Instrument TECHNOLOGY

FLUKE®

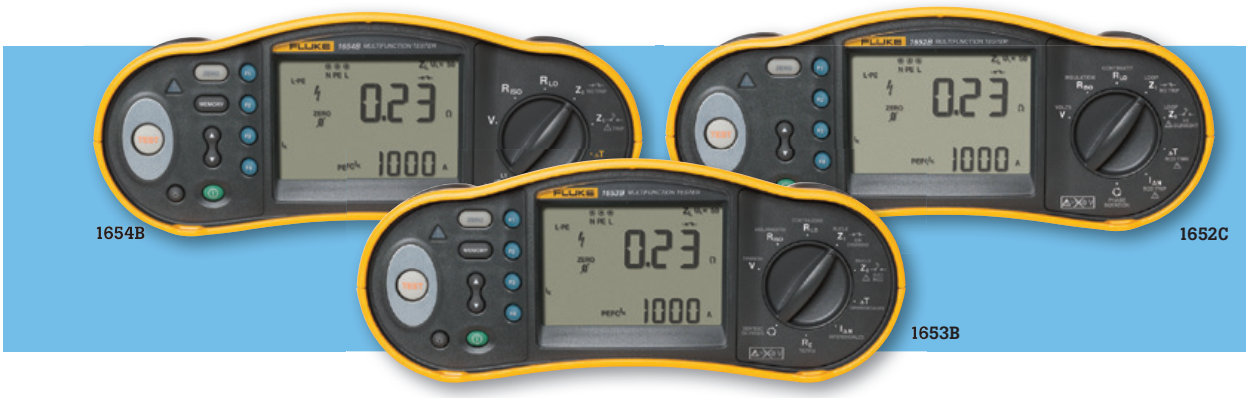
Fluke 1650 Series

Multifunction Installation Testers

Extended Specifications

The installation testing solution for demanding environments

The Fluke 1650 Series testers, with new advanced features, are the perfect installation testing tool for verifying the safety of electrical installations in domestic, commercial, and industrial applications. Ensure that fixed wiring is correctly installed and compliant with IEC 60364, HD 384 requirements, and all relevant local standards. The 1650 Series is efficient to use by allowing the user to measure loop impedance without tripping RCD's, eliminating the need to bypass them. Slim reach probes allow you to keep your eyes on the panel while probing hard to reach areas. With easy-to-operate controls, a large display with a wide viewing angle, padded neck strap, and a compact, ergonomic design, these testers are comfortable enough to use for all day testing.



- Compact, lightweight and comfortable to wear
- Simple operation for fast, easy testing
- Fast high current loop test (high current mode)
- Advanced loop testing prevents RCDs from tripping
- Variable RCD current mode for customized settings
- Zero adapter for easy test lead compensation
- The PASS/FAIL indicator takes the guesswork out of RCD testing
- Insulation test voltages (1652C: 250 V, 500 V, 1000 V), (1653B/1654B: 50 V, 100 V, 250 V, 500 V, 1000 V) for a variety of applications
- Select voltage measurement quickly and easily between L-N, L-PE, and N-PE
- Dual display gives simultaneous readout of mains voltage and frequency
- Auto discharge allows fast and safe discharge of electrical energy in capacitive circuits
- Added safety through live circuit detection, to check and inhibit test if circuit under test is live
- Wiring connection check indication and live circuit detection for added safety
- Time saving auto-null feature subtracts lead resistance from measurements, and stores it in memory even after powering down
- High resolution measurements down to 0.01 ohm for a high level of accuracy
- User selectable safety voltage level of 50 V or 25 V for varied environments
- Rotary knob labeling available in six versions. English, French, German, Italian, Spanish and a user-friendly symbols version
- Perform ground tests with auxiliary earth spikes eliminating the need for multiple instruments (1653B/1654B only)
- Download up to 444 (1653B) or 1500 (1654B) stored results with IR port and adapter for professional reporting
- Detachable leads for easy replacement
- EN-61557 and VDE 0413 compliant

