FEV100

Electrical Vehicle Charging Station Test Adapter

Users Manual

PN 5278136, April 2021

Symbols

Symbol	Description
⚠	WARNING. RISK OF DANGER.
⚠	WARNING. HAZARDOUS VOLTAGE. Risk of electric shock.
	Consult user documentation.
	Double Insulated.
CAT II	Measurement Category II is applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage MAINS installation.
⏚	Earth.
PE	Protective Earth.
CP	Control Pilot.
	Vehicles not requiring ventilation for indoor charging areas.
	Vehicles requiring ventilation for indoor charging areas.
	This product complies with the WEEE Directive marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as category 9 "Monitoring and Control Instrumentation" product. Do not dispose of this product as unsorted municipal waste.

Table 1. Symbols

Introduction

The FEV100 (the Product) tests the function and safety of AC charging stations Level 2 (208 V AC or 240 V AC) and Level 1 (120 V AC). With this adapter, charging stations are tested in accordance with SAE J1772.

The adapter imitates a car and opens up a charging cycle (activate voltage/current output). Use additional test and measurement equipment, such as but not limited to: Multimeters, Clamps, Insulation testers or Multifunction Testers, to test a charging station. In addition, the adapter has a built in quick safety test that does not require separate equipment.

Safety Information

A **Warning** identifies conditions and procedures that are dangerous to the user. A **Caution** identifies conditions and procedures that can cause damage to the Product or the equipment under test.

⚠⚠ Warning

To prevent the possibility of electric shock or personal injury:

- **Read all safety information before you use the Product.**
- **Do not alter the Product and use only as specified, or the protection supplied by the Product can be compromised.**
- **Carefully read all instructions.**
- **Do not touch voltages >30 V ac rms, 42 V ac peak, or 60 V dc.**
- **Before each use, examine the Product. Look for cracks or missing pieces of the Product and cable assembly insulation. Also look for loose or weakened components. Carefully examine the insulation around the cable assembly connector.**
- **Only connect the Product to the charging stations as indicated in the Specification section.**
- **Use the Product within the operating range only. The operating range is specified in the Specification section.**
- **Do not touch any part of charging station during the GFCI test. The GFCI test may place hazardous voltage onto conductive parts of the charging station during the test if the charging station is not properly grounded.**
- **Do not use the Product around explosive gas, vapor, or in damp or wet environments.**
- **Do not apply more than the rated voltage, between the terminals or between each terminal and earth ground.**
- **Use the correct terminals, function, and range for measurements.**
- **Do not use the Product if it operates incorrectly.**
- **Do not operate the Product with covers removed or the case open. Hazardous voltage exposure is possible.**
- **Use only specified replacement parts.**
- **Do not use the Product if it is altered or damaged.**
- **Have an approved technician repair the Product.**

Transport and Storage

Please keep the original packaging for future transport (for example if calibration is necessary). Any transport damage due to faulty packaging will be excluded from warranty claims.

The adapter must be stored in dry, closed areas. In case of the adapter being transported in extreme temperatures, a minimum recovery time of 2 hours is required prior to any operation.

Available Measurements

- Grounding system Pre-Test (verifies that there is no presence of dangerous voltage at the Ground terminal)
- Phase indicator (presence of voltage)
- CP State simulation (A, B, C ⊛ , D ⊛) for Control Pilot
- CP Error “E” simulation (Control Pilot CP signal short-circuited to PE)
- GFCI ground fault circuit interrupter test
- Fault Voltage test in normal conditions (no GFCI test current) and during GFCI test
- PE Error (Earth Fault) simulation (interruption of PE conductor)
- Measurements on live conductors (L1, L2/N) and on PE ground conductor
- Test of Control Pilot CP signal

Kit Components

The FLK-FEV100/TY1 Kit contains the following items:

