Logo_SE_Green_A4

**TEST EQUIPMENT SPECIFICATION**

**Automatic Functional Test System for AFCI MCB with Plug-on Neutral**

**New CAFI PROJECT**

**Update history**

|  |  |  |  |
| --- | --- | --- | --- |
| Revision | Date | Update description | Author |
| P1 | 23 FEB 2023 | Initial draft (Changes from PKR2083802 P8. Added PAC requirements and cell 14 open items) | M. Pedraza |
| P2 | 31 Mar 2023 | Just testing | J. Vélez |
| P3 | 31 Mar | Second change of the day | J Vélez |
| P3 | 01 April |  | J Velez |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Table of Contents**

[1. General Information 5](#_Toc128040327)

[2. Equipment design 6](#_Toc128040328)

[2.1 Mechanical 6](#_Toc128040329)

[2.2 Electrical 7](#_Toc128040330)

[2.3 Environmental Sensors 8](#_Toc128040331)

[2.4 Programming 8](#_Toc128040332)

[2.5 HMI 8](#_Toc128040333)

[3. Test Flow 9](#_Toc128040334)

[3.1 DF 9](#_Toc128040335)

[3.2 CAFI 10](#_Toc128040336)

[3.3 CSA CAFI 11](#_Toc128040337)

[4. Test Functions (DF) 12](#_Toc128040338)

[4.1 Degauss 12](#_Toc128040339)

[4.2 Trip Speed 2 (UL943 5th edition sec 6.7) 12](#_Toc128040340)

[4.3 Power Up 13](#_Toc128040341)

[4.4 Ground Fault Threshold (unloaded) (UL943 5th edition sec ??) 13](#_Toc128040342)

[4.5 Ground Fault Threshold (loaded) (UL943 5th edition sec ??) 14](#_Toc128040343)

[4.6 Ground Fault Threshold Delta 14](#_Toc128040344)

[4.7 Grounded Neutral Trip (UL943 5th edition sec 6.7.4) 15](#_Toc128040345)

[4.8 Grounded Neutral No Trip (UL943 5th edition sec 6.7.4) 15](#_Toc128040346)

[4.9 Mag 16](#_Toc128040347)

[4.10 Degauss 16](#_Toc128040348)

[4.11 False Trip (UL943 5th edition sec 6.8) 17](#_Toc128040349)

[4.12 Trip Speed 1 (UL943 5th edition sec 6.7) 17](#_Toc128040350)

[4.13 Handle Indicate 18](#_Toc128040351)

[4.14 HVI 19](#_Toc128040352)

[4.15 Push 20](#_Toc128040353)

[5. Test Functions (CAFI) 21](#_Toc128040354)

[5.1 Mag 21](#_Toc128040355)

[5.2 Power On 21](#_Toc128040356)

[5.3 Trip Speed 22](#_Toc128040357)

[5.4 Power Up Test 22](#_Toc128040358)

[5.5 Grounded Neutral Trip (To be performed on CSA CAFI ONLY) 23](#_Toc128040359)

[5.1 Grounded Neutral No Trip (To be performed on CSA CAFI ONLY) 23](#_Toc128040360)

[5.2 Ground Fault Threshold (unloaded) 24](#_Toc128040361)

[5.3 Ground Fault Threshold (loaded) 24](#_Toc128040362)

[5.4 Handle Indicate 25](#_Toc128040363)

[5.5 HVI 26](#_Toc128040364)

[5.6 Push 26](#_Toc128040365)

[6. Maintenance 27](#_Toc128040366)

[7. Qualification and Acceptance 27](#_Toc128040367)

[8. Miscellaneous 27](#_Toc128040368)

[9. Deliverables 27](#_Toc128040369)

[9.1 From =S= 27](#_Toc128040370)

[9.2 From supplier 27](#_Toc128040371)

[10. Glossary 28](#_Toc128040372)

# General Information

This document is part of a family of documents which describe the automated portion of a production line for the QO/HOM MCBs (Qwik-Open/HOMeline Miniature Circuit Breakers. This portion is known as the Automated Finishing Line (AFL) because it is used to set, or to calibrate the thermal response of fully assembled breakers and to test for correct functionality. This document describes only what is required to functionally test these breakers.

