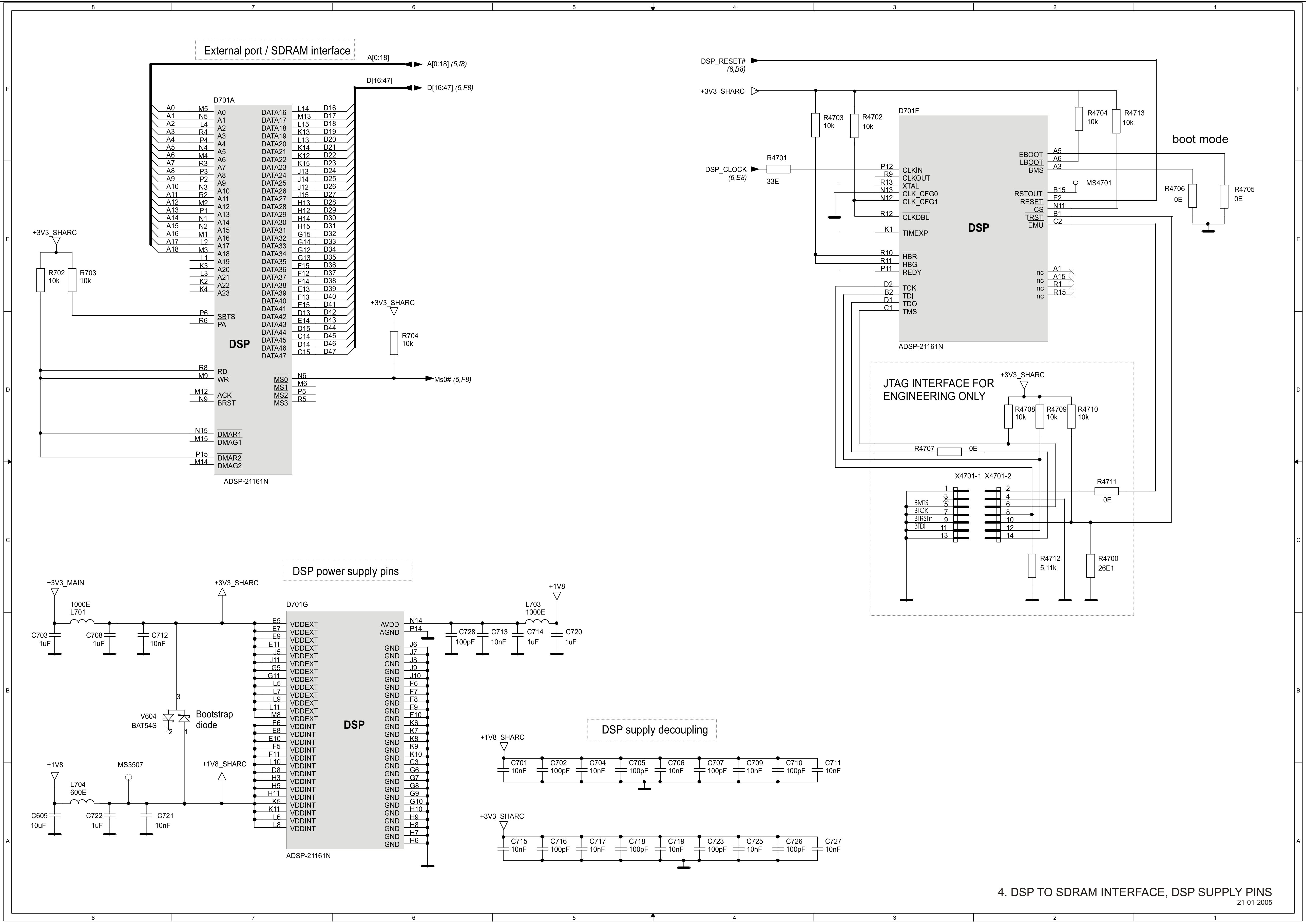


Figure 9-4. Digital Signal Processor (DSP, part 1)