Specifications

Features by Model

Measurement Function	1652C	1653B	1654B
Voltage & Frequency	✔	✔	✔
Wiring polarity checker	✔	✔	✔
Insulation Resistance	✔	✔	✔
Continuity & Resistance	✔	✔	✔
Loop & Line Resistance	✔	✔	✔
Loop & Line Resistance–mΩ resolution			✔
Prospective Earth Fault Current (PEFC/I_K) Prospective Short-Circuit current (PSC/I_K)	✔	✔	✔
RCD switching time	✔	✔	✔
RCD tripping level	✔ ramp test	✔ ramp test	✔ ramp test
RCD variable current	✔	✔	✔
Automatic RCD test sequence	✔	✔	✔
Test pulse current sensitive RCDs (Type A)	✔	✔	✔
Test smooth dc sensitive RCDs (Type B)			✔
Earth Resistance		✔	✔
Phase Sequence Indicator	✔	✔	✔
Other Features			
Self-test	✔	✔	✔
Illuminated Display	✔	✔	✔
Memory, Interface			
Memory		✔	✔
Extended Memory			✔
Computer Interface		✔	✔
Time and date (When used with FlukeView software)		✔	✔
Software (Optional)		✔	✔
Included Accessories			
Hard case	✔	✔	✔
Remote control probe	✔	✔	✔
Zero Adapter	✔	✔	✔

General Specifications

Specification	Characteristic
Size	10 cm (L) x 25 cm (W) x 12.5 cm (H)
Weight (with batteries)	1.3 kg
Battery size, quantity	Type AA, 6 ea.
Battery type	Alkaline supplied. Usable with 1.2 V NiCd or NiMH batteries (not supplied)
Battery life (typical)	200 hours idling
Fuse	T3.15 A, 500 V, 1.5 kA 6.3 x 32 mm (PN 2030852)
Operating Temperature	-10 °C to 40 °C
Storage Temperature	-10 °C to 60 °C indefinitely (to -40 °C for 100 hrs)
Relative Humidity	Noncondensing 80 % 10 to 35 °C; 70 % 35 to 40 °C
Operating Altitude	0 to 2000 meters
Shock, Vibration	Vibration to Class 3 per Mil-Prf-28800F 1 meter drop test, six sides, oak floor
Sealing	IP 40
EMC	Complies with EN61326-1: 2006
Safety	Complies with EN61010-1 Ed 2.0 (2001-02), UL61010, ANSI/ ISA -s82.02.01 2000 and CAN/CSA c22.2 No.1010 2nd edition Overvoltage Category III (CAT III), 600 V Measurement Category III is for measurements performed in the building installation. CAT IV, 300V. Examples are distribution panels, circuit breakers, wiring and cabling. Performance EN61557-1, EN61557-2, EN61557-3, EN61557-4, EN61557-5, EN61557-6, EN61557-7 Second edition. EN61557-10 First edition.
Maximum voltage between any terminal and earth ground	500 V
Surge Protection	6 kV peak per EN 61010-1 Ed. 2.0 (2001-02)

Electrical Measurement Specifications

The accuracy specification is defined as ±(% reading +digit counts) at 23 °C ±5 °C, ≤80 % RH. Between –10 °C and 18 °C and between 28 °C and 40 °C, accuracy specifications may degrade by 0,1 x (accuracy specification) per °C. The following tables can be used for the determination of maximum or minimum display values considering maximum instrument operating uncertainty per EN61557-1, 5.2.4.

