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Three Phase Power Quality Analyzer Specification

(Fluke 434)

Chapter 23
Specifications

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.

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.

INPUT CHARACTERISTICS

Voltage inputs	
Number of inputs	4 (3 phases + neutral) DC coupled
⚠ Maximum input voltage	1000 Vrms
⚠ Nominal Voltage range	50…500 V internally devided in three ranges 500 V, 250 V and 125 V
⚠ Maximum peak voltage	6 kV
Input impedance	4 MΩ // 5 pF
Bandwidth	> 10 kHz, up to 100kHz for transient display
Scaling	1:1, 10:1, 100:1, 1000:1 and variable

Current inputs	
Number of inputs	4 (3 phases + neutral) DC coupled
Type	Clamp on current transformer with mV output
⚠ Nominal input Range	0 - ± 5.625 Vpeak, 0 - 3.97 Vrms sinewave
Range	1..400 Arms with included clamps (I400S) 0.1..3000 Arms with optional clamps
Input impedance	50 kΩ
Bandwidth	>10 kHz
Scaling	0.1, 1, 10, 100, 1000 mV/A, variable, i5s and i430flex

Nominal frequency	40..70 Hz
Sampling system	
Resolution	16 bit analog to digital converter on 8 channels
Maximum sampling speed	200kS/s on each channel simultaneously
RMS sampling	5000 samples on $10/12^2$ cycles according IEC 61000-4-30
PLL synchronization	4096 samples on $10/12^2$ cycles according IEC 61000-4-7

DISPLAY MODES

Waveform display	Available in Scope and Transient mode Captures 8 waveforms simultaneously Display update rate 5x per second Up to 10/12 times horizontal zoom Cursors: Single vertical line showing min, max, avg reading at cursor position.
Phasor	Shows real time phasor diagram Available in Scope and Unbalance mode Display update rate 5x per second
Meter readings	Available in Volts/Amps/Hertz, Harmonics, Power & Energy, Flicker, Unbalance and Logger4 mode.
AutoTrend graph	Available in Volts/Amps/Hertz, Dips & Swells, Harmonics, Power & Energy, Flicker, Unbalance, Inrush, Mains Signaling[4] Logger[4] and Monitor mode Cursors: single vertical line showing with min, max, avg reading at cursor position.
Bargraph	Available in Harmonics and Monitor mode
Eventlist	Available in Dips & Swells Mains Signaling[4], Logger[4] and Monitor mode

MEASUREMENT MODES

Scope	Vrms, Arms, Vcursor, Acursor, Vfund, Afund, Hz, V phase angles, A phase angles
Volts/Amps/Hertz	Vrms, Vpk, V Crest Factor, Arms, Apk, A Crest Factor, Hz
Dips and Swells	Vrms½, Arms½ Captures up to 1000 events with date, time, duration, magnitude and phase identification with programmable thresholds
Harmonics DC, 1 … 50	Harmonic Volts, THD Volt, Harmonic Amps, THD Amps, K Amps, Harmonic Watts, THD Watts, K Watts, Interharmonic Volts[4], Interharmonic Amps[4] (relative to fundamental or to total rms)
Power and Energy	Watts, VA, VAR, Power factor, Cos φ / DPF, Arms, Vrms, kWh, kVAh, KVARh, peak demand interval using trend, KYZ revenue meter verification via optional input.
Flicker	Pst(1min), Pst, Plt, PF5, Vrms½, Arms½, Dc, Dmax, TDEX
Unbalance	Vneg, Vzero, Aneg, Azero, Vfund, Afund, Hz, V phase angles, A phase angles
Transients	Vrms, Arms, Vcursor, Acursor
Inrush Currents	Inrush Current, Inrush duration, Arms½, Vrms½
Mains Signaling[4]	Relative signaling voltage and absolute signaling voltage averaged over three seconds for two customer selectable frequencies
Logger[4]	Measures and records up to 100 parameters on all 4 phases simultaneously with selecable averaging time. Captures up to 10000 events with date, time, duration, magnitude and phase identification with programmable thresholds
System Monitor	Vrms, Arms, Harmonic Volts, THD Volts, Plt, Vrms½, Arms½, Vneg, Hz, dips and swells, unbalance. All parameters are measured simultaneously in accordance with EN50160. Using Flagging to indicate unreliable readings according IEC61000-4-30.

