Test Report

Report No:	TP01-2107001-2
Sample Description:	35kV Class Small Interface Connector
Date of Issue:	2024/03/05

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Approved by:

Doris Hsieh

Chardon Taiwan Laboratory Test Report

Chardon Taiwan Test Lab adhere to the highest laboratory ISO 17025 management standards.

INTRODUCTION

The Chardon 35kV Class Small Interface System is a fully shielded and insulated connector for connecting underground cable to transformers, switchgear, and other apparatus equipped with deadbreak bushings, junctions, or other deadbreak connectors.

The Chardon 35kV Class Small Interface Connector meets all the requirements of IEEE Standard 386, and is fully interchangeable with competitor's products and mating products that also meet IEEE Standard 386.

TEST PROGRAM

i. Object

To verify the Chardon Power Systems 35kV Class Small Interface connector that the parts meet ANSI/IEEE Standard 386-2016.

ii. Procedure

Design tests were performed on the number of samples as specified in Table 8 of IEEE Standard 386-2016. The 35kV Class Small Interface Connector parts were randomly selected from finished goods inventory and dimensionally checked to ensure that the interfaces were in compliance with the applicable figures of IEEE Standard 386-2016.

iii. Product List

The 35kV Class Small Interface Connector System consists of the products listed below:

1.	35-LE200	35 kV 200A Loadbreak Elbow
2.	35-LBI200	35 kV 200A Loadbreak Bushing Insert
3.	35-LIC200	35 kV 200A Loadbreak Protective Cap
4.	35-SOB200	35 kV 200A Insulated Stanfoff Bushing
5.	35-LJ200	35 kV 200A Loadbreak Junction
6.	35-ETP600	35 kV 600A Elbow Tap Plug
7.	35-LPFT200	35 kV 200A Loadbreak Portable Feed Thru
8.	35-LFTI200	35 kV 200A Loadbreak Feed-Thru Insert
9.	35-LFE200	35 kV 200A Loadbreak Fuse Elbow

iv. Other

Test Type:	Type Test
Date of Receipt:	2021/02/18
Date of Test:	2021/02/18 ~ 2024/03/1
Compliance:	ANSI/IEEE Standard 386-2016
Client:	Chardon Taiwan Sales & Customer Service Department
Address:	No. 37 Min-Chie Road Tung Lo Industrial Park Miao Li, Taiwan 366
Manufacturer:	Chardon Taiwan Group
Address:	No. 37 Min-Chie Road Tung Lo Industrial Park Miao Li, Taiwan 366
Test Laboratory:	Chardon Taiwan Test Laboratory
Address:	No. 37 Min-Chie Road Tung Lo Industrial Park Miao Li, Taiwan 366

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1. Sequence A: Partial Discharge Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.4, 35kV partial discharge requirement of 26kV/5pC.

Procedure and Testing Spec

The purpose of this test is to verify that the partial discharge minimum extinction voltage of the specimen is not less than of the 26kV.

The test voltage shall be raised to 20% above the partial discharge minimum extinction voltage of 26kV. If the partial discharge peak value exceeds 5pC, the test voltage shall be lower to the partial discharge minimum extinction voltage of 26kV and be maintained at this level for at least 3 seconds but not more than 60 seconds. Partial discharge readings taken during the interval 3 seconds to 60 seconds shall not exceed 5pC peak.

Results

The products tested were 1-9 of the Product List on page 1.

For all ten samples of each product tested the corona level was less than 5pC at the specified minimum corona extinction voltage level of 26kV rms.

2. Sequence A: AC Withstand Voltage Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.5.1, 35kV AC withstand requirement of 50kV/ 1 min.

Procedure and Testing Spec

The test voltage shall be raised to the value of 50kV in 30 seconds. The test sample shall withstand the specified test voltage for 1 minute without flashover or puncture.

Results

The products tested were 1-9 of the Product List on page 1.

All samples of each product withstood a 50kV rms, 60Hz ac one minute voltage withstand without a puncture or flashover.

3. Sequence A: Impulse Withstand Voltage

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.5.3, impulse withstand testing requirements of 1.2×50µs ±150kV wave., 3 positive and 3 negative full-wave impulses.

Procedure and Testing Spec

The test voltage shall be 1.2/50µs wave having the crest value (BIL) of 150kV. The wave shape shall meet the requirements of IEEE Std 4.

Prior to application of the first full-wave impulse, preconditioning pulses at 50% and then at 75% of the BIL. During a change of polarity, the preconditioning pulse sequence may again be applied.

The connector shall withstand 3 positive and 3 negative full-wave impulses without flashover or puncture.