With a few exceptions noted in this document, any information for this equipment outside of testing the circuit breaker such as procurement, description of the product, equipment safety and ergonomics, etc., will be found in document PKR203802.

# Equipment design

## Mechanical

A receptacle to collect any condensate from the cooling unit must be provided, and it should include a device such as a petcock for the purpose of emptying. It is permissible to omit the drain and instead remove the receptacle from the equipment provided: (1) tools are not required, and (2) the process to remove and reinstall takes no more time than using a petcock if one was provided. Siphoning is NOT permitted.

The following parts must be redesigned or modified:

17009-200-00-B as reference

* item 7 at times prevents full extension of item 15 resulting in a machine fault
  + item 7 is unnecessary and there exists a revision of drawing 17009-200-00 missing this item which in fact is not in place in photos of Cell 12 while in MDC-France
* either eliminate item 7 or fix into place such that it does not prevent full extension of item 15
* during HVI test step arcing can occur from item 4 to item 12
  + reduce 25 mm diameter on item 4
  + reduce 28 mm diameter on item 3

17055-130-00 for reference

* the entire assembly on this drawing must be removed from the equipment to service 3, 5, 24, or 29
* redesign or modify item 2 such that 24 enters from the top
* because the end of item 3 is threaded at the joint of item 11, the fastener (not on this drawing) enters item 11 from the bottom making full and proper engagement of the hex key very difficult for proper torquing
  + despite the use of thread-locking fluid on this fastener, this joint often loosens giving the mass of item 11, the design of this joint allowing rotation, and the repeated movement of this entire assembly during normal equipment operation
* redesign or modify items 3 and item 11 to allow the fastener to enter from the top as well as the joint itself

17055-060-05 damages load electrodes when resuming test sequence after certain faults

* eliminate or relocate feature with a width of 13 mm located at the lower left of plate when viewing drawing

## Electrical

Refer to the detailed finishing line equipment specification PKR2038002.

Specific to this equipment however, a power quality meter with associated measuring components, i.e., current transformers (CTs) must be installed into each electrical cabinet to monitor 3-phase supply.

Model number of specified power quality meter is: METSEPM8243

There are two ethernet ports on this power quality meter marked as ETH1 and ETH2. Each of these ports must be extended to the outside of the electrical cabinet for connection to other equipment on this finishing line.

The Haefely must be connected to the nearest copper grounding bus bar using the equipment grounding terminal on the rear of the Haefely and a 6 AWG wire.

18 AWG wire must be used on the GSPD output.

It has been requested that a shielded multiconductor cable be used between the GSPD output and contactor KA303.1. However, any potential benefit gained by a using such a cable will be severely compromised unless each wire within the cable is terminated in adjacent terminals of contactor KA303.1. Even if shielded cable is used between the GSPD and the contactor, it is not possible to use shielded cable between the contactor and the UUT in part because this part of the circuit utilizes bus bars which are not near one another.

The following signal connection points must be provided in accordance with **PKR2038002 Appendix 4**

* 47-9 (feedback signal of relay B402.2)
* 47-10 (feedback signal of relay B402.3)
* 47-11 (feedback signal of relay B402.4)
* I100.3 (feedback signal of relay B303.1)
* I100.5 (feedback signal of relay B303.2)
* I100.7 (indirect output signal of B30.1)
* I100.55 (output signal of voltage detection card B48.11)
* B100.36 (output signal of actuator V106 when in the extended position)
* GSPD output at a point that excludes any current to the voltage detection card

Access to any of these connection points must not require ladders, stepstools, or similar equipment, and must be accessible from a standing position.

Provide a physical visual indicator connected electrically between the Line(~) circuit and Panel(N) which illuminates when the UUT is being powered by the programmable power supply. It must be located within the footprint of the fixture plate and clearly visible during at all times. It must be rated to operate at the various voltages supplied to the UUT during the normal test sequence. **It MUST be disconnected from the breaker during the HVI test.**

For drawing 4267335 revision D: Component KS402.1 most switch in the primary side of transformer (T40.3) and be replaced to a *solid-state* solution.