ACCURACY, RESOLUTION AND RANGE

Volt/Amps/Hertz	Measurement Range	Resolution	Accuracy
Vrms(AC+DC) Fluke 435 Fluke 434	1…600 Vrms 600…1000 Vrms 1…1000 Vrms	0.01 Vrms 0.01 Vrms 0.1 Vrms	± 0.1% of nominal voltage ± 0.1% ± 0.5% of nominal voltage
Vpk	1…1400 Vpk	1 V	5% of nominal voltage
Voltage Crest Factor (CF)	1.0 ... > 2.8	0.01	± 5%
Arms (AC+DC) Fluke 435 Fluke 434 Fluke 434 with i400s Fluke 435 with I430flex	 0…20.00 kArms[1] 0…20.00 kArms[1] 0…40 / 400 Arms 30…3000 Arms	 0,001…10 Arms[1] 0,001…10 Arms[1] 0.1 and 1 Arms 1 Arms	 ± 0.5% ± 5 counts[3] ± 1% ± 5 counts[3] ± 1% ± 5 counts[3] ± 0.5% ± 20 counts[3]
Apk using 1mV/A scaling	0 - 5500 Apk	1A	± 5%
A Crest Factor (CF)	1 … 10	0.01	± 5%
Hz[5] Fluke 435 @ 50Hz nominal Fluke 435 @ 60Hz nominal Fluke 434 @ 50Hz nominal Fluke 434 @ 60Hz nominal	 42.500 ... 57.500 Hz 51.000 ... 69.000 Hz 42.50 ... 57.50 Hz 51.00 ... 69.00 Hz	 0.001 Hz 0.001 Hz 0.01 Hz 0.01 Hz	 ± 0.01Hz ± 0.01Hz ± 0.01Hz ± 0.01Hz

Dips and swells	Measurement Range	Resolution	Accuracy
Vrms½ (AC+DC) Fluke 435 Fluke 434	 0.0% ….200% of nominal voltage 0.0% ….200% of nominal voltage	 0.1Vrms 0.1Vrms	 ± 0.2% of nominal voltage ± 1% of nominal voltage
Arms½ (AC+DC) Fluke 435 Fluke 434 Fluke 434 with i400s Fluke 435 with i430flex	 0 … 20,000 Arms[1] 0 … 20,000 Arms[1] 0 … 400 Arms 30 … 3000 Arms	 0,001 Arms…10 Arms 0,001 Arms…10 Arms 0.1 Arms and 1 Arms 1 Arms	 ± 1% ± 10 counts[3] ± 2% ± 10 counts[3] ± 2% ± 10 counts[3] ± 1% ± 20 counts[3]
Threshold levels	Programmable thresholds in percent of nominal voltage Event detection based upon ½cycle rms voltages Captures Dips, Swells Interruptions and Rapid Voltage Changes		
Duration	hhh,mm,ss,mmm	Half cycle	One cycle

Harmonics	Measurement Range	Resolution	Accuracy
Harmonic order (n)	DC, 1..50 Grouping: Harmonic groups according to IEC 61000-4-7		
Inter-Harmonic order	Off, 1..49 Grouping: Harmonic and Interharmonic subgroups according to IEC 61000-4-7		
Vrms Relative (%f): Fluke 435 Absolute: Fluke 434 Absolute:	0.0 … 100.0% 0.0 … 1000 Vrms 0.0 … 1000 Vrms	0.1% 0.1 Vrms 0.1 Vrms	± 0.1% ± n x 0.1% (± 0.4% for %r) ± 0.05% of nominal voltage if < 1% of nominal voltage ± 5% if ≥ 1% of nominal voltage ± 5% ± 2 counts
Arms Relative (%f): Absolute:	0.0 … 100.0% 0.0 … 4000 mV x clamp scaling	0.1% 1 mVrms x clamp scaling	± 0.1% ± n x 0.1% (± 0.4% for %r) ± 5% ± 5 counts
Watts Relative: (Harmonics only) Watts Absolute: (Harmonics only)	0.0 … 100.0% depends on clamp and voltage scaling	0.1%	± n x 2% ± 5% ± n x 2% ± 10 counts
DC Relative: Fluke 435 Absolute V: Fluke 434 Absolute V: Absolute A: Absolute W:	0.0 … 100.0% 0.0 … 1000V 0.0 … 1000V 0.0 … 4000 mV x clamp scaling depends on clamp and voltage scaling	0.1% 0.1V 0.1V 1 mVrms x clamp scaling 0.1V depends on scaling	± 0.1% V and A (± 2% Watt) ± 0.2% of nominal voltage ± 5% ± 10 counts ± 5% ± 10 counts ± 5% ± 10 counts
$THD_{(n=40)}$ (relative %f or %r)	0.0 … 100.0 %	0.1%	± 2.5% V and A (± 5% Watt)
Hz	0 … 3500 Hz	1 Hz	± 1Hz
Phase angle Fluke 435 Fluke 434	 -360° ... +0° -360° ... +0°	 1° 1°	 ± n × 1° ($^{\circ}$) ± n × 1.5° ($^{\circ}$)