Results

The products tested were 1-9 of the Product List on page 1.

All samples of each product withstood three positive and three negative full wave impulses with 150kV crests without a puncture or flashover.

4. Sequence A: Test Point Capacitance Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.17.1, test point testing requirement.

Procedure and Testing Spec

The purpose of this test is to verify that the capacitance values of the test point meet the requirements of 6.5.1 in IEEE Std 386.

The connector shall be installed on a cable of the type for which it is designed to operate, and the shielding shall be grounded in the normal manner. The capacitances from test point to cable and test point to ground shall be measured with suitable instruments and proper shielding techniques.

The capacitance between the test point and conductor system shall be at least 1.0pF. The ratio of the capacitance between test point and ground shield to the capacitance between the test point and conductor system shall not exceed 12.0.

Results

The product tested were 1, 9 of the Product List on page 1.

The test point capacitance test verified that the capacitance between the test point and conductor was at least 1.0 pF for each of the ten elbow samples. The ratio of capacitance between test point and ground shield to the capacitance between the test point and the conductor system did not exceed 12.0 for each of the ten elbow samples.

5. Sequence A: Test Point Voltage Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.17.2, test point testing requirement.

Procedure and Testing Spec

The purpose of this is to verify proper operation of the test point.

The connector shall be installed on a cable of the type for which it is designed to operate, and the shielding shall be grounded in the normal manner. With a test elbow latched to the insert, a voltage of 21±2 kV was applied.

Results

The product tested were 1, 9 of the Product List on page 1.

An energized voltage condition was detected on the test points of all ten elbows at an applied voltage of 21±2 kV.

6. Sequence B: Accelerated Sealing Life Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.12, accelerated sealing life testing requirement.

Procedure and Testing Spec

Four samples shall be assembled in series on 750kcmil XLPE insulated cable.

The cable shall be compatible with the thermal conditions of this test. A mandrel simulating the test cable may be substituted during the oven aging portion of this test.

The four connector assemblies shall be placed in an oven having 121°C temperature and remain there for three weeks. After this time has elapsed, the four samples shall be removed from the oven and each operated once by using the operating eye or an appropriate location on the axis of the separable interface.

The four connector assemblies shall then be subjected to 50 cycles of the following sequence of operations:

a) The assemblies shall be heated in air using sufficient current to raise the temperature of the conductor of the control cable to 90°C ± 5°C for the following time period:

2) 600 A and 900 A connectors: 4 h

b) The assemblies shall be de-energized and within 3 min, submerged in 25°C ± 10°C conductive water (5000 Ω-cm maximum) to a depth of 30 cm (1 ft) for the following time periods:

2) 600 A and 900 A connectors: 2 h

After the 50th cycle, the connector and cable assembly shall withstand a design impulse test (see 7.5.3).

The test point, if provided, shall be capable of passing the voltage test specified in 7.17.2.

Results

The products tested were 1, 2, 5-9 of the Product List on page 1.

Following the 50 accelerated sealing life test cycles, all four assemblies withstood three positive and three negative full wave impulses having 150kV crest values, without a puncture or flashover.

After the impulse test, the elbow test point of each assembly indicated an energized condition with an applied voltage of 21±2 kV.

7. Sequence C: Switching and Fault-closure

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.7 switching test & 7.8 fault-closure test.

Procedure and Testing Spec

Test all samples in accordance with IEEE Standard 386-2016 sections 7.7 “Switching Test” under the conditions described in Tables 10 and 11, Figure 28(a) of the standard. Each sample is subjected to 10 complete switching operations at 21.1/36.6 kV, 200A using a mechanical fixture.

Test all samples that successfully passed 10 switching operations in accordance with IEEE Standard 386-2016 sections 7.8 “Fault-closure Test” under the conditions described in Table 11 and 12, Figure 29(a) of the standard. Each sample is subjected to 1 fault-close operation.

Results

The products tested were 1, 2 of the Product List on page 1.

Switching passed; Fault-closure passed. Testing performed at Powertech Labs Inc, Surrey BC Canada.

Powertech Report № PL-02179 REP1

Powertech

REPORT OF PERFORMANCE

CLIENT	Chardon Taiwan Corporation No. 37 Min-Chie Road Tung Lo Industrial Park
MANUFACTURER	Chardon Taiwan Corporation
TEST OBJECTS	Chardon 200 A/35 kV Class Loadbreak Bushing Insert Chardon 200 A/35 kV Class Loadbreak Elbow
TESTED BY	Powertech Labs Inc. 12388 - 88th Ave, Surrey, BC Canada V3W 7R7 www.powertechlabs.com
TEST DATE(S)	2018-07-23 to 2018-07-26
TEST SPECIFICATION	IEEE 386-2016, Clause 7.7 and 7.8

Prepared by:

2018-11-22

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA Q. LI #42871

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Senior Engineer, High Power Lab
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Reviewed by:

2018-11-22

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA C. P. MORTON # 20747

C. Morton, P. Eng.
Specialist Engineer, High Power Lab
Powertech Labs Inc.

8. Individual tests: Short-time Current Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.6, short-time current testing requirement.