Module API-107 Get damaged without warning or error code, a new alternative should be provided, or online detection method should be added to detect and correct this issue.

The machine design should have a method to prevent that the voltage detection card detects no voltage at the beginning of test erroneously flagging the breaker as tripped at 0ms.

## Environmental Sensors

Sensors for factors such as temperature and humidity shall be installed into top of each cabinet.

## Programming

Refer to the detailed finishing line equipment specification PKR2038002.

In the same manner used today to manually control the pneumatic actuators and to view the status of each actuator, the program must have the ability to control, in an electrically-safe manner, any contactor/relay/light directly connected to a PLC output or other software-controlled device (e.g., MDC card) and to view the status of each of those contactors/relays directly on the HMI. A light obviously can be viewed directly.

The operational status of any instrument (namely the Haefely, Chroma, and GSPD) must be actively monitored. In the event of a malfunction, a fault which is both descriptive and specific to the instrument, must be produced and displayed clearly on the HMI in the area used for that purpose.

All feedback or device status signals must be actively monitored, and in the event of malfunction, a fault which is both descriptive and specific to the device must be produced and displayed clearly on the HMI in the area used for that purpose.

Feedback signals for relays B402.2, B402.3, and B402.4 must be actively monitored, and in the event of malfunction, a fault which is both descriptive and specific to the relay must be produced and displayed clearly on the HMI in the area used for that purpose.

## HMI

Refer to the detailed finishing line equipment specification PKR2038002.

# Test Flow

The CSA version of CAFI receive additional tests which are not required for the UL version of CAFI.

All DF circuit breakers receive the same tests, and the test set for DF is more extensive than CAFI because of the Ground Fault (GF) and Grounded Neutral (GN) functions.

Loads subjected to any breaker is equal to its handle rating.

## DF

The current test sequence for all DF circuit breakers is shown below. This is subject to change as it is desirable to reduce the overall test time.

[](#_Degauss)

## CAFI

The current test sequence for UL CAFI circuit breakers ONLY is shown below. This is subject to change as it is desirable to reduce the overall test time.



## CSA CAFI

The current test sequence for CSA CAFI circuit breakers ONLY is shown below. This is subject to change as it is desirable to reduce the overall test time.



# Test Functions *(DF)*

## Degauss

##### Aim of this test:

To remove any remnant magnetic field in the ground fault current transformer located on the PCBA

6

##### Test principle:

Pass a current of specific amplitude and frequency between the Panel (N)eutral and the Load (N)eutral terminals while reducing amplitude to zero at a specific rate.

##### Test:

Input configuration:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Set the circuit breaker to the ON (closed) or OFF (open) position.

Apply a 60 Hz, 400 mA RMS sine wave to Load (N)eutral. Reduce this current to zero at a ramp rate of 20 mA/cycle.

##### Measurement:

None.

On failure, report fault code “F11”.

End of test

## Trip Speed 2 (UL943 5th edition sec 6.7)

##### Aim of this test:

Determine response time of powered breaker to open with ground fault current applied~~.To~~ **to** ensure correct mechanical assembly of breaker.

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and induce a specific current between Panel (N)eutral and Load (N)eutral terminals.

##### Test:

Input configuration:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply **a** 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create a 264mA, 60Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST open within **25 mS**

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between application of 264 mA signal and loss of 102 VAC at Load (~).

On failure, report fault code “F6”.

End of test

## Power Up

##### Aim of this test:

Determine powered breaker does not open with ground fault current applied when initially powered

##### Test principle:

Power breaker in the ON position at 110% nominal line voltage and induce a specific current between Panel (N)eutral and Load (N)eutral terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 132 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create a 2 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST remain closed for **2 seconds**.

##### Measurement:

Presence of 132 VAC at Load (~) terminal to determine state of breaker.

Time between application of 2 mA signal and loss of 132 VAC at Load (~).