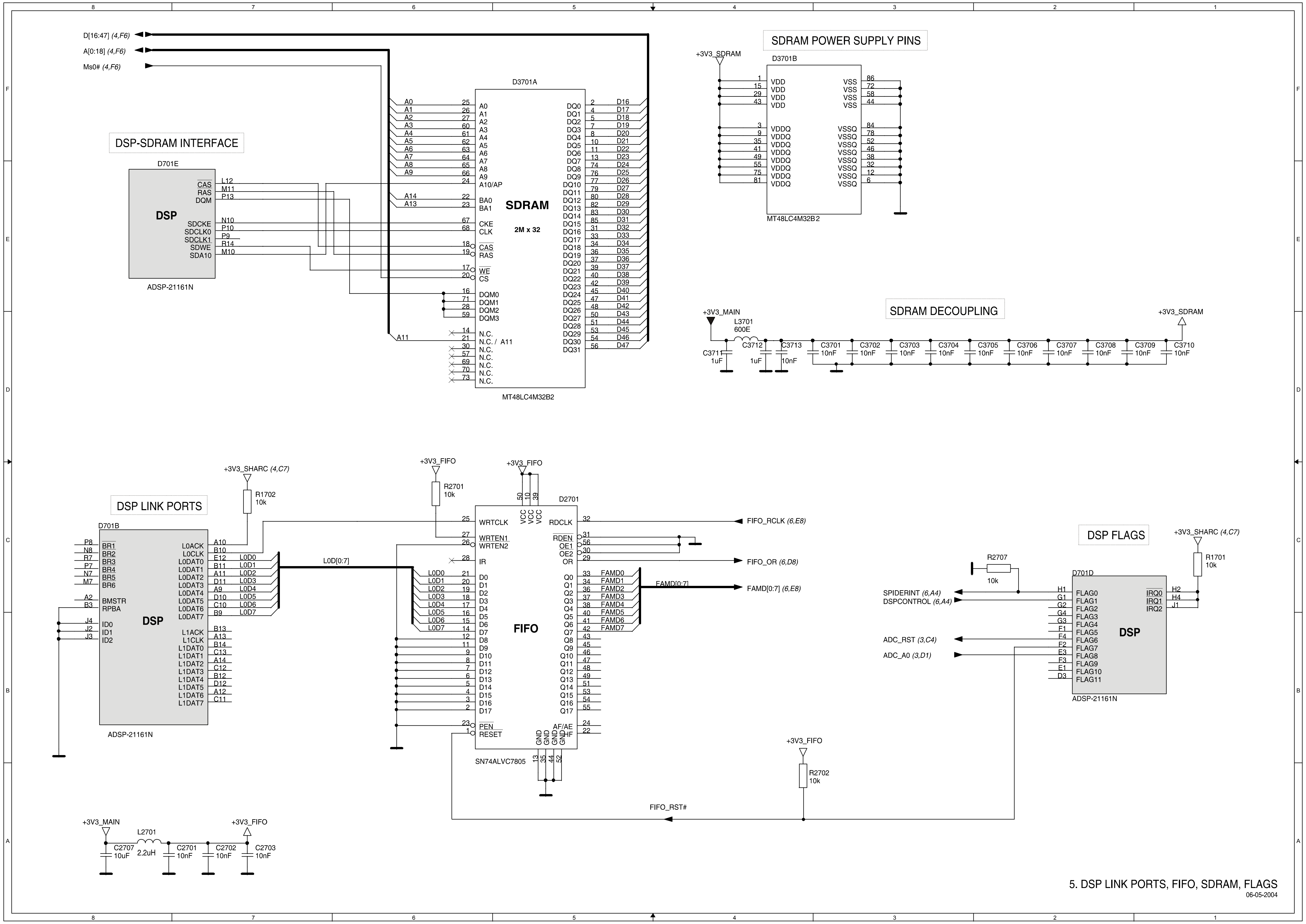


Figure 9-5. Digital Signal Processor (DSP, part 2), FIFO and SDRAM

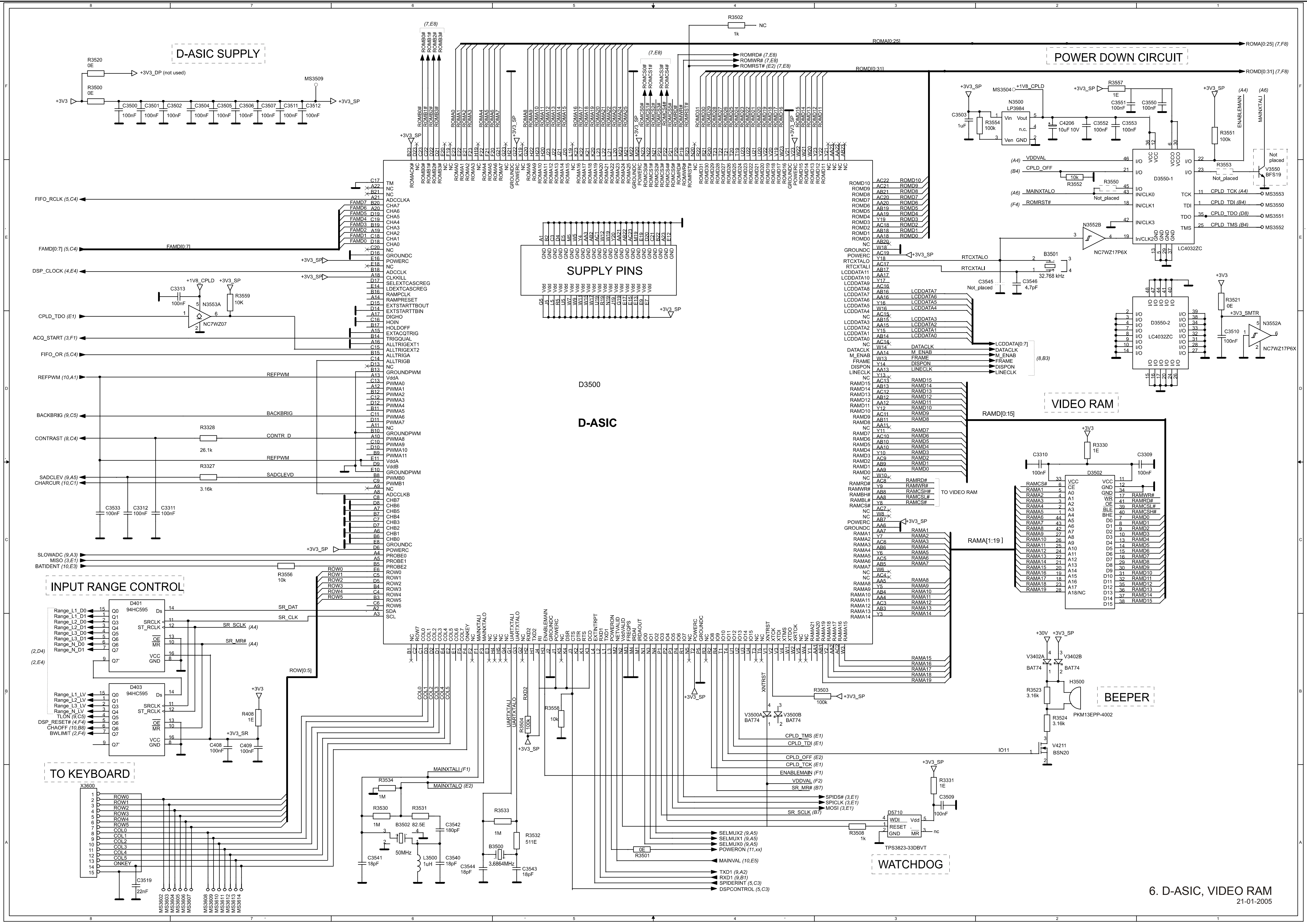


Figure 9-6. Digital Asic (D-Asic) and Video RAM

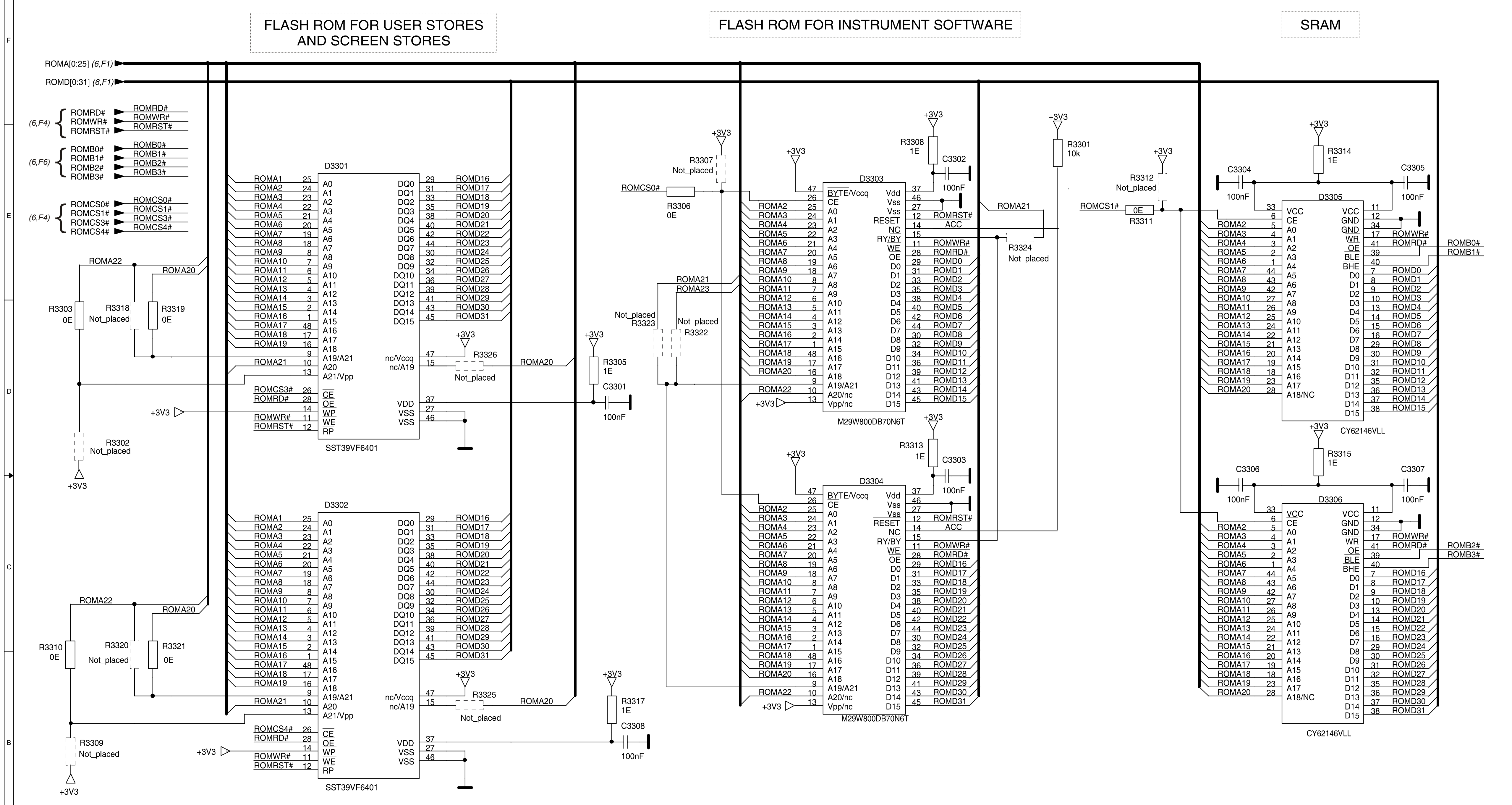


Table 1. Used FlashROM types D3301&D3302 and required resistors

D3301 D3302	R3302 R3309	R3303 R3310	R3318 R3320	R3319 R3321	R3326 R3325
32Mbit	-	-	-	X	-
32Mbit Intel	X	-	-	-	X
64Mbit	-	X	-	X	-
64Mbit Intel	X	-	X	-	X