Procedure and Testing Spec

The peak value of the first major loop of a current wave shall be not less than the value specified in Table 4 multiplied by 2.63 (X/R=20) for 600 A connectors. The magnitude shall be measured in accordance with ANSI/IEEE C37.09.

Connectors shall withstand the current without separation of interfaces or impairing the ability to meet the other requirements of the standard.

Results

The products tested were 1, 2, 5-9 of the Product List on page 1.

All samples of each product withstood short-time currents with magnitudes and durations of 10,000 amperes symmetrical for 3 seconds and 25,000 amperes symmetrical for 0.17 seconds (10 cycles) without any separation of the interfaces or impairing the connector's ability to meet the other requirements of IEEE Standard 386-2016.

9. Individual tests: Current-cycling Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.11, current-cycling test for uninsulated components of 600 A and 900A connectors.

Procedure and Testing Spec

A control cable, used for the purpose of obtaining conductor temperature, shall be installed in the current cycling loop between two equalizers. Its length shall be 183 cm (72 in). The control cable shall be the same type as the cable used to join the connectors under test.

Four samples shall be assembled in series on 750kcmil XLPE insulated cable having a length of 91 cm (36 in). The cable insulation thickness shall be selected according to its voltage class.

Current-cycling tests shall be conducted at an ambient temperature of 15°C to 35°C in a space free of drafts.

The current-cycle amperes shall be adjusted to result in a steady-state temperature of 90 °C ± 5 °C on the surface of the conductor of the control cable. The temperature shall be measured at the approximate center of the control cable.

The test shall consist of 50 current cycles, with the current on 6 h and off 6 h for each cycle. The temperature of the hottest spot of the connector shall be measured every ten cycles and shall not exceed the temperature of the conductor of the control cable.

Results

The products tested were 1, 2, 5-9 of the Product List on page 1.

The temperatures at each transfer point did not exceed the temperature of the control conductor during the test.

10. Individual tests: Test Point Cap Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 386-2016, Section 7.16, test point cap testing requirement.

Procedure and Testing Spec

A tensile force shall be gradually applied to the test point cap in the direction parallel with the probe axis at −20°C, +25°C, and +65°C.

A tensile force of 445 N (100 lbf) shall be applied to the test point cap operating eye for 1 min at −20°C, +25°C, and +65°C.

Some distortion of the operating eye is acceptable provided the test point cap is serviceable after the test.

Results

The product tested were 1, 9 of the Product List on page 1.

The test point cap operating force of each sample was within the specified requirements of 8 to 49 pounds-force at each temperature of -20°C, +25°C and +65°C.

The test point cap operating eye of each sample withstood the applied tensile force of 100 pounds-force at each temperature of -20°C, +25°C and +65°C.

11. Individual tests: Shielding Test

Object

To verify the Chardon 35kV Class Small Interface Systems connectors that the parts meet ANSI/IEEE Standard 592-2007, Section 4, shielding resistance & fault-current requirement.

Procedure and Testing Spec

Connectors shall have an electrically conductive shield and, where required, shall have provision for connecting an external ground to the shield. Except for nonelastomeric components, connectors shall meet the requirements of IEEE Std 592.

IEEE Std 592 4.2 Shield resistance test:

The resistance of the semiconducting shield shall be measured using the voltmeter-ammeter method, with either an AC or DC current supply. The current connections shall be as follows:

- For a separable insulated connector, the current connections shall be made on the shield at the cable entrance and at the farthest shield extremity, using a circumferential connection at both locations to give a uniform current distribution.
- For a joint, the current connections shall be made on the shield at the cable entrance and at the physical center of the shield, using a circumferential connection at both points to give a uniform current distribution.

The voltage shall be measured with the current adjusted to 1.0 mA ± 0.2 mA.

- Resistance measurements shall be made on test specimens that have had the following histories:

  a) Unaged
  b) Air oven aged for 504 h at 121°C ± 5°C

- Resistance measurements shall be made with the test specimen temperature at 20°C ± 5°C and at 90°C ± 5°C.

IEEE Std 592 4.2 Fault-current initiation test:

1) The test specimen used in 4.2 shall be assembled onto the cable(s) in conformance with the manufacturer's instructions, with the exception that the metallic cable shield shall be extended over the accessory shield (see Figure 1 and Figure 2).