On failure, report fault code “F1”.

End of test

## Ground Fault Threshold (unloaded) (UL943 5th edition sec ??)

##### Aim of this test:

Determine ground fault current amplitude which causes breaker to open when load current is not present.

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and pass a range of ground fault currents between Load (N) and Panel (N) terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply **a** 102 VAC, 60Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create a 4 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Increase the 4 mA current to a maximum of 6 mA in steps of 300 uA/second until the breaker opens.

Breaker MUST open when fault current is between 4.5 – 5. 4mA.

Save load current for use later.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Load current.

On failure, report fault code “F3”.

End of test

## Ground Fault Threshold (loaded) (UL943 5th edition sec ??)

##### Aim of this test:

Determine ground fault current amplitude which causes breaker to open when load current equivalent to handle rating is present.

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and pass a range of ground fault currents between Load (N) and Panel (N) terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 V~~AC~~, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create a resistive load current equal to the breaker handle rating between Load (~) and Load (N)eutral.

Create a 4 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Increase the 4 mA current to a maximum of 6 mA in steps of 300uA/second until the breaker opens.

Breaker MUST open when fault current is between 4.4 – 5.5 mA.

Save load current for use later.

Remove power.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Load current.

On failure, report fault code “F4”.

End of test

## Ground Fault Threshold Delta

##### Aim of this test:

Ensure performance of ground fault current transformer located on PCBA.

##### Test principle:

Determine difference (absolute value) between ground fault thresholds when unloaded and loaded.

##### Test:

Connections to breaker are not necessary.

Simply subtract the final value of ground fault threshold when loaded from the final value of ground fault threshold when unloaded.

##### Measurement:

Difference must not exceed 425 uA

On failure, report fault code “F15”.

End of test

## Grounded Neutral Trip (UL943 5th edition sec 6.7.4)

*NOTE: To reduce additional and unwanted impedance in this circuit, it is important that the components used during this test are mounted as close to the UUT as is practically possible.*

##### Aim of this test:

Ensure impedance threshold of grounded neutral detection circuit which causes breaker to open

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and connect fixed resistive impedance between Load (N)eutral and Panel (N)eutral.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 V~~AC~~, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Connect 2.50 Ω resistor between Panel (N)eutral and Load (N)eutral.

Breaker MUST open within 900 mS.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between application of impedance in neutral loop and the opening of the breaker.

On failure, report fault code “F7”.

End of test

## Grounded Neutral No Trip (UL943 5th edition sec 6.7.4)

*NOTE: To reduce additional and unwanted impedance in this circuit, it is important that the components used during this test are mounted as close to the UUT as is practically possible.*

##### Aim of this test:

Ensure impedance threshold of grounded neutral detection circuit which does not cause breaker to open

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and connect fixed resistive impedance between Load (N)eutral and Panel (N)eutral.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 V~~AC~~, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Connect 4.93 Ωbetween Panel (N)eutral and Load (N)eutral.

Breaker MUST remain closed for a minimum of 900 mS.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between application of impedance in neutral loop and end of test.

End of test

## Mag

##### Aim of this test:

Ensure correct operation of magnetic tripfunction

##### Test principle:

Pass fixed current from Line (~) to Load (N)eutral with breaker in ON position.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 V~~AC~~, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Remove 102 VAC from breaker

Pass one half line cycle of 260 Arms 60 Hz from Line (~) to Load (~) terminals.

Breaker MUST open after one half line cycle.

Apply a 102 V~~AC~~, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

##### Measurement:

Absence of 102 VAC at Load (~) terminal to determine state of breaker.

On failure, report fault code “F9”.

End of test

## Degauss

##### Aim of this test:

To remove any remnant magnetic field in the ground fault current transformer located on the PCBA

##### Test principle:

Pass a current of specific amplitude and frequency between the Panel (N)eutral and the Load (N)eutral terminals while reducing amplitude to zero at a specific rate.

##### Test:

Input configuration:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Set the circuit breaker to the ON (closed) or OFF (open) position.