1	FLK-FEV100/BASIC Test Adapter
1	FLK-FEV-COM/TY1 Type 1 Connector & Cable
1	Soft Carrying Case
1	Users Manual

Description of Warning Marks on Front Panel

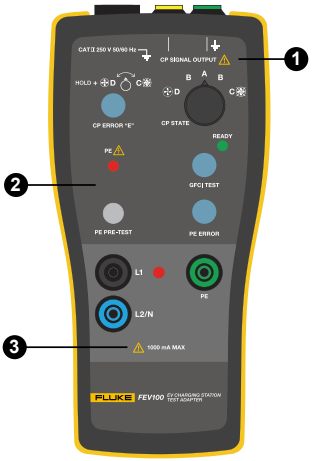

Figure 1. Front panel warning marks

1. Terminals with low voltage output (approx. ±12 V) powered by the charging station. Terminal marked with ⏚ is connected to PE. Use for test purposes only. The CP Signal Output terminals can be hazardous if there is a charging station error or incorrect wiring.
2. High danger of electric shock is present when PE Pre-Test indicator illuminates while performing PE pre-test (see *Grounding protection Pre-Test*). In this case, stop testing immediately. Make sure to ground your body sufficiently while doing this test.
3. Dangerous voltages can be present at L1, L2/N, and PE terminals while the test adapter is plugged into the charging station. Use the test sockets for test purposes only. Do not supply any appliance or charge an electric vehicle via these connectors. Terminals N and PE can be hazardous if there is a charging station error or incorrect wiring.

Operation Elements and Connectors

1. CP Error “E” button
2. Protective Grounding test ⏚ Pre-Test warning indicator
3. Protective Grounding ⏚ Pre-Test touch probe
4. Measurement terminals L1, L2/N
5. Voltage presence indicator
6. Measurement Ground terminal
7. Grounding error simulation button
8. GFCI test button and green READY indicator
9. CP State rotary switch selector (A, B, C ❋ , D ✣)

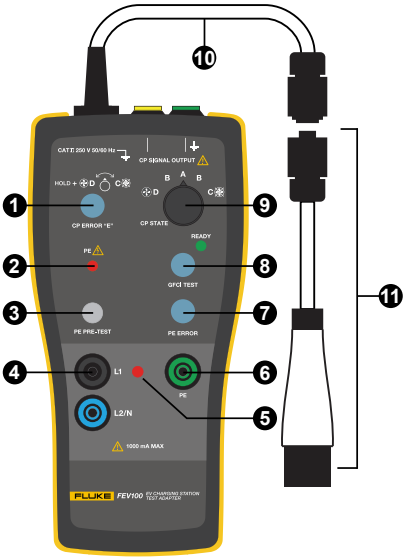

Figure 2. Front panel function

10. Test cable input with 5-pole male connector
11. Test cable for specific EV charging station (Type 1 or Tesla)

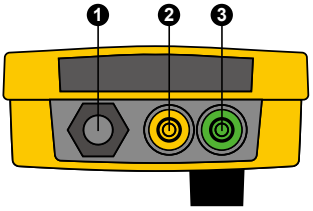

Figure 3. Top of the Product

1. Test cable input
2. CP Signal output terminal (yellow)
3. CP Signal output terminal (connected to PE) (green)

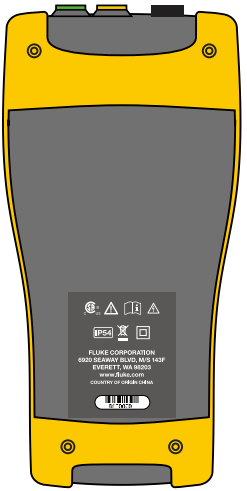

Figure 4. Back of the Product

Testing Charging Stations

⚠⚠ Warning

To prevent possible electric shock, fire, or personal injury:

- **Before starting any tests, the operator must be familiar with the standard: SAE J1772, "SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler" and the documentation of the charging station in use.**
- **Before starting any tests, refer to the local regulations and standards for: safety at work and any relevant publications from the Health and Safety Executive.**
- **Only skilled persons, competent in verification and the types of tests suitable for installations and charging stations, should do the tests.**
- **If the wrong types of tests are done or if testing is done in an incorrect sequence then a potentially hazardous situation can occur for both the operator and the DUT (Device Under Test).**
- **The operator must fully understand the various tests required and how they should be done.**
- **The charging station must pass the Protective Earth (Ground) PE Pre-Test prior to the operator touching exposed metal surfaces or any other test. If the PE Pre-Test fails, stop further testing. Resolve any faults before proceeding. In case of error, all metal parts of the charging station including output terminals and PE can have hazardous voltage. In this case, there is a high risk of electric shock to the operator and other persons nearby.**
- **The PE Pre-Test detects the presence of hazardous voltage on Protective Earth but may not detect an open Protective Earth.**

Testing a charging station

To test the charging station:

1. Do a safety grounding protection pre-test (to verify that no dangerous voltage is present in the grounding circuit due to possible miswire or electrical wiring or grounding malfunction).
2. Verify station output voltage using an additional meter.