Power and Energy	Measurement Range	Resolution	Accuracy
Watt (VA, VAR) Fluke 435 Fluke 434	 1.0 … 20.00MW[1] 1.0 … 20.00MW[1]	 0.1 … 1 kW[1] 0.1 … 1 kW[1]	 ± 1% ± 10 counts[3] ± 1.5% ± 10 counts[3]
kWh[6] (kVA[6], kVAR[6])	00.00 kWhr…200.0 GWhr[1] 00.00 kWhr…200.0 GWhr[1]	0.01 Xhr….100 Whr[1] 0.01 Whr….100 Whr[1]	± 1% ± 10 counts[3] ± 1.5% ± 10 counts[3]
Power Factor	0…1	0.01	± 0.03[3]
Cos φ / DPF	0…1	0.01	± 0.03[3]

Flicker	Measurement Range	Resolution	Accuracy
Pst (1min), Pst, Plt, PF5 instantenous Flicker	0.00 … 20.00	0.01	Within ±5% of tabulated values according IEC61000-4-15
Dc%, Dmax% and Time d(t) exceeds limits. As described per IEC 61000-3-3	0.0 … ± 100.0% for Dc% and Dmax% and 0.000 … 9.999s for Time	0.1% for Dc% and Dmax% and 10 ms for Time	± 1% for Dc% and Dmax% and 20 ms for Time

Unbalance	Measurement Range	Resolution	Accuracy
Volts Fluke 435 (neg. and zero seq.) Volts Fluke 434 neg. and zero seq.)	0.0 … 5.0% 0.0 … 5.0%	0.1% 0.1%	± 0.15% ± 0.5%
Current (neg. and zero seq.)	0.0 … 20%	0.1%	± 1%

Transient capture	Measurement Range	Resolution	Accuracy
Volts cursor reading rms reading	 ± 6000 Vpk 10 … 1000 Vrms	 1 V 1 V	 ± 15% of cursor reading ± 2.5% of Vnominal
Minimum detect duration	5 µs		
Sampling rate	200kS/s		

Inrush mode	Measurement Range	Resolution	Accuracy
Arms (AC+DC)	0.000 … 20.00 kArms[1]	0.001.. 10 Arms[1]	± 1% of meas ± 5 counts
Inrush Duration	mm:ss:mmm between 7.5s … 30minutes selectable	10ms	± 20 ms (Fnominal = 50 Hz)

Mains Signaling[4]	Measurement Range	Resolution	Accuracy
Threshold levels	Thresholds, limits and signaling duration is programable for two independent signalling frequencies.		
Signaling frequency	60 … 3000 Hz	0.1 Hz	
Relative V%	0% .. 100% of	0.1%	± 0.4%
Absolute V3s (3 second average)	0.0 … 1000 V	0.1 V	± 5% of nominal voltage

TREND RECORDING

Method	AutoTrend automatically records min, max and average values over time for all readings being displayed for the 3 phases and neutral simultaneously.

Volts/Amps/Hertz, Harmonics, Power & Energy, Flicker, Unbalance and Mains Signaling[4] mode									
Sampling	5 readings/sec continuous sampling per channel								
Recording time	From 30 min with 1 second display resolution up to 450 days with 6 hour display resolution.								
Zoom	Up to 6x horizontal zoom								
Memory	1800 min, max and avg points for each reading								
Duration	30 min.	2.5 h	7.5 h	15 h	30 h	150 hr	450 hr	900 hr	75 days
Resolution	1 s	5 s	15 s	30 s	60 s	5 min.	15 min.	30 min.	1 hr

Dips & Swells mode									
Sampling	100/120[2] readings/sec continuous sampling per channel								
Recording time	From 90 sec with 25msec display resolution up to 450 days with 3 hr display resolution.								
Zoom	Up to 12x horizontal zoom								
Memory	3600 min, max and avg points for each reading								
Duration	90 s	180 s	6 min.	12 min.	30 min.	1 hr	2.5 hr	7.5 hr	15 hr	30 hr
Resolution	25 ms	50 ms	100 ms	200 ms	500 ms	1s	2.5 s	7.5 s	15 s	30 s