Table 2. Used FlashROM types D3303&D3304 and required resistors

D3303/D3304	R3323	R3322	R3324
8Mbit	-	-	-
8Mbit Intel	-	-	-
16Mbit	X	-	-
16Mbit Intel	-	-	X
32Mbit	X	-	-
32Mbit Intel	-	-	X

X = Place 0 Ohm resistor; - = Do not place 0 Ohm resistor

7. FLASH ROM & RAM
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Figure 9-7. Flash-ROM's and RAM's

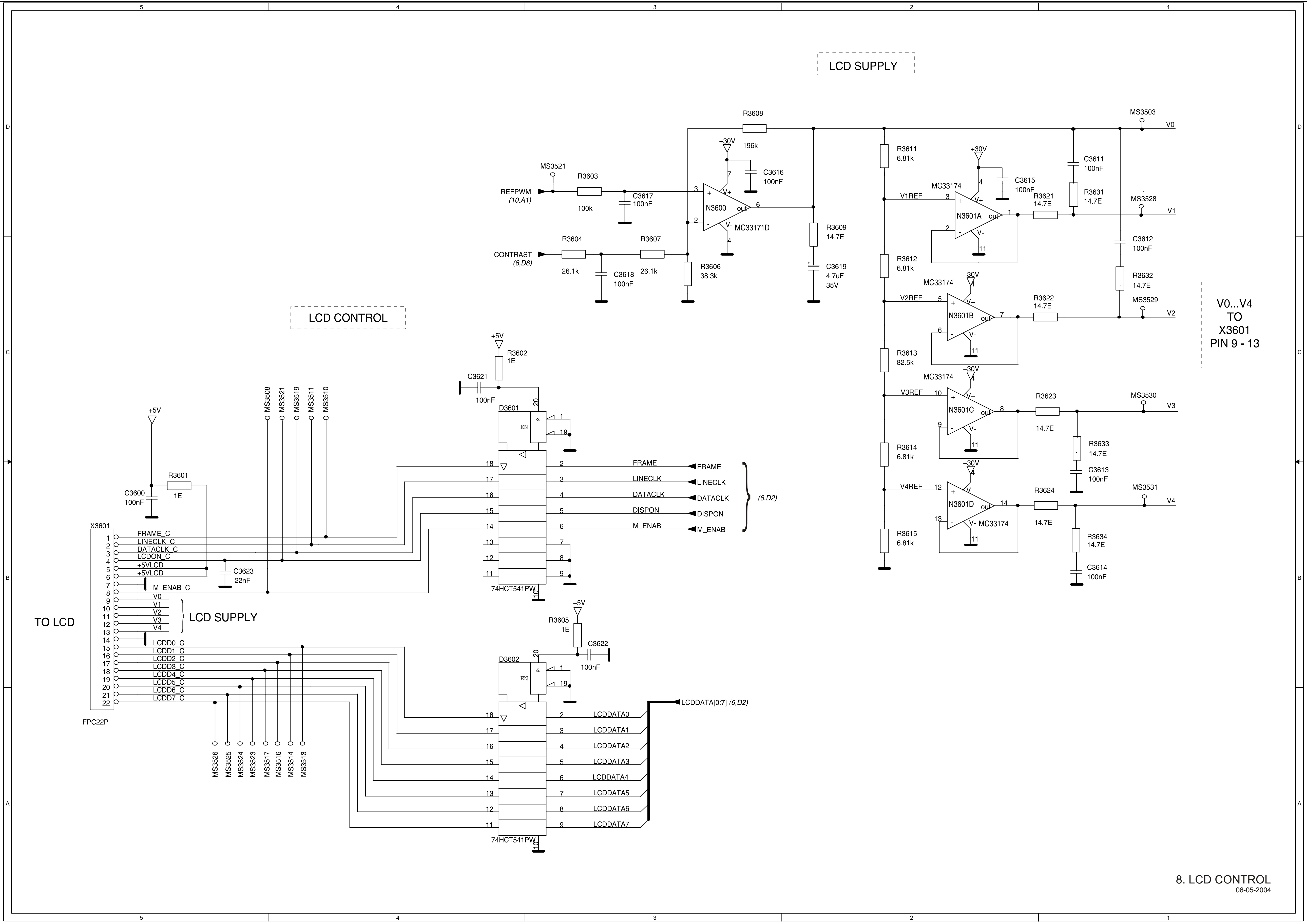

Figure 9-8. LCD-control and LCD-supply

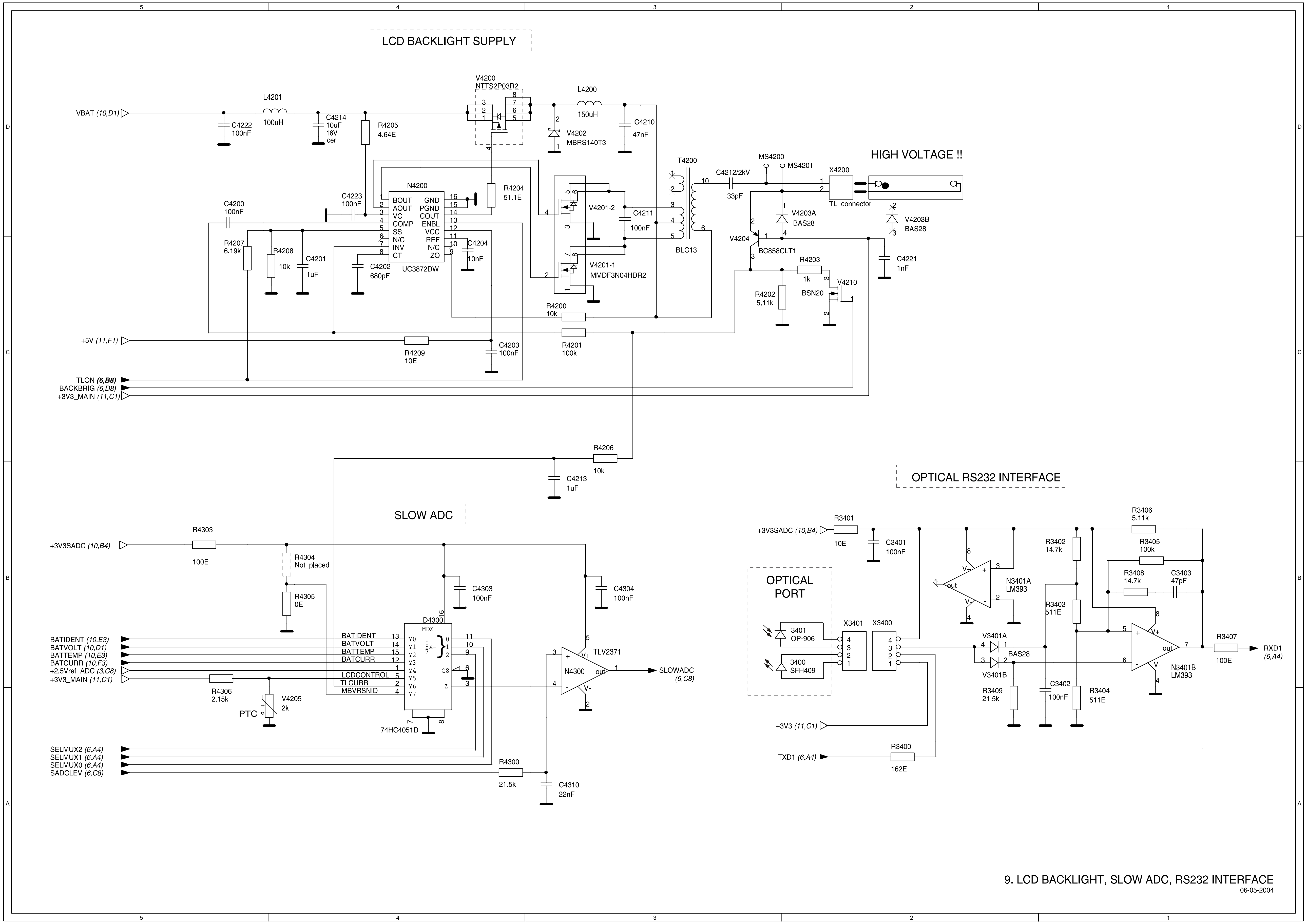

Figure 9-9. Slow-ADC, RS-232 Interface, LCD Backlight Converter