3. Verify station maximum preset charge current using CP terminals and a meter with duty cycle function or an oscilloscope.
4. Simulate the error states as described in the SAE J1772 standard: CP Error “E”, GFCI trip test, and Grounding Error.

Additional advanced tests such as Insulation Resistance, Power Quality, Analysis of the Control Pilot waveform, and Loop Impedance can also be done using the adapter in conjunction with appropriate test and measurement equipment. The adapter is compatible with Fluke and Amprobe test and measurement instrumentation.

Grounding protection Pre-Test

The Grounding ⏚ Pre-Test safety feature allows the operator to test the PE conductor for possible presence of dangerous voltage against earth. In normal circumstances, the grounding conductor is connected to earth and therefore has no voltage against earth. However, if the grounding conductor is not connected to earth (for example, connected to phase by mistake or the grounding wire is disconnected or broken) the situation may be hazardous.

Operator skin contact is required on the PE PRE-TEST button (do not wear gloves) as well as a suitable operator reference to a known earth ground (through the operator's shoes etc.) Do not touch any metal parts of the charging station while performing this test. In case of improper connection to earth (for example, isolated placement of your body) this indication may be not reliable.

⚠⚠ Warning
The PE Pre-Test detects the presence of hazardous voltage on Protective Earth but may not detect an open Protective Earth.

Test procedure:

1. Connect the test adapter to the charging station.
2. Touch the probe with a bare finger. If PE Light (item ❷, Figure 2) is illuminated, then dangerous voltage is present at ground conductor. Stop further testing immediately and check for a possible wiring fault of the tested ground conductor. In case of this error, the ground terminal carries hazardous voltage. There is a high risk of electric shock.

Possible errors are:

- PE interrupted / not connected
- PE carries voltage (for example, connected to phase)

Verifying charging voltage - vehicle simulation

Use the CP State rotary switch selector, to simulate various vehicle states when the test adapter is connected to the charging station. Vehicle states are simulated with different resistances connected between CP and PE conductors. Correlation between resistance and vehicle states is shown in Table 2 below.

Marking of Vehicle State	Electric Vehicle (EV) State	Resistance between CP and PE	Voltage at CP terminal
A	EV not connected	Open (∞)	±12 V 1 kHz
B	EV connected, not ready to charge	2.74 kΩ	+9 V / -12 V 1 kHz
C	EV connected, ventilation not required, ready to charge	882 Ω	+6 V / -12 V 1 kHz
D	EV connected, ventilation required, ready to charge	246 Ω	+3 V / -12 V 1 kHz

Table 2. Correlation between resistance, vehicle state and CP voltage signal.

Initiating a charging cycle:

1. Connect the adapter cable to the charging station.
2. Turn a CP switch to B position and wait 3 to 5 seconds – in commercial stations this may initiate a station to ask for payment information
3. Turn a CP switch to either C or D position depending on the type of station you are testing (respectively with or without indoor charging area ventilation requirement) to open the charging cycle.

Note

If the station does not begin the charging cycle, turn the CP switch to position A. Then turn the CP switch to position B and wait 3 to 5 seconds. Then turn the CP switch to position C or D. Some EV charging stations require a time delay to establish a proper connection when CP State B is selected.

The red LED indicates that the charging station opened for the charging cycle and voltage is present at the adapter terminals. The green READY indicator should light up to indicate that the GFCI test circuit is ready for testing.

Measuring terminals of the adapter are directly connected to Phase 1 (L1), Phase 2 (L2/N) or N (L2/N), and PE conductors of the charging station via the test cable. Use these terminals for measuring purposes only. Do not use the terminals to supply power to any other equipment.

Connect a meter to the L1 and L2/N terminals to perform output voltage measurement. The terminals can be also used to perform other tests (for example the loop impedance or Power Quality).

Verification of the charging station's preset maximum charging current and CP signal

The purpose of the CP function is communication between a vehicle and charging station. The duty cycle of the PWM Pulse Width Modulation signal defines the maximum available charging current.

CP output terminals are connected to CP and Ground conductors of the charging station under test via the test cable. The green socket is connected to Ground. These outputs are for connection of a meter with a duty cycle function or an oscilloscope to check the waveform and amplitude of the CP signal.

For details of communication protocol refer to SAE J1772 and the documentation of the manufacturer of the charging station.