Inrush Currents and Flicker PF5 mode										
Sampling	100/120[2] readings/sec continuous sampling per channel									
Recording time	From 7.5 sec with 25msec display resolution up to 30 min with 500msec display resolution for Inrush measurements and up to 2hr with 2.5 sec display resolution for PF5 recordings.									
Zoom	Up to 12x horizontal zoom									
Memory	3600 min, max and avg points for each reading									
Duration	7.5 s	15 s	30 s	90 s	180 s	6 min.	12 min.	30 min.	1 hr	2hr
Resolution	25 ms	25 ms	25 ms	25 ms	50 ms	100 ms	200 ms	500 ms	1 s	2s

Logger mode									
Sampling	Combination of 5 readings/sec and 100/120[2] readings/sec continuous sampling per channel depending on the parameter measured								
Recording time	Depends on selected readings and averaging time								
Zoom	Two zoom positions, display all or 1x								
Memory	User configurable shared memory, upt to 15 MB on Fluke 435, Up to 7 MB on Fluke 434[4]								
Nr of readings on 3 phases + N	1			10			100		
Averaging time	0.5 s	10 min	2 hr	0.5 s	10 min	2 hr	0.5 s	10 min	2 hr
Max[7] duration using 15MB	66 hr	9 years	100 years	6 hr	333 days	10 years	18 min	31 days	1 year

Monitor mode	
Sampling	Combination of 5 readings/sec and 100/120[2] readings/sec continuous sampling per channel depending on the parameter measured.
Recording time	Up to 1 week with 10 min resoluton
Memory	1008 min, max and avg points for each reading, 10 minute resolution
Limits	According EN50160 or customer definable

MEASUREMENT METHOD

Vrms, Arms	$10/12^2$ cycle contiguous non overlapping intervals using $500/416^2$ samples per cycle in accordance with IEC 61000-4-30
Vpeak, Apeak	Absolute highest sample value within $10/12^2$ cycle interval with 40µs sample resolution
V Crest Factor	Measures ratio between the Vpeak and Vrms
A Crest Factor	Measures ratio between the Apeak and Arms
Hz	Measured every 10 sec in accordance with IEC61000-4-30
Vrms½ ,Arms½	Value is measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half-cycle. This technique is independent for each channel in accordance with IEC 61000-4-30.
Harmonics	Calculated from 10/12-cycle gapless harmonic group measurements on Voltage and Amps according to IEC 61000-4-7
Watt	Selectable Total or Fundamental real power display Calculates average value of instantaneous power over 10/12 cycle period for each phase Total Active Power $P_T = P_1 + P_2 + P_3$
VA	Selectable Total or Fundamental apparent power display Calculates apparent power using Vrms x Arms value over 10/12 cycle period Total Apparent Power is root mean square of real and apparent power
VAR	Selectable Total of Fundamental reactive power display Calculates reactive power as root of VA squared minus Watt squared over 10/12 cycle period. Capacitive and inductive load is indicated with capacitor and inductor icons
Power Factor	Calculated Watt / VA
Cos φ / DPF	Cos of angle between fundamental voltage and current
Unbalance	The supply voltage unbalance is evaluated using the method of symmetrical components according to IEC61000-4-30
Flicker	According to IEC 61000-4-15 Flickermeter - Functional and design specification. Includes 230V 50Hz lamp and 120V 60Hz lamp models
Transient capture	Captures waveform triggered on signal envelope. Additionally triggers on dips, swells, interruptions and Amps level as specified by IEC61000-4-30
Inrush current	The inrush current begins when the Arms half cycle rises above the inrush threshold, and ends when the Arms half cycle rms is equal to or below the inrush threshold minus a user-selected hysteresis value. The measurement is the square root of the mean of the squared Arms half cycle values measured during the inrush duration. Each half-cycle interval is contiguous and non-overlapping as recommended by IEC 61000-4-30. Markers indicate inrush duration. Cursors allow measurement of peak Arms half cycle.