Insulation Resistance (R_{ISO})

50 V		100 V		250 V		500 V		1000 V	
Limit Value	Maximum Display Value	Limit Value	Maximum Display Value	Limit Value	Maximum Display Value	Limit Value	Maximum Display Value	Limit Value	Maximum Display Value
1	1.12	1	1.12	1	1.3	1	1.3	1	1.3
2	2.22	2	2.22	2	2.4	2	2.4	2	2.4
3	3.32	3	3.32	3	3.5	3	3.5	3	3.5
4	4.42	4	4.42	4	4.6	4	4.6	4	4.6
5	5.52	5	5.52	5	5.7	5	5.7	5	5.7
6	6.62	6	6.62	6	6.8	6	6.8	6	6.8
7	7.72	7	7.72	7	7.9	7	7.9	7	7.9
8	8.82	8	8.82	8	9.0	8	9.0	8	9.0
9	9.92	9	9.92	9	10.1	9	10.1	9	10.1
10	11.02	10	11.02	10	11.2	10	11.2	10	11.2
20	22.02	20	22.02	20	22.2	20	22.2	20	22.2
30	33.02	30	33.2	30	33.2	30	33.2	30	33.2
40	44.02	40	44.2	40	44.2	40	44.2	40	44.2
50	55.02	50	55.2	50	55.2	50	55.2	50	55.2
		60	66.2	60	66.2	60	66.2	60	66.2
		70	77.2	70	77.2	70	77.2	70	77.2
		80	88.2	80	88.2	80	88.2	80	88.2
		90	99.2	90	99.2	90	99.2	90	99.2
		100	110.2	100	110.2	100	110.2	100	110.2
				200	220.2	200	220.2	200	220.2
						300	347	300	345
						400	462	400	460
						500	577	500	575
								600	690
								700	805
								800	920
								900	1035
								1000	1150

Continuity (R_{LO})

Limit Value	Maximum Display Value
0.2	0.16
0.3	0.25
0.4	0.34
0.5	0.43
0.6	0.52
0.7	0.61
0.8	0.7
0.9	0.79
1	0.88
2	1.78
3	2.68
4	3.58
5	4.48
6	5.38
7	6.28
8	7.18
9	8.08
10	8.98
20	17.98
30	26.8

Loop Tests (Z_L)

Loop Z_L Hi Current		Loop Z_L No Trip		Loop Z_L		Loop R_E	
Limit Value	Maximum Display Value	Limit Value	Maximum Display Value	Limit Value	Maximum Display Value	Limit Value	Maximum Display Value
0.20	0.14	–	–	3	2.53	3	2.72
0.30	0.23	–	–	4	3.38	4	3.62
0.40	0.32	0.40	0.28	5	4.23	5	4.52
0.50	0.41	0.50	0.37	6	5.08	6	5.42
0.60	0.50	0.60	0.45	7	5.93	7	6.32
0.70	0.59	0.70	0.54	8	6.78	8	7.22
0.80	0.68	0.80	0.62	9	7.63	9	8.12
0.90	0.77	0.90	0.71	10	8.48	10	9.02
1.00	0.86	1.00	0.79	20	16.98	20	18.02
1.10	0.95	1.10	0.88	30	25.3	30	27.2
1.20	1.04	1.20	0.96	40	33.8	40	36.2
1.30	1.13	1.30	1.05	50	42.3	50	45.2
1.40	1.22	1.40	1.13	60	50.8	60	54.2
1.50	1.31	1.50	1.22	70	59.3	70	63.2
1.60	1.40	1.60	1.30	80	67.8	80	72.2
1.70	1.49	1.70	1.39	90	76.3	90	81.2
1.80	1.58	1.80	1.47	100	84.8	100	90.2
1.90	1.67	1.90	1.56	200	169.8	200	180.2
2.00	1.76	2.00	1.64	300	253	300	272
–	–	–	–	400	338	400	362
–	–	–	–	500	423	500	452
–	–	–	–	600	508	600	542
–	–	–	–	700	593	700	632
–	–	–	–	800	678	800	722
–	–	–	–	900	763	900	812
–	–	–	–	1000	848	1000	902

