File E351896
Project 11CA63894

MONTH DAY YEAR

REPORT

On

COMPONENT - PHOTOVOLTAIC (PV) DC ARC-FAULT DETECTOR (PV-AFD)

SANTON HOLLAND BV
Rotterdam, NL

DESCRIPTION

PRODUCT COVERED:

    US-Recognized – Photovoltaic DC Arc-Fault Detector Module (PV AFD) Cat no. ADU.

GENERAL:

    These devices have been investigated for compliance with the applicable provisions of Standard for Safety for Arc Fault Circuit Interrupters, UL 1699, Second Edition, including revisions dated February 11, 2012, and Outline of Investigation Subject 1699B, Photovoltaic (PV) DC Arc-Fault Circuit Protection, Issue Number 2, dated January 14, 2013.

    The PV DC Arc-Fault Detector (AFD) is intended to provide DC series arcing (Type 1) protection to the PV system and wiring against the unwanted effects of arcing by enabling an interruption or shorting device to interrupt power delivered to an arcing fault. The PV-AFD will only provide a signal output when it detects the presence of a series arcing event. It is intended to be integrated within a PV Inverter, combiner box, or converter that has been Listed according to UL 1741 the Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, 2nd edition, dated January 28th, 2010.

The PV DC AFD requires that the supervisory circuit be initiated either by depressing a momentary switch button for 5 Seconds. The supervisory circuit simulates an arc such that the arc detection circuit is caused to detect the simulated arc. The results of this test will be indicated visually by a flashing LED on the display. In the event of a failed supervisory test, the LED will repeatedly flash, and the output will not change state. When a series arcing fault is detected, the AFD output will change state, signalling to the end use application the presence of a detected series arcing event. The output signal will remain latched until the supervisory circuit is re-initiated. Only when it has passed the supervisory circuit test it will return back to "detection mode".

The Microcontroller and software have been evaluated in accordance with the Second Edition of ANSI/UL 1998, Software in Programmable Components, revision date October 28, 2008, as referenced by the Subject 1699B, Photovoltaic (PV) DC Arc-Fault Circuit Protection, Issue Number 2, dated January 14, 2013, and the Second Edition of UL 1699, Arc-Fault Circuit Interrupters, revision date February 11, 2012.

The PV DC Arc-Fault Detection (AFD) may be mounted on standoffs or provided with an optional din rail mounted enclosure.

Electrical Ratings Cat No ADU:

- Monitors up to 1000 VDC
- Type 1 DC Series Arc Detection only
- PV DC AFD Module
- Operating Temp –35 to 66C
- Control Input Supply 24Vdc

ENGINEERING CONSIDERATIONS (NOT FOR UL REPRESENTATIVE USE)

Use - For use only in products where the acceptability of the combination is determined by UL LLC.

Conditions of Acceptability – These PV DC AFD's cannot be Listed for the following reasons:

1-   The DC PV AFD shall be provided with a suitable enclosure that provides pollution degree 2 protection, (only non-conductive pollution exists, however a temporary conductivity caused by condensation may be expected). Additional evaluation may be required if used in environments other than the above.

2-   The DC PV AFD shall be used within its recognized ratings.

3-   These devices are intended for factory wiring only with the suitability of the connections (including spacings of the factory wiring connectors) determined in the end use application.

4-   The DC PV AFD module is intend for use in products that will be permanently installed. These devices shall be mounted in the intended manner in an enclosure or application having adequate strength and thickness with acceptable spacings being provided.

5-   The need for the following tests shall be considered with the DC PV AFD installed within the end product enclosure:

          UL 1699   Section 56 Crush Test
          UL 1699   Section 53 Strain Relief
          UL 1699   Section 55 Mechanical Test

6-   The DC PV AFD module alone was subjected to UL 1699B Section 21 Corrosion test with the PWB coated with conformal coating. The need for a corrosion test shall be considered when integrated within an inverter, converter, charge controller with integral DC PV Arc Fault Detection Module.

7-   The DC PVAFD PWB requires a rated 24V DC control power supply to be provided by the end product. The DC PV AFD Module was tested and meets requirements with a control supply operating range of 21.6 VDC to 26.4VDC. If an unregulated power supply is used in the end use arc detection shall be verified at 90%, 100%, and 110% of rated supply limits.

ENGINEERING CONSIDERATIONS (NOT FOR UL REPRESENTATIVE USE)

Use - For use only in products where the acceptability of the combination
is determined by UL LLC.

Conditions of Acceptability Continued – These PV DC AFD's cannot be Listed
for the following reasons:

8-   The DC PVAFD Module has been tested and complies with the required
      clearing time per table 23.2 of Subject 1699B with no interrupting
      means provided.

      The Unwanted Tripping test and the Operation Inhibition test (Masking
      test) was not conducted as part of the detector evaluation and will
      need to be conducted when incorporated in the end product system.