Verification of the maximum charging current with a multimeter

Set a maximum charging current of the charging station using the internal switch. The value of the maximum charging station current cannot exceed the max current allowed by the gauge of the installed electrical wires and breaker according to the National Electrical Code.

Testing maximum charging current:

1. Connect adapter to the charging station and select either state C or D using rotary switch depending on the type of station to start the charging cycle.
2. Connect meter set to Duty Cycle to the Control Pilot (CP) terminals located on the top of the adapter. See Figure 3, use items ❷ and ❸. Make sure to connect COM input of the meter to the Green (Ground) output of the CP terminal.
3. Read the duty cycle value and translate to maximum charging current using the below formulas or a quick reference table (based on J1772 standard).

Note

- *Do not connect to L1, L2/N terminals.*
- *Connect the multimeter test leads after the charging station starts the charging cycle. In some situations, the meter can influence the CP signal, and prevent the station from starting the charging cycle.*

9.5 % ≤ Duty Cycle < 10 %, Maximum current = 6 A
10 % ≤ Duty Cycle ≤ 80 %, Maximum current = (duty cycle %) x 0.6
85 % < Duty Cycle ≤ 96 %, Maximum current = (duty cycle % - 64) x 2.5
96 % < Duty Cycle ≤ 96.5 %, Maximum current = 80 A
See detailed calculations in Table 3 below.

Duty Cycle (%)	Max Amps	Duty Cycle (%)	Max Amps	Duty Cycle (%)	Max Amps
9.5	6.0	40	24.0	70	42.0
10	6.0	41	24.6	71	42.6
11	6.6	42	25.2	72	43.2
12	7.2	43	25.8	73	43.8
13	7.8	44	26.4	74	44.4
14	8.4	45	27.0	75	45.0
15	9.0	46	27.6	76	45.6
16	9.6	47	28.2	77	46.2
17	10.2	48	28.8	78	46.8
18	10.8	49	29.4	79	47.4
19	11.4	50	30.0	80	48.0
20	12.0	51	30.6	81	48.6
21	12.6	52	31.2	82	49.2
22	13.2	53	31.8	83	49.8
23	13.8	54	32.4	84	50.4
24	14.4	55	33.0	85	51.0
25	15.0	56	33.6	86	55.0
26	15.6	57	34.2	87	57.5
27	16.2	58	34.8	88	60.0
28	16.8	59	35.4	89	62.5
29	17.4	60	36.0	90	65.0
30	18.0	61	36.6	91	67.5
31	18.6	62	37.2	92	70.0
32	19.2	63	37.8	93	72.5
33	19.8	64	38.4	94	75.0
34	20.4	65	39.0	95	77.5
35	21.0	66	39.6	96	80.0
36	21.6	67	40.2	96.5	80.0
37	22.2	68	40.8		
38	22.8	69	41.4		

Table 3. Calculations of max. charging current on basis of duty cycle.

Error states:

Duty Cycle = 0 % (Duty Cycle < 3 %), State F or E (see SAE J1772 Standard); no charging allowed

Duty Cycle = 5 % (4.5 % ≤ Duty Cycle ≤ 5.5 %), Indicates that digital communication is needed

7 % < Duty Cycle < 8 %, Error state; no charging allowed

Duty Cycle = 100 %, State B1, C1 or D1; no charging allowed

CP Error “E” simulation

The standard SAE J1772 defines Error “E” as a state when charging station is: disconnected from vehicle, disconnected from utility, there is a loss of utility power or control pilot is short to control pilot reference (ground).

To simulate the CP Error “E”:

1. Push and hold CP Error “E”.
2. While holding the CP Error “E” button turn the CP rotary switch to either C or D position.
3. The station should NOT open the charging cycle and a new charging process should be prevented.

Note

The charging station is not required to actively generate the error code, so the active charging process will not be interrupted if CP Error “E” button is pushed after the charging cycle is initiated.

GFCI test

Each charging station is required to be equipped with GFCI protection. On many stations the GFCI protection is fully automatic and does not need a manual reset after the GFCI circuit is tripped.

Testing a GFCI protection:

1. Turn the CP switch to either C or D position depending on the type of station you are testing (respectively with or without indoor charging area ventilation required) to open the charging cycle.
2. The green READY indicator next to GFCI test button illuminates.