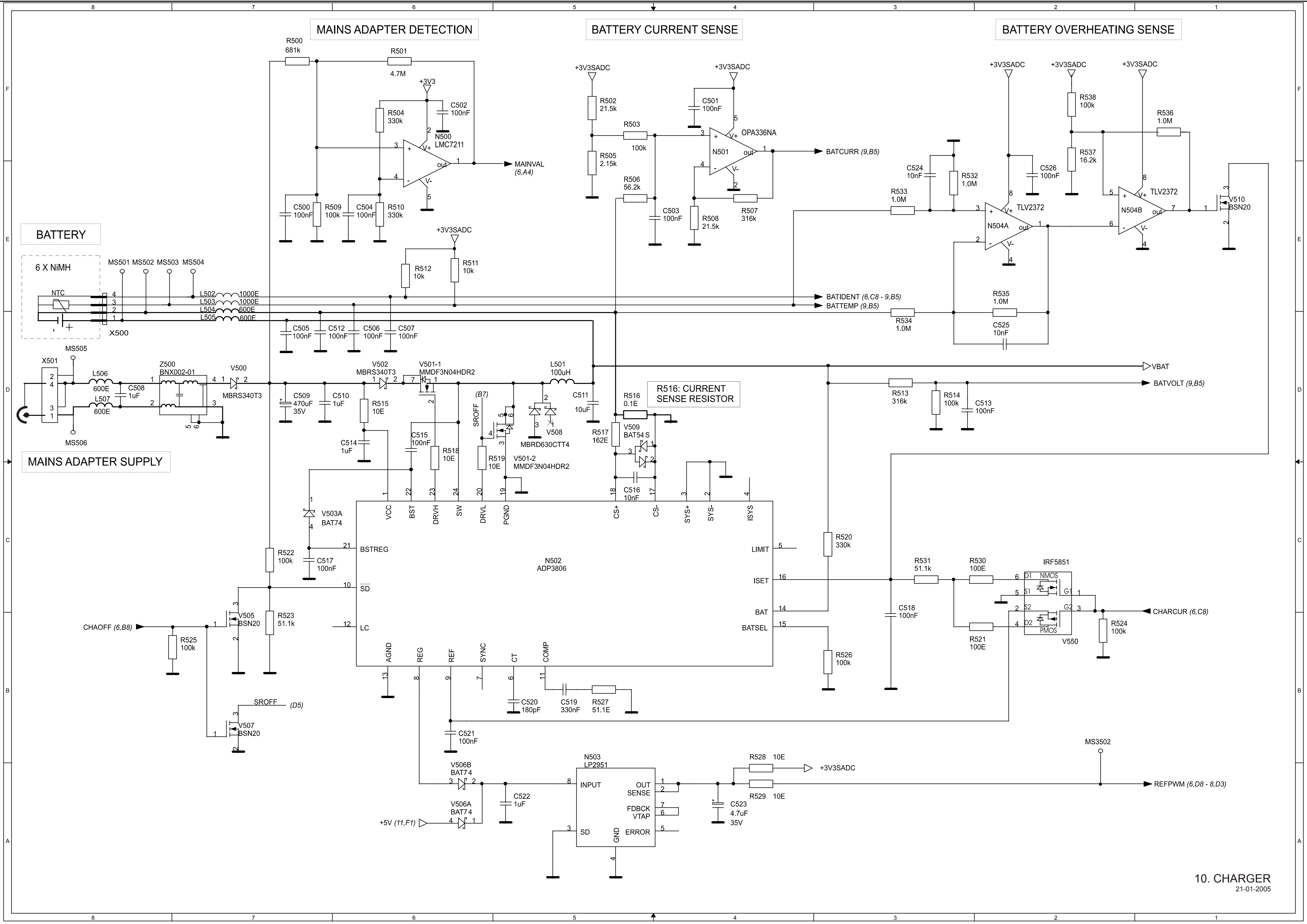

Figure 9-10. Battery Charger

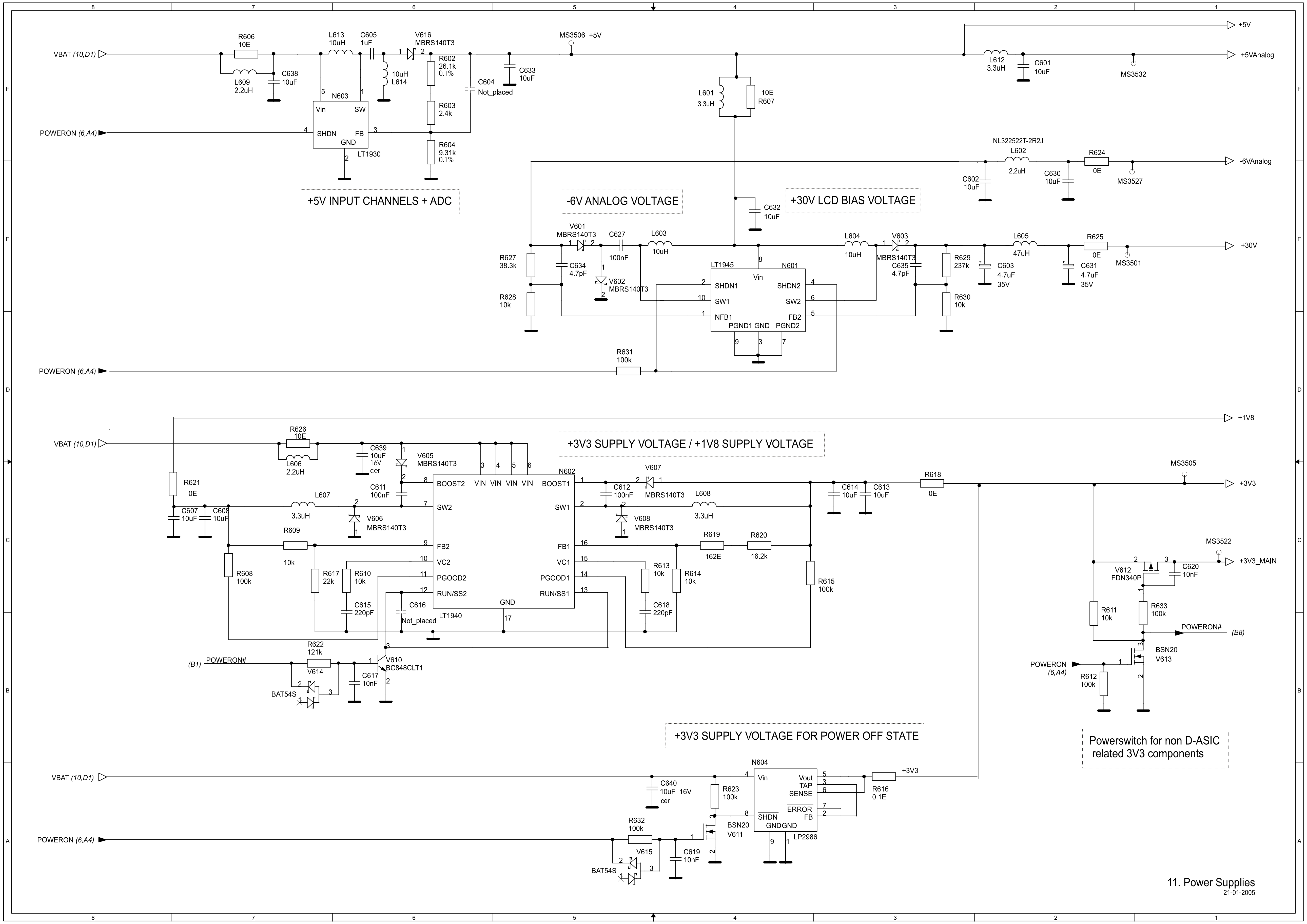

Figure 9-11. Power Supplies

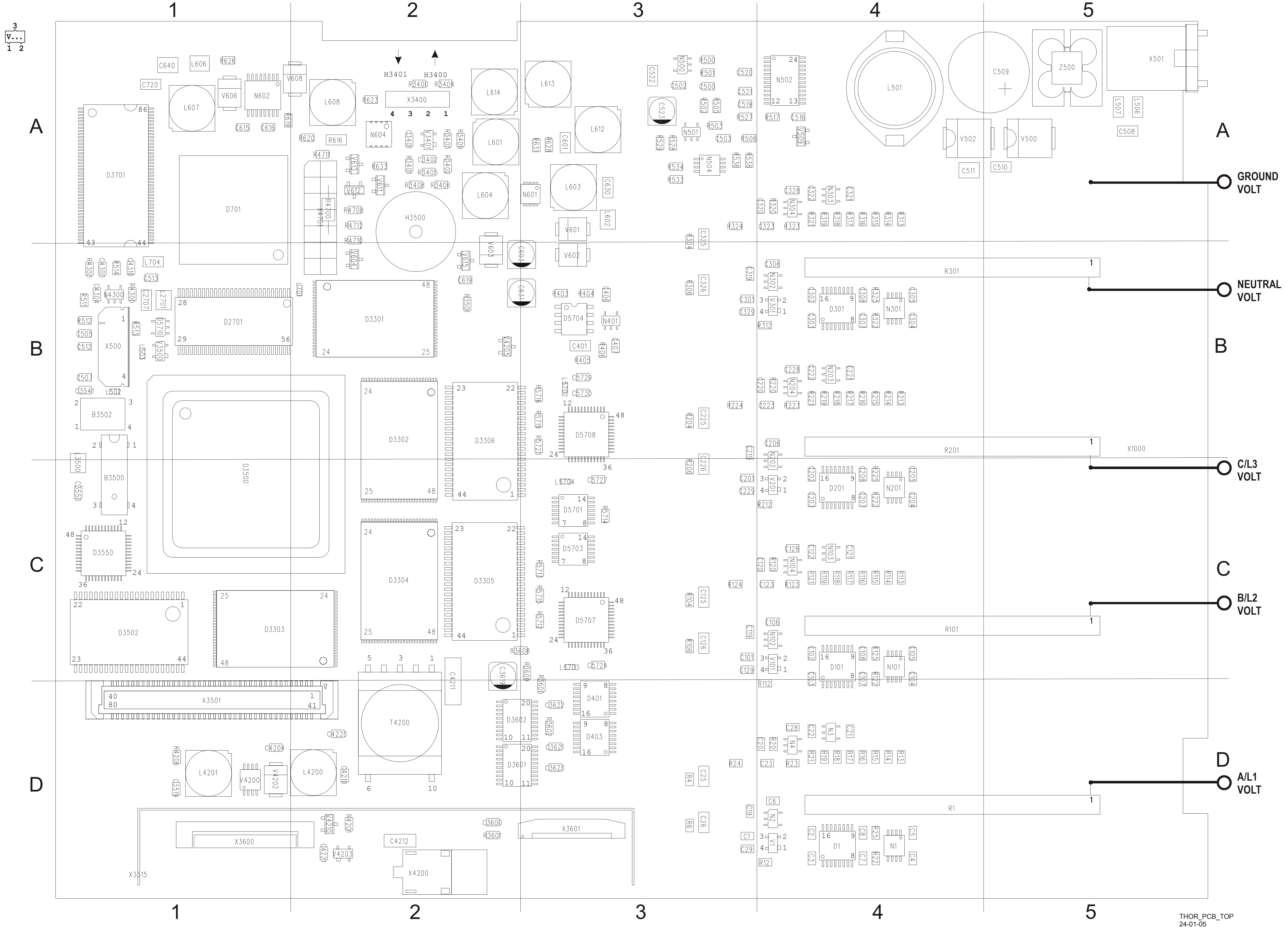

Figure 9-12. Top View of Main PCA

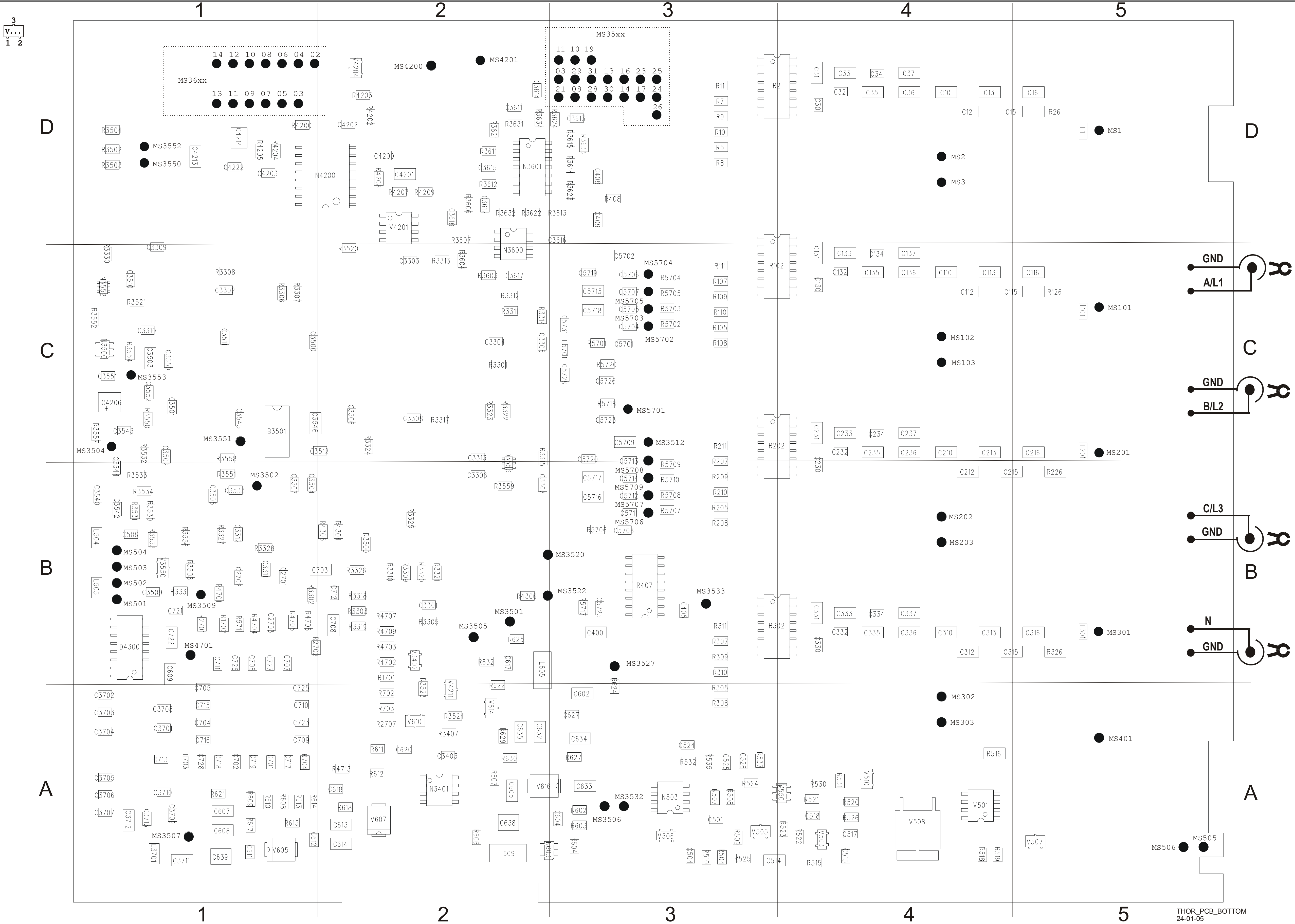

Figure 9-13. Bottom View of main PCA

Chapter 10
Modifications

Title	Page

10.1 General

Changes and improvements made to the Analyzer are documented in Product Change Notices (PCN), and on supplemental change/errata sheets (MSU, Manual Supplement) .