Apply a 60 Hz, 400 mA RMS sine wave to Load (N)eutral. Reduce this current to zero at a ramp rate of 20 mA/cycle.

##### Measurement:

None.

On failure, report fault code “F11”.

End of test

## False Trip (UL943 5th edition sec 6.8)

##### Aim of this test:

Ensure breaker does not trip when connected to load with normal transient disturbances.

##### Test principle:

Power breaker in the ON position at 110% nominal line voltage and introduce a RC load across the Load (~) and Panel (N)eutral terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 132 V~~AC~~, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Connect a load between Load (~) and Panel (N)eutral terminals consisting of a total resistance of 64 kohms and a .015 uF capacitor in parallel.

Maintain these connections for 500 mS.

Breaker MUST remain closed during this time.

##### Measurement:

Presence of 132 VAC at Load (~) terminal to determine state of breaker.

On failure, report fault code “F8”.

End of test

## Trip Speed 1 (UL943 5th edition sec 6.7)

##### Aim of this test:

Determine response time of powered breaker to open with ground fault current ~~just above~~ applied.

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and pass a specific current between Panel (N)eutral and Load (N)eutral terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create a 6 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST open within 500 mS.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between application of 6mA load and loss of 102 VAC at Load (~).

On failure, report fault code “F5”.

End of test

## Handle Indicate

##### Aim of this test:

Clear the trip information from the microcontroller on PCBA.

##### Test principle:

With the breaker in the OFF (opened) position, depress PTT button and power breaker at 85% nominal line voltage for the duration of the test. Breaker is closed and must trip within given time. The breaker is reset (trip-open-closed) and upon closing, the breaker must trip within given time. This cycle is repeated four more times for a total trip count within given time of six. The breaker is reset once more and should not trip. This is the indication that the data has been cleared.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Ensure breaker is in the OFF (opened) position.

Depress PTT button.

Apply 102VAC, 60Hz sine wave to Line (~) and Panel (N)eutral terminals.

Place breaker in the ON (closed) position.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST not open.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between closing the breaker and loss of 102VAC at Load (~).

On failure, report fault code “F14”.

End of test

## HVI

*NOTE: The HVI power supply takes approximately 8 - 9 seconds to fully charge to the required 6kV. To reduce test time, it will be required to begin the charging process such that charging has completed by the time this test step is reached. The point at which this charging process is to commence will need to be determined during the tester program development/debug process.*

##### Aim of this test:

Surge immunity test.

##### Test principle:

Power breaker in the ON position at 100% nominal line voltage and apply 6kVAC, 100kHz ring wave to Line (~) and Panel (N)eutral terminals. Breaker must not display arcing or be damaged.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Using the HVI generator, apply 120 VAC 60Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Disconnect Load (~) and Load (N)eutral terminals.

Apply 6 kVAC +/-5%, 100 kHz, 30 Ω impedance ring wave at 270 degrees to Line (~) and Panel (N)eutral terminals.

Query the HVI power supply for maximum current and voltage measured during the test.

##### Measurement:

Peak current from HVI power supply 0 – 10 A.

Peak voltage from HVI power supply 5.7 kV – 6.3 kV.

Connect Load (~) and Load (N)eutral terminals.

Presence of 120 VAC at Load (~) terminal to determine state of breaker.

On failure, report fault code “F16”.

End of test

## Push

##### Aim of this test:

Ensure breaker will open when PTT button is depressed.

##### Test principle:

Power breaker at 85% nominal line voltage and depress PTT button.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply **a** 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Depress PTT button.

Breaker MUST open within 500 mS

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

On failure, report fault code “F2”.

End of test

# Test Functions *(CAFI)*

## Mag

##### Aim of this test:

Ensure correct operation of short circuit function.

##### Test principle:

Pass fixed current from Line (~) to Load (N)eutral with breaker in ON position.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply **a** 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Remove 102 VAC, from breaker

Pass 1 line cycle of 260 Arms 60 Hz from Line (~) to Load (~) terminals.

Breaker MUST open after 1 line cycle.

Apply **a** 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

##### Measurement:

Absence of 102 VAC at Load (~) terminal to determine state of breaker.

