

Assessment of Solar PV Connector Temperature Under Load

The operating temperature of a range of commercially available DC connectors, together representing a majority of the market, was assessed under standard test conditions while enclosed in the ArcBox and found in all cases to remain within manufacturers' recommended temperature limits.

1.0 The Aim of the Study

The goal of the study was to confirm that the ArcBox DC connector enclosure does not impact on the functionality and durability of commercially available DC solar connectors.

Connectors were tested based on the Temperature Rise requirements of IEC 62852 and IEC 60512-5-1 under the manufacturers' maximum rated operating conditions to assess whether the connectors remained within their rated operating temperature range when used in combination with the ArcBox.

The test was conducted independently by the University of Loughborough CREST PV Measurement and Calibration Laboratory using connector manufacturer's guidelines.

2.0 Test Method

2.1 Sample Preparation

Eight models of DC connector from five manufactures were tested with and without ArcBox and for all cable sizes for which the connector has a stated compatibility.

Male and female solar DC connectors were attached to lengths of EN50618-compliant PV cable, using manufacturer's specialist tools and following manufacturer's instructions. The connector pairs were mated together and thermocouple temperature probes of minimal thermal mass were attached to the outside face as shown in Figure 1.

For those tests with the ArcBox installed, the DC connector was placed inside the ArcBox which is mounted in the test chamber on an ARC-BM-25 bracket.



Figure 1. Thermocouple mounted on DC connector surface

2.2 Test Procedure

Tests were conducted following the IEC standards 62852 and 60512-5-1, Test 5a - determination of temperature rise under normal operation.

Samples were suspended inside an environmental chamber set to an 85°C ambient temperature.

A programmable DC power supply in current control mode, passes a current through the connector set to the connector manufacturer's maximum rated current for the connector. (The maximum current rating varies between different makes and models and cable cross sectional area, see table 1).

The temperature of the connector pair is monitored over time by the temperature probe and used to determine a stabilised temperature after a period of continuous operation.



Figure 2 - ArcBox with DC Connector and thermocouple before closing

Thermocouples were verified by cross-calibration over a heat-up and cool-down cycle for the chamber without test sample (approximately 1.5 hours duration), demonstrating sensor comparability, see figure 3.

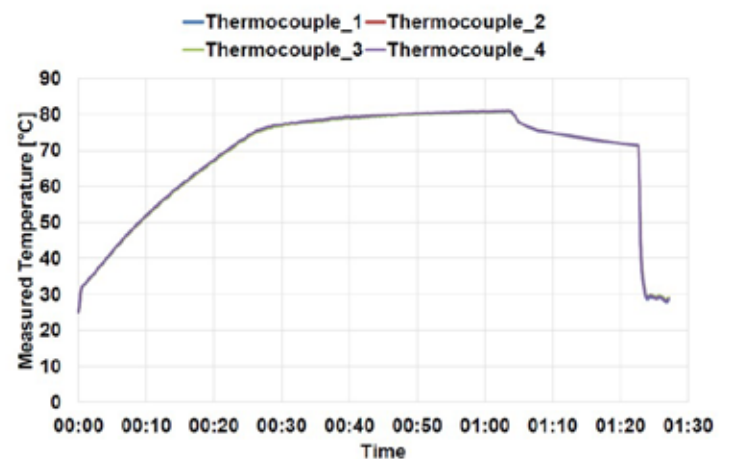


Figure 3: Thermocouple cross-calibration check

For each sample tested:

The thermocouple was checked for good contact to the mated connector pair. The sample was then mounted in the environmental chamber which was set to 85°C. After a sufficient time to achieve a stable temperature, current injection into the connector commenced. Once the connector temperature has stabilised again under conditions of current injection, its temperature was monitored for a duration of one hour.

Temperature data was recorded throughout, and Figure 4 shows a typical, ~4-hour profile from the thermocouples measuring the chamber ambient and connector surface temperatures (and the test fail threshold).

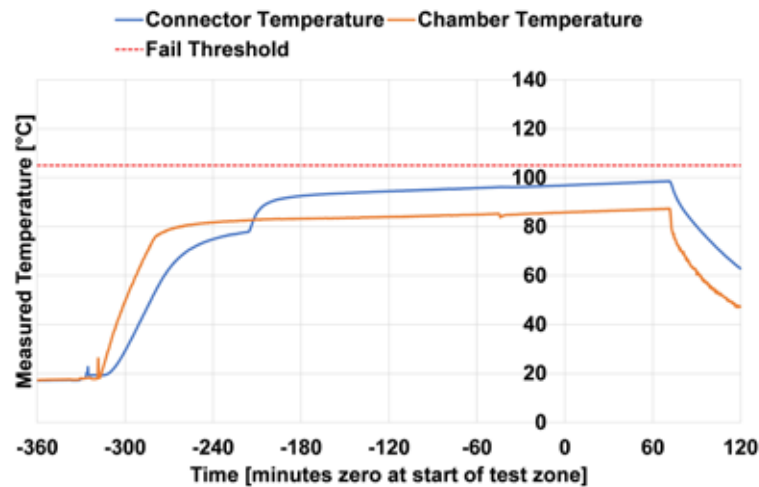


Figure 4 - Temperature data from one sample

Manufacturer	Connector Model	Conductor Area (mm ²)	Max. Current (A)	Temperature Limit (°C)	Temperature without ArcBox (°C)	Temperature with ArcBox (°C)
Elkay	EMPV4N	4	45	110	94.2 ✓	103.9 ✓
	EMPV4N	6	54	110	93.7 ✓	102.2 ✓
Heangdra Electrical Co.	PV-ST01	4	30	100	87.9 ✓	91.8 ✓
	PV-ST02	4	40	110	91.9 ✓	98.2 ✓
	PV-ST03	4	30	100	90.1 ✓	92.5 ✓
	PV-ST01	6	30	100	87.4 ✓	90.0 ✓
	PV-ST02	6	50	110	95.0 ✓	101.1 ✓
Leader Technology	PV-BN101A	4	30	100	90.9 ✓	92.7 ✓
Staubli	MC4	4	39	105	91.9 ✓	98.6 ✓
	MC4-Evo2	4	45	115	91.5 ✓	98.9 ✓
	MC4	6	39	105	89.9 ✓	94.5 ✓
	MC4-Evo2	6	53	115	93.2 ✓	100.2 ✓
Tongling	TL-CABLE01	4	30	100	89.8 ✓	92.8 ✓

Table 1. Summary of Results

3.0 Results

Test results are shown in Table 1, below.

All the connectors tested in this evaluation passed the IEC standard temperature rise tests at their respective maximum ambient operating temperature and electrical current (worst-case stress scenario).

The ArcBox does not cause the connector temperatures to rise above the upper limit as set by the respective manufacturers and connectors can operate safely inside the ArcBox without any requirement to derate the current.