10.2 Software modifications

Changes and improvements made to the Analyzer software are identified by incrementing the software version number.

To see the Analyzer software version number press SETUP . The model number and the installed software version are indicated in the screen header: for instance Fluke 434 V01.02. The software version in this example is V01.02.

10.3 Hardware modifications

Changes and improvements made to the Analyzer PCA (Printed Circuit Assembly) hardware and to the (PCB) Printed Circuit Board itself are identified by incrementing its revision number (the revision numbers need not necessarily to be increased by 1). This number is printed on a sticker located on the Main PCA unit shielding box and a sticker on the PCB. Figure 10-1 shows the sticker on the PCB. In this example it has revision number 01.

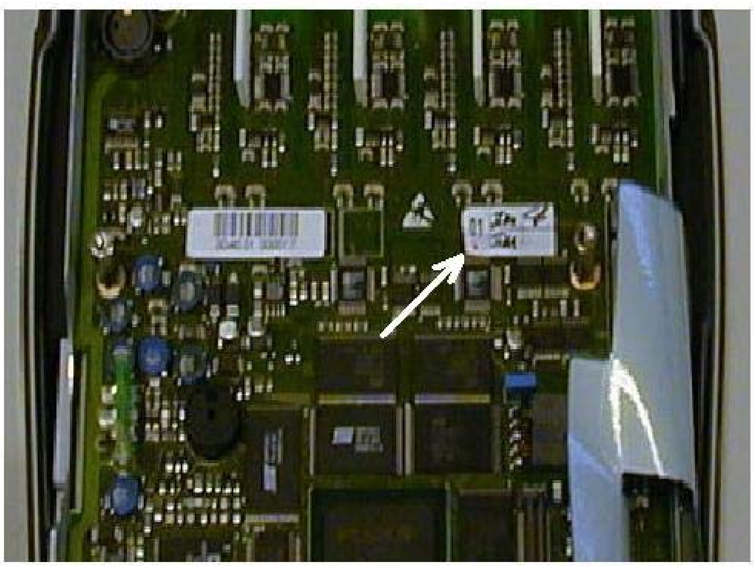

Figure 10-1. Example of a Revision Sticker on the PCA

PCB (Printed Circuit Board) identification.

The PCB (Printed Circuit Board without parts) version can be identified by checking its 12 digit code. This code is located on the board edge near the connector for the flat cable of the keyboard.

The code is 0040 245 0**002x: x** is the version number of the PCB.

10.4 Main PCA Unit Versions, Software Versions.

The models Fluke 433 and 434 use the same PCA. Also the software is identical for Fluke 433 and 434. The software is loaded with dedicated tools that are available in the authorized Fluke Service center. This tool is also used to determine the model.