On failure, report fault code “F9”.

End of test

## Power On

##### Aim of this test:

Ensure circuit breaker does not open when initially powered.

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and induce a specific current between Panel (N)eutral and Load (N)eutral terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Wait 50 mS.

##### Measurement:

None.

End of test

## Trip Speed

##### Aim of this test:

Determine response time of powered breaker to open with ground fault current applied.

To ensure correct mechanical assembly of breaker.

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and induce a specific current between Panel (N)eutral and Load (N)eutral terminals.

##### Test:

Input configuration:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply **a** 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create an 88 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST open within 66 mS

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between application of 88 mA signal and loss of 102 VAC at Load (~).

On failure, report fault code “F5”.

End of test

## Power Up Test

##### Aim of this test:

Ensure powered breaker does not open with ground fault current applied when initially powered.

##### Test principle:

Power breaker in the ON position at 110% nominal line voltage and induce a specific current between Panel (N)eutral and Load (N)eutral terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply **a** 132 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create a 12 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST remain closed for1 second.

##### Measurement:

Presence of 132 VAC at Load (~) terminal to determine state of breaker.

Time between application of 12 mA signal and loss of 132 VAC at Load (~).

On failure, report fault code “F1”.

End of test

## Grounded Neutral Trip (To be performed on CSA CAFI ONLY)

*NOTE: To reduce additional and unwanted impedance in this circuit, it is important that the components used during this test are mounted as close to the UUT as is practically possible.*

##### Aim of this test:

Ensure impedance threshold ofgrounded neutral detection circuit which causes breaker to open

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and connect fixed resistive impedance between Load (N)eutral and Panel (N)eutral.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply **a** 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Connect ~~1~~ 0.5 Ω resistor between Panel (N)eutral and Load (N)eutral.

Breaker MUST open within **900 mS**.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between application of impedance in neutral loop and the opening of the breaker.

On failure, report fault code “F7”.

End of test

## Grounded Neutral No Trip (To be performed on CSA CAFI ONLY)

*NOTE: To reduce additional and unwanted impedance in this circuit, it is important that the components used during this test are mounted as close to the UUT as is practically possible.*

##### Aim of this test:

Ensure impedance threshold of grounded neutral detection circuit which does not cause breaker to open

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and connect fixed resistive impedance between Load (N)eutral and Panel (N)eutral.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 VAC, 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Connect 2 Ω resistor between Panel (N)eutral and Load (N)eutral.

Breaker MUST remain closed for a minimum of 900 mS.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between application of impedance in neutral loop and end of test.

End of test

## Ground Fault Threshold (unloaded)

##### Aim of this test:

Ensure ground fault current amplitude which causes breaker to open when load current is not present.

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and pass a range of ground fault currents between Load (N) and Panel (N) terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 VAC 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create a 28 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST remain closed for 500 mS.

Create a 55 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST open with 500 mS.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Load current.

On failure, report fault code “F3”.

End of test

## Ground Fault Threshold (loaded)

##### Aim of this test:

Ensure ground fault current amplitude which causes breaker to open when load current equivalent to handle rating is present.

##### Test principle:

Power breaker in the ON position at 85% nominal line voltage and pass a range of ground fault currents between Load (N) and Panel (N) terminals.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply a 102 VAC 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Create a resistive load current equal to the breaker handle rating between Load (~) and Load (N)eutral.

Create a 28 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST remain closed for 500 mS.

Create a 55 mA, 60 Hz current between Panel (N)eutral and Load (N)eutral terminal.

Breaker MUST open with 500 mS.

Remove power.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Load current.

On failure, report fault code “F4”.

End of test

## Handle Indicate

##### Aim of this test:

Clear the trip information from the microcontroller on PCBA.

##### Test principle:

With the breaker in the OFF (opened) position, depress PTT button and power breaker at 85% nominal line voltage for the duration of the test. Breaker is closed and must trip within given time. The breaker is reset (trip-open-closed) and upon closing, the breaker must trip within given time. This cycle is repeated four more times for a total trip count within given time of six. The breaker is reset once more and should not trip. This is the indication that the data has been cleared.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Ensure breaker is in the OFF (opened) position.