   If the READY indicator blinks before you press the GFCI test button, then fault voltage is higher than 45 V at the PE terminal. Check and improve the grounding system before you do further tests.

   ⚠⚠ Warning

   Do not touch any part of charging station during the GFCI test. The GFCI test may place hazardous voltage onto conductive parts of the charging station during the test if the charging station is not properly grounded.
3. Press the GFCI test button.

   The station should terminate a charging cycle as soon as the GFCI button is pressed.

   If the READY indicator starts to blink after you press the GFCI test button, then fault voltage during GFCI test was higher than 45 V. The fault voltage was caused by the test current. Check and improve the grounding system before you do further tests.
4. Unplug the adapter to reset the GFCI protection, if necessary.

Ground Error (Ground Fault) simulation

The Ground ⏚ Error button simulates an interruption of the ground conductor. As a result, the pending charging process is aborted, and new charging processes are prevented.

Maintenance

When using the test adapter in compliance with the Users Manual, no special maintenance is required. However, should functional errors occur during normal operation, after sales service will repair your instrument. Please contact the local service office.

Cleaning

⚠⚠ Warning

- **Remove all input signals and measurement circuits before you clean the Product.**
- **Never use acid-based detergents or solvent liquids for cleaning.**
- **After cleaning, do not use the Product until the Product is dried completely.**

To clean the Product, use a wet cloth and a mild household detergent.

Specifications

General Features

Input voltage ..... $U_{L1/N}$ = 120 V, $U_{L2/N}$ = 120 V, $U_{L1/L2}$ = 208 V, 60 Hz (three-phase system) or $U_{L1/N}$ = 120 V, $U_{L2/N}$ = 120 V, $U_{L1/L2}$ = 240 V, 60 Hz (single-phase system), ±10% voltage fluctuations from nominal

EV connector (EVC-13)..... SAE J1772 socket, 16 A (type 1, 5P single-phase)

Internal power consumption ..... 2 W max.

Operating temperature ..... -4 °F to 104 °F (-20 °C to 40 °C)

Storage temperature ..... -4 °F to 122 °F (-20 °C to 50 °C)

Operating humidity range ..... 10 % to 85 % relative humidity non-condensing

Storage relative humidity..... 0 % to 85 % non-condensing

Operating altitude ..... 6561 ft (2000 m) max.

Dimensions (H × W × D) ..... Approx. 8.66 x 4.33 x 1.77 in (220 x 110 × 45 mm) without cable assembly

Weight..... Approx. 4.4 lb (2 kg)

Safety standards..... IEC 61010-1, Pollution Degree 2
IEC 61010-2-030

Measurement category..... CAT II 250 V

IP protection class IP54

Electromagnetic Compatibility (EMC)

International ..... IEC 61326-1:
Basic Electromagnetic Environment;
CISPR 11: Group 1, Class A

Group 1: Equipment has intentionally generated and/or uses conductively-coupled radio frequency energy that is necessary for the internal function of the equipment itself.
Class A: Equipment is suitable for use in all establishments other than domestic and those directly connected to a low-voltage power supply network that supplies buildings used for domestic purposes. There may be potential difficulties in ensuring electromagnetic compatibility in other environments due to conducted and radiated disturbances.
Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

USA (FCC) 47..... 47 CFR 15 subpart B. This product is considered an exempt device per clause 15.103.

Functions

CP states ..... A, B, C, D

CP Error “E” ..... On/off

PE Error ..... On/off

GFCI test ..... Yes, test resistor of 2 kΩ connected between L1 and PE, time limitation 40 ms

PE Pre-Test (typical)..... Visible indication >30 V on PE conductor

Outputs (for test purpose only)

Measuring terminals

L1, L2/N, PE ..... Max. 250 V 50/60 Hz, CAT II 250 V

CP signal output terminals ..... Approx. ±12 V (under normal conditions), in case of wrong wiring or error of the charging station these terminals can be hazardous ≥ max. 250 V against PE

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is three years and begins on the date of shipment. Parts, product repairs, and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries, or to any product which, in Fluke's opinion, has been misused, altered, neglected, contaminated, or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on nondefective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available only if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center to obtain return authorization information, then send the product to that service center, with a description of the difficulty, postage and insurance prepaid (FOB Destination). Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that failure was caused by neglect, misuse, contamination, alteration, accident, or abnormal condition of operation or handling, including overvoltage failures caused by use outside the product's specified rating, or normal wear and tear of mechanical components, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

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Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

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