      The following tests shall be conducted in combination with the
      disconnecting means in the end product as a system mounted as
      intended: (Note: Also applies to solid state disconnects)

              UL 1699 Section 36 Humidity
              UL 1699 Section 37 Leakage #
              UL 1699 Section 38 Voltage Surge (AC Side) Ring-Combo
              SU 1699B Section 16 Arc Fault Detection
                            (25C, 66C, -35C, and repeated 25C) followed
                      by
              SU 1699B Section 22 Dielectric Withstand Test

              UL 1699 Section 45 Temperature test (Disconnect)

              UL 1699 Section 46 Overvoltage #
              SU 1699B Section 18 Overload
              SU 1699B Section 18 Endurance followed by
              SU 1699B Section 22 Dielectric Withstand Test

              SU 1699B Section 24 Unwanted Tripping
              SU 1699B Section 25 Inhibition
              UL 1699 Section 49 Abnormal Operations
              SU 1699B Section 20 Short Circuit followed by
              SU 1699B Section 22 Dielectric Withstand Test

              UL 1699 Section 17 – Resistance to Environmental Noise
              (Note: See Consideration of Acceptability item 8)
                    UL 1699 Section 44.2 ElectroStatic Discharge
                    UL 1699 Section 44.3 Radiated EMI
                    UL 1699 Section 44.4 Fast Transients #
                    UL 1699 Section 44.5 Voltage Surge #
                    UL 1699 Section 44.6 Induced RF fields
                    UL 1699 Section 44.7 Voltage Dips#
                    Followed by Su 1699B Section 16 Arc Fault Detection

              UL 1699 Section 46 Overvoltage #
              UL 1699 Section 50 Surge Current #
              UL 1699 Section 51 Abnormal Overvoltage (High and Limited) #

              # Note: only applicable to devices with power supplies deriving
              power from utility power.

ENGINEERING CONSIDERATIONS (NOT FOR UL REPRESENTATIVE USE)

Use - For use only in products where the acceptability of the combination is determined by UL LLC.

Conditions of Acceptability Continued – These PV DC AFD's cannot be Listed for the following reasons:

9-   If the DC PVAFD module is used in combination with a solid state interrupting means, the end product interrupting components shall be evaluated per Section 32, Electronic Interruption, of Subject UL 1699B

10-   The DC PVAFD was tested and evaluated per Part II of UL 1699B as a PVAFD Module. When the DC PVAFD module is utilized in an inverter, converter, and charge controller that has been listed per UL 1741, the combination is required to meet the construction and performance requirements per Part III of UL 1699B.

11-   The DC PVAFD has been evaluated for Type 1 DC Series Arc Detection only.

12-   An investigation of the safety-related software was conducted in accordance with UL's Standard for Software in Programmable Components, ANSI/UL 1998, dated May 29, 1998 with revisions dated October 28, 2008 based on the guidelines of Software Class 1 as referenced by the Subject 1699B, Photovoltaic (PV) DC Arc-Fault Circuit Protection, Issue Number 2, dated January 14, 2013, and the Second Edition of UL 1699, Arc-Fault Circuit Interrupters, revision date February 11, 2012.

ENGINEERING CONSIDERATIONS (NOT FOR UL REPRESENTATIVE USE)

Use - For use only in products where the acceptability of the combination
is determined by UL LLC.

Conditions of Acceptability Continued – These PV DC AFD's cannot be Listed
for the following reasons:

13- The PV DC AFD has an integrated supervisory circuit. The supervisory
     circuit simulates an arc such that the arc detection circuit is
     caused to detect the simulated arc. If incorporated into an inverter,
     converter or charge controller, the combination is required to meet
     additional requirements described in UL 1699B, Part III Section 31.
     The end product shall operate and monitor the proper operation of the
     supervisory circuit.

     The supervisory circuit can be operated by two methods as follows:

     1- The supervisory circuit can be initiated manually by depressing the
        momentary switch button for 5 Seconds or
     2- The supervisory circuit can be triggered by a "hard" reset.
        (initial power up)

     A successful passing result of the supervisory circuit will be
     indicated and required to be monitored by the end product application
     by two methods:

     1- Visually by a flashing LED on the PWBA and/or
     2- Monitoring the output terminal for feedback by state change, at
        Connector J2, Pin 2 or Pin 3.

     In an event of a failed supervisory test check, the LED will
     repeatedly flash, and the output will not change state.

     This requires that the end product application to monitor the results
     of supervisory check and only allow export of power if supervisory
     circuit results yield passing results.

14- In the event the AFD detects a series arcing fault the AFD output will
     change state, signalling to the end use application the presence of a
     detected series arcing event. The output signal will remain latched
     in the "tripped" indication output state until the supervisory circuit
     is re-initiated (reset). This requires that the end product
     application to reinitiate the supervisory circuit by the means
     described in item 13 above. When the detection circuitry has passed
     the supervisory circuit test, it will return back to "detection mode"
     and the end product shall be permitted to export power.

15- End product shall be marked as required per page 7 of this report.