Mains Signaling	Measurement are based on: either the corresponding 10/12-cycle r.m.s. value interharmonic bin or the rms of the four nearest 10/12-cycle rms value interharmonic bins per IEC 61000-4-30 Limit setup for Monitor mode follows EN50160 "Meistercurve"
Time Synchronisation	Optional GPS430 timesync module provides time uncertainty ≤ 20 ms or ≤ 16.7 ms^2 for time tagging of events and time aggregated measurements. When synchoronisation becomes unavailable, time tolerance is ≤ 1-s/24h

WIRING COMBINATIONS

3Ø WYE	Three phase four wire system WYE
3Ø DELTA	Three phase three wire system Delta
1Ø + NEUTRAL	Single phase with neutral
1Ø SPLIT PHASE	Split phase
1Ø IT NO NEUTRAL	Single phase system with two phase voltages without neutral
3Ø IT	Three phase system without neutral WYE
3Ø HIGH LEG	Four wire three phase Delta system with center tapped high leg
3Ø OPEN LEG	Open delta three wire system with 2 transformer windings
2-ELEMENT	Three phase three wire system without current sensor on phase L2 / B (2 Watt meter method)
2½-ELEMENT	Three phase four wire system without voltage sensor on phase L2 / B

GENERAL

Case	
Design	Rugged, shock proof with integrated protective holster
Drip and dust proof	IP51 according to IEC60529 when used in tilt stand position
Shock and Vibration	Shock 30g, Vibration: 3g Sinusoid, Random $0.03g^2$/Hz according to MIL-PRF-28800F Class 2

Display	Bright Full-Color LCD with CCFL backlight, $80cd/m^2$
Size	115.2 x 86.4 mm
Resolution	320 x 240 pixels
Contrast and brightness	User adjustable, temperature compensated

Memory	
Screens	50 screen memories
Data	10 data memories for storing data including recordings
Logger	User configurable shared memory, up to 15 MB on Fluke 435, Up to 7 MB on Fluke 434[4]
Limit templates	2 preprogrammed, 2 administrator (programmable via FlukeView), 2 user locations
Real-time clock	Time and date stamp for AutoTrend, Transient display and SystemMonitor

MECHANICAL

Size	256 x 169 x 64 mm
Weight	2kg

POWER

⚠ Line power	Switchable 115V, 230V adapter with country specific plug
⚠ Power Adapter input voltage	15 ... 23 V dc; Use only Power Adapter BC430
Battery power	Rechargeable NiMH BP190 (installed)
Battery operating time	> 7 hours
Battery charging time	4 hours, 8 hours for /006 version (Instrument off)
Power saving	Adjustable time for dimmed backlight with on screen power indicator

STANDARDS

Measurement methods used	IEC61000-4-30 class A
Measurement performance	Fluke 435 IEC61000-4-30 Class A, Fluke 434 IEC61000-4-30 Class B
Power Quality	EN50160
Flicker	IEC 61000-4-15
Harmonics	IEC 61000-4-7

CROSS TALK

Between V inputs	-60 dB @ Fnominal
Voltage to current input	-95 dB @ Fnominal

SAFETY

⚠	Compliance with	IEC/EN61010-1-2001, CAN/CSA C22.2 No 61010-1-04, UL std No 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1: General requirements, Rated: 600V CAT IV 1000V CAT III Pollution Degree 2
⚠	Max voltage on banana input	1000 V CAT III / 600 V CAT IV
⚠	Max voltage on current BNC input 42 Vpeak	

ENVIRONMENTAL

Operating temperature	0°C to +50°C battery only, 0°C to +40°C with adapter, within spec +15°C to +35°
Storage temperature	-20 °C to +60 °C
Humidity	10 .. 30 °C: 95% RH non condensing 30 .. 40 °C: 75% RH non condensing 40 .. 50 °C: 45% RH non condensing battery only
Maximum operating altitude	3000m. Derate to 1000 V CAT II / 600 V CAT III / 300 V CAT IV above 2000m
Maximum storage altitude	12km

PRINTERS AND INTERFACE

Type	Serial, optically isolated. Compatible with PM9080 (RS-232) or OC4USB (USB)
Baud rate	1200, 2400, 9600 … 57k6
Print out facility (B&W only)	Via optional adapter PM9080 or PAC 91
Print protocol	Epson FX LQ, Deskjet, LaserJet , DPU-414 or PostScript

ELECTRO MAGNETIC COMPATIBILITY (EMC)

Item	Customer Specification	Additional Information
Emission and Immunity	EN-61326	Fluke 434/435, 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).		

[1] depending clamp scaling, volt scaling 1:1

[2] 50Hz/60Hz nominal frequency according to IEC 61000-4-30

[3] Add clamp accuracy

[4] The logger and Mains Signaling function are optional for the Fluke 434 and standard available on the Fluke 435

[5] Measured on reference voltage input A/L1

[6] Maximum time 9999 hours

[7] Estimated duration

[8] Add ±(n-1) x 2.5° for Amp. when using i430flex