RCD/FI Tests ($_{\Delta}T$, $I_{\Delta}N$)

RCD/FI Time		RCD/FI Current	
Limit Value	Maximum Display Value	Limit Value	Maximum Display Value
20	18.1	0.5	0.43
30	27.1	0.6	0.52
40	36.1	0.7	0.61
50	45.1	0.8	0.7
60	54.1	0.9	0.79
70	63.1	1	0.88
80	72.1	2	1.78
90	81.1	3	2.68
100	90.1	4	3.58
200	180.1	5	4.48
300	271	6	5.38
400	361	7	6.28
500	451	8	7.18
600	541	9	8.08
700	631	10	8.98
800	721	20	17.98
900	811	30	26.8
1000	901	40	35.8
2000	1801	50	44.8
		60	53.8
		70	62.8
		80	71.8
		90	80.8
		100	89.8
		200	179.8
		300	268
		400	358
		500	448

Earth Tests (R_E)

Limit Value	Maximum Display Value
10	8.8
20	17.8
30	26.8
40	35.8
50	44.8
60	53.8
70	62.8
80	71.8
90	80.8
100	89.8
200	179.8
300	268.0
400	358.0
500	448.0
600	538.0
700	628.0
800	718.0
900	808.0
1000	898.0
2000	1798.0

AC Voltage Measurement (V)

Range	Resolution	Accuracy 50Hz – 60Hz	Input Impedance	Overload Protection
500 V	0.1 V	0.8 % + 3	3.3 MΩ	660 V rms

Continuity Testing (R_{LO})

Range (Autoranging)	Resolution	Open Circuit Voltage	Accuracy
20 Ω	0.01 Ω	>4 V	±(1.5 % + 3 digits)
200 Ω	0.1 Ω	>4 V	±(1.5 % + 3 digits)
2000 Ω	1 Ω	>4 V	±(1.5 % + 3 digits)
Note The number of possible continuity tests with a fresh set of batteries is 3000.			

Range R_{LO}	Test Current
7.5	210 mA
35	100 mA
240	20 mA
2000	2 mA

Test Probe Zeroing	Press the zero button to zero the test probe. Can subtract up to 2 Ω of lead resistance. Error message for >2 Ω.
Live Circuit Detection	Inhibits test if terminal voltage >10 V ac detected prior to initiation of test.

Insulation Resistance Measurement (R_{ISO})

Test Voltages		Accuracy of Test Voltage (at rated test current)
Model 1652C	Model 1653B & 1654B	
250–500–1000 V	50–100–250–500–1000 V	+10 %, -0 %

Test Voltage	Insulation Resistance Range	Resolution	Test Current	Accuracy
50 V	10 kΩ to 50 MΩ	0.01 MΩ	1 mA @ 50 kΩ	±(3 % + 3 digits)
100 V	100 kΩ to 20 MΩ	0.01 MΩ	1 mA @ 100 kΩ	±(3 % + 3 digits)
	20 MΩ to 100 MΩ	0.1 MΩ		±(3 % + 3 digits)
250 V	10 kΩ to 20 MΩ	0.01 MΩ	1 mA @ 250 kΩ	±(1.5 % + 3 digits)
	20 MΩ to 200 MΩ	0.1 MΩ		±(1.5 % + 3 digits)
500 V	10 kΩ to 20 MΩ	0.01 MΩ	1 mA @ 500 kΩ	±(1.5 % + 3 digits)
	20 MΩ to 200 MΩ	0.1 MΩ		±(1.5 % + 3 digits)
	200 MΩ to 500 MΩ	1 MΩ		±10 %
1000 V	100 kΩ to 200 MΩ	0.1 MΩ	1 mA @ 1 MΩ	±(1.5 % + 3 digits)
	200 MΩ to 1000 MΩ	1 MΩ		±10 %
Note The number of possible insulation tests with a fresh set of batteries is 2000.				