Depress PTT button.

Apply 102 VAC 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Place breaker in the ON (closed) position.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST open (tripped) position between 70 – 120 mS.

Reset breaker by moving handle to OFF and then to ON.

Breaker MUST not open.

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

Time between closing the breaker and loss of 102 VAC at Load (~) each time.

On failure, report fault code “F14”.

End of test

## HVI

*NOTE: The HVI power supply takes approximately 8 - 9 seconds to fully charge to the required 6kV. To reduce test time, it will be required to begin the charging process such that charging has completed by the time this test step is reached. The point at which this charging process is to commence will need to be determined during the tester program development/debug process.*

##### Aim of this test:

Surge immunity test.

##### Test principle:

Power breaker in the ON position at 100% nominal line voltage and apply 6 kVAC, 100 kHz ring wave to Line (~) and Panel (N)eutral terminals. Breaker must not display arcing or be damaged.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Using the HVI generator, apply 120 VAC 60Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Disconnect Load (~) and Load (N)eutral terminals.

Apply a 6 kVAC, 100 kHz, 30 Ω impedance ring wave at 270 degrees to Line (~) and Panel (N)eutral terminals.

Query the HVI power supply for maximum current and voltage measured during the test.

##### Measurement:

Peak current from HVI power supply 0 – 20 A.

Peak voltage from HVI power supply 5.7 kV – 6.3 kV.

Connect Load (~) and Load (N)eutral terminals.

Presence of 120 VAC at Load (~) terminal to determine state of breaker.

On failure, report fault code “F16”.

End of test

## Push

##### Aim of this test:

Ensure breaker will open when PTT button is depressed.

##### Test principle:

Power breaker at 85% nominal line voltage and depress PTT button.

##### Test:

Make connections to Line (~), Load (~), Panel (N)eutral, and Load (N)eutral terminals.

Apply **a** 102 VAC 60 Hz sine wave to Line (~) and Panel (N)eutral terminals.

Ensure breaker is in the ON (closed) position.

Depress PTT button.

Breaker MUST open within 500 mS

##### Measurement:

Presence of 102 VAC at Load (~) terminal to determine state of breaker.

On failure, report fault code “F2”.

End of test

# Maintenance

Refer to the detailed finishing line equipment specification PKR2038002

# Qualification and Acceptance

Refer to document PKR2038313 - Equipment and Tools Qualification Plan

# Miscellaneous

None

# Deliverables

## From =S=

Schneider Electric shall provide the following to the equipment supplier:

* Equipment Specification (this document)
* Qualification plan
* QO 15 Amp Plug-On-Neutral circuit breakers (quantity 50)
* QO 20 Amp Plug-On-Neutral circuit breakers (quantity 50)
* HOM 15 Amp Plug-On-Neutral circuit breakers (quantity 50)
* HOM 20 Amp Plug-On-Neutral circuit breakers (quantity 50)

Note: The exact model number for the circuit breakers listed above will be determined later in the project as we have quite a bit of leeway on exactly which models to choose. The choice may be based on available inventory and production requirements.

## From supplier

Refer to the detailed finishing line equipment specification PKR2038002.

# Glossary

=S= Schneider Electric

AFCI Arc Flash Circuit Interrupter

AFL Automated Finishing Line

CAFI Combination Arc Fault Interrupter

CSA Canadian Standards Association

DF Dual Function

GSPD **G**énérateur à **S**équence **P**rogrammable version **D**ifférentielle (FR) or **D**ifferential version **P**rogrammable **S**equence **G**enerator (EN)

HMI Human Machine Interface

HOM HOMeline

HVI High Voltage Impulse

MCB Miniature Circuit Breaker

MDC Machine Design Center

PCBA Printed Circuit Board Assembly

PLC Programmable Logic Controller

PTT Push-To-Test

QO Qwik-Open

UL Underwriters Laboratories

UUT Unit Under Test