Auto Discharge	Discharge time constant <0.5 second for C = 1 µF or less.
Live Circuit Detection	Inhibits test if terminal voltage >30 V prior to initiation of test.
Maximum Capacitive Load:	Operable with up the 5 µF load.

Loop and Line Impedance (Z_L)

No Trip and Hi Current Modes RCD/FI

Mains Input Voltage Range	100 – 500 V ac (50/60 Hz)
Input Connection (soft key selection)	Loop Impedance: phase to earth Line impedance: phase to neutral
Limit on Consecutive Tests	Automatic shutdown when internal components are too hot. There is also a thermal shutdown for RCD tests.
Maximum Test Current @ 400 V	20 A sinusoidal for 10 ms
Maximum Test Current @ 230 V	12 A sinusoidal for 10 ms

Range	Resolution	Accuracy*
10 Ω	0.001 Ω	Hi Current Ω: ±(2% + 15 digits)
20 Ω	0.01 Ω	No Trip mode: ±(3 % + 6 digits)
		Hi Current mode: ±(2 % 4 digits)
200 Ω	0.1 Ω	No Trip mode: ±(3 %)
		Hi Current mode: ±(2 %)
2000 Ω	1 Ω	±6 %**

Notes
* Valid for resistance of neutral circuit <20 Ω and up to a system phase angle of 30°. Test leads must be zeroed before testing.
** Valid for mains voltage >200 V.

Prospective Earth Fault Current Test (PSC/I_K)

Computation	Prospective Earth Fault Current (PEFC/IK) or Prospective Short Circuit Current (PSC/IK) determined by dividing measured mains voltage by measured loop (L–PE) resistance or line (L–N) resistance, respectively.	
Range	0 to 10 kA or 0 to 50 kA (See Power-On Options earlier in this manual)	
Resolution and Units	**Resolution**	**Units**
	IK <1000 A	1 A
	IK >1000 A	0.1 kA
Accuracy	Determined by accuracy of loop resistance and mains voltage measurements.	

RCD Testing

RCD Types Tested

RCD Type[6]		Model 1652C	Model 1653B	Model 1654B
AC[1]	G[2]	✔	✔	✔
AC	S[3]	✔	✔	✔
A[4]	G	✔	✔	✔
A	S	✔	✔	✔
B[5]	G			✔
B	S			✔

Notes
[1] AC – Responds to ac
[2] G – General, no delay
[3] S – Time delay
[4] A – Responds to pulsed signal
[5] B – Responds to smooth dc
[6] RCD test inhibited for V >265 ac
RCD tests permitted only if the selected current, multiplied by earthing resistance, is <50 V.

Test Signals

RCD Type	Test Signal Description
AC	The waveform is a sinewave starting at zero crossing, polarity determined by phase selection (0° phase starts with low to high zero crossing, 180° phase starts with high to low zero crossing). The magnitude of the test current is $I_\Delta n$ x Multiplier for all tests.
A	The waveform is a half wave rectified sinewave starting at zero, polarity determined by phase selection (0° phase starts with low to high zero crossing, 180° phase starts with high to low zero crossing). The magnitude of the test current is 2.0 x $I_\Delta n$ (rms) x Multiplier for all tests for $I_\Delta n$ = 0.01A. The magnitude of the test current is 1.4 x $I_\Delta n$ (rms) x Multiplier for all tests for all other IΔn ratings.
B	Smooth DC current according to EN61557-6 Annex A

Tripping Speed Test (ΔT)

Current Settings[1]	Multiplier	Current Accuracy
10–30–100–300–500–1000 mA -VAR	x 1/2	+0 %, -10 % of test current
10–30–100–300–500–1000 mA -VAR	x 1	+10 %, -0 %
10–30–100 mA	x 5	+10 %, -0 %
Note [1] 1000 mA type AC only. 700 mA maximum type A in VAR mode, not avilable for type B.		

Current Multiplier	*RCD Type	Measurement Range		Trip Time Accuracy
		Europe	UK	
x 1/2	G	310 ms	2000 ms	±(1 % Reading + 1 ms)
x 1/2	S	510 ms	2000 ms	±(1 % Reading + 1 ms)
x 1	G	310 ms	310 ms	±(1 % Reading + 1 ms)
x 1	S	510 ms	510 ms	±(1 % Reading + 1 ms)
x 5	G	50 ms	50 ms	±(1 % Reading + 1 ms)
x 5	S	160 ms	160 ms	±(1 % Reading + 1 ms)
Notes *G – General, no delay *S – Time delay				

Maximum Trip Time

The RCD √ symbol switches on when testing the RCD trip time if the trip time meets the following conditions.

RCD	I Δ N	Trip Time Limits
AC G, A, B	x 1	Less than 300 ms
AC, G – S type, A – S type, B – type	x 1	Between 130 ms and 500 ms
AC G, A, B	x 5	Less than 40 ms
AC, G – S type, A – S type, B – type	x 5	Between 50 ms and 150 ms

RCD/FI-Tripping Current Measurement/Ramp Test ($I_{\Delta N}$)

Current Range	Step Size	Dwell Time		Measurement Accuracy
		Type G	Type S	
30 % to 110 % of RCD rated current[1]	10 % of $I_{\Delta N}$[2]	300 ms/step	500 ms/step	±5 %
Notes 1 30 % to 150 % for Type A $I_{\Delta N}$ >10 mA 30 % to 210 % for Type A $I_{\Delta N}$ = 10 mA 20 % to 210 % for Type B **Specified trip current ranges (EN 61008-1):** 50 % to 100 % for Type AC 35 % to 140 % for Type A (>10 mA) 35 % to 200 % for Type A (≤10 mA) 50 % to 200 % for Type B 2 5% for Type B				

Earth Resistance Test (R_E)

Model 1653B & 1654B Only. This product is intended to be used to measure installations in process plants, industrial installations, and residential applications.

Range	Resolution	Accuracy
200 Ω	0.1 Ω	±(2 % + 5 digits)
2000 Ω	1 Ω	±(3.5 % + 10 digits)

Range: $R_E + R_{PROBE}$[1]	Test Current
2200 Ω	3.5 mA
16000 Ω	500 µA
52000 Ω	150 µA
Note [1] Without external voltages	

Frequency	Output Voltage
128 Hz	25 V

Live Circuit Detection	Inhibits test if terminal voltage >10 V ac is detected prior to start of test.

Phase Sequence Indication

Icon	icon Phase Sequence indicator is active.
Display of Phase Sequence	Displays "1-2-3" in digital display field for correct sequence. Displays "3-2-1" for incorrect phase. Dashes in place of a number indicate a valid determination could not be made.
Mains Input Voltage Range (phase-tophase)	100 to 500 V

Mains Wiring Test

Icons () indicate if L-PE or L-N terminals are reversed. Instrument operation is inhibited and an error code is generated if the input voltage is not between 100 V and 500 V. The UK Loop and RCD tests are inhibited if the L-PE or the L-N terminals are reversed.

Operating Ranges and Uncertainties per EN 61557

Function	Display Range	EN 61557 Measurement Range Operating Uncertainty	Nominal Values
V EN 61557-1	0.0 V ac – 500 V ac	50 V ac – 500 V ac ±(2% + 2 dgt)	U_N = 230/400 V ac f = 50/60 Hz
R_{LO} EN 61557-4	0.00 Ω - 2000 Ω	0.2 Ω - 2000 Ω ±(10 % + 2 dgt)	4.0 V dc <UQ <24 V dc R_{LO} ≤2.00 Ω I_N ≥200 mA
R_{ISO} EN 61557-2	0.00 MΩ - 1000 MΩ	1 MΩ - 200 MΩ ±(10 % + 2 dgt) 200 MΩ - 1000 MΩ ±(15 % + 2 dgt)	U_N = 50 / 100 / 250 / 500 / 1000 V dc I_N = 1.0 mA
Z_l EN 61557-3	Z_l (No Trip) 0.00 Ω - 2000 Ω	0.4 Ω – 2000 Ω ±(15 % + 6 dgt)	U_N = 230/400 V ac f = 50/60 Hz I_K = 0 A – 10.0 kA
	Z_l (Hi Current) 0.00 Ω - 2000 Ω	0.2 Ω - 200 Ω ±(10 % + 4 dgt)	
	Z_l (Hi Current, Hi Res) 0 mΩ - 9999 mΩ	100 mΩ - 9999 mΩ ±(8 % + 20 dgt)	
	R_E 0.00 Ω - 2000 Ω	10 Ω - 1000 Ω ±(10 % + 2 dgt)	
	$_{\Delta}T$ 0.0 ms – 2000 ms	25 ms – 2000 ms ±(10 % + 1 dgt)	$_{\Delta T}$ = 10 / 30 / 100 / 300 / 500 / 1000 / VAR mA
$_{\Delta}T$, $I_{\Delta N}$ EN 61557-6	$I_{\Delta N}$ 3 mA – 550 mA (VAR 3 mA – 700 mA)	3 mA – 550 mA ±(10 % + 1 dgt)	$I_{\Delta N}$ = 10 / 30 / 100 / 300 / 500 / VAR mA
R_E EN 61557-5	0.0 Ω - 2000 Ω	10 Ω - 2000 Ω ±(10 % + 2 dgt)	f = 128 Hz
Phase EN 61557-7			1 : 2 : 3

Operating Uncertainties per EN 61557

The Operating Uncertainty shows the maximum possible uncertainty when all influence factors E1–E10 are counted.

	Volts	RLo EN 61557-4	RISO EN 61557-2	Z I EN 61557-3	ΔT EN 61557-6	IΔN EN 61557-6	RE EN 61557-5
Intrinsic Uncertainty A	0.80 %	1.50 %	10.00 %	6.00 %	1.00 %	5.00 %	3.50 %

Influence Quantity	Volts	RLo EN 61557-4	RISO EN 61557-2	Z I EN 61557-3	ΔT EN 61557-6	IΔN EN 61557-6	RE EN 61557-5
E1 – Position	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
E2 – Supply Voltage	0.50 %	3.00 %	3.00 %	3.00 %	3.00 %	2.75 %	2.25 %
E3 -Temperature	0.50 %	3.00 %	3.00 %	3.00 %	3.00 %	2.25 %	2.75 %
E4 – Series Interferences Voltage	–	–	–	–	–	–	1.50 %
E5 – Resistance of the probes and auxiliary earth electrodes	–	–	–	–	–	–	4.00 %
E6.2 – System phase angle	–	–	–	1.00 %	–	–	–
E7 – System frequency	0.50 %	–	–	2.50 %	–	–	0.00 %
E8 – System voltage	–	–	–	2.50 %	2.50 %	2.50 %	0.00 %
E9 – Harmonics	–	–	–	2.00 %	–	–	–
E10 – D.C. Quantity	–	–	–	2.50 %	–	– –	

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Ordering information

1654B Multifunction Installation Tester
1653B Multifunction Installation Tester
1652C Multifunction Installation Tester

Optional accessories
- MTC1363 Mains Test Cord
- MTC77 Mains Test Cord
- ES165X Earth Spike Test Kit (1653, 1654B only)
- FVF-SC2 FlukeView Software (1653 only)
- Fluke DMS software

Included with 1650:
- TP165X Remote Control Probe
- TL165X STD Standard Test Lead Set
- C1600 Hard Carrying Case
- Mains test cord
- Zero adapter
- Padded carrying strap
- Quick reference guide
- 6 AA batteries

Fluke. *Keeping your world up and running.®*

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