2) The fault rod shall be of an erosion resistant metal, such as copper-tungsten, 318-in in diameter, and threaded at one end to engage the accessory connector through a drilled hole not to exceed 3/8-in in diameter (see Figure 1 and Figure 2). The rod shall be flush with the shield surface as shown in Figure 1 and Figure 2.

3) The fault rod placement and the attitude of the accessory during the fault initiation test shall be as shown in Figure 1 and Figure 2. For separable insulated connectors, the rod shall be as close to the shield extremity as practicable. For joints, the rod shall be in the physical center of the connector.

4) The voltage source shall be connected between specimen neutral ground and cable conductor. The test voltage shall be as specified in Table 1. With an available short circuit current of 10 000 A nns symmetrical, the test specimen shall be subjected to two tests that cause initiation of a fault-current arc to ground. Each operation shall have a minimum current flow duration of 10 cycles at the normal power frequency used. After energizing the test circuit, the fault initiation must occur within 3 s. The second test shall be initiated in the shortest practical time. The test specimen must not be disturbed between operations.

Results

The product tested were 1 of the Product List on page 1.

The shield resistance measurements between the extremities of the elbow were all less than the maximum allowable 5000 ohms.

Shielding passed. Testing performed at Powertech Labs Inc, Surrey BC Canada.

Chardon – Powertech Report № PL-26365

Powertech Labs Inc. • 12388 - 88th Avenue, Surrey, B.C. Canada • V3W 7R7

Test Report № PL-26365

The tests were performed in accordance with
IEEE Standard 592-2007, section 4.3

Project №:	PL-26365	**Test Date:**	15 June 2017
Tested equipment:	Two Separable Insulated Connectors (SIC's) manufactured by Chardon Taiwan Corporation, prefaulted in accordance with IEEE Standard 592-2007, Figure 1. The samples were numbered by the client.		
Voltage rating:	21.1 $kV_{phase\text{-}to\text{-}ground}$		
Test voltage:	12.5 $kV_{phase\text{-}to\text{-}ground}$		
Test current:	10 kA_{rms} prospective		
Tests performed:	Fault-Current Initiation Tests per Section 4.3. Each sample was subjected to two current pulses at a prospective current of 10 kA_{rms} for 10 cycles.		
Test winesses:	Luke Yang Jack Tseng Shun Huang	Chardon Taiwan Corporation Chardon Taiwan Corporation Chardon Taiwan Corporation	
Test results:	All tested samples passed the tests.		
Remarks:	The samples were provided and identified by the client. The samples were supplied already prefaulted.		

Tested by:

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA Q. LI #42871

2017-08-25

Qian (Eric) Li, Ph.D., P. Eng.
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Reviewed by:

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2017-08-25

C. Morton, P. Eng.
Specialist Engineer, High Power Lab

12. Individual tests: Operating interface ac withstand test

Object

To verify the connectors that the parts meet ANSI/IEEE standard 386-2016 35kV Operating interface AC withstand requirements.

Procedure and Testing Spec

The purpose of this test is to demonstrate that loadbreak and livebreak separable connectors or devices are capable of performing an opening operation under expected field conditions without a flashover to ground. All separable connectors or devices, designed to be operated while energized shall pass the requirements of this test. The connector component designed to prevent partial vacuum flashovers shall also demonstrate the ability to meet the requirements of this test when tested with mating components from other manufacturers where applicable.

If necessary, operating interfaces under test can be cleaned with a laboratory grade of isopropyl alcohol (2-pro-penal). After cleaning, the samples shall dry for a minimum of 15 min before assembly to allow the cleaning solvent to evaporate from the interface.

Further preparation of the samples shall follow Option A or Option B as follows:

Option A: The operating interfaces shall be free of any lubrication. Twelve separable connectors or devices to be evaluated should have test cable installed where appropriate and be assembled onto 12 mating connectors or components at an ambient temperature of 25 °C ±5 °C.

After Option A or Option B, chill the connector assemblies in a cold chamber at -20 °C to -25 °C for a minimum of 16 h. Remove one connector assembly at a time from the cold chamber and mount the assembly to a grounded test stand. Attach ground leads to the external shields of the connector. Adjacent grounds are not required. This conditioning may be performed at -1 °C to +4 °C for any connector or device that is to be mated for less than 24 h in any field applications, such as direct-test probes.

Separate the connector or device assembly from the bushing within 10 min after removal from the cold chamber. The opening operation shall be performed with a positive continuous motion applied manually or by a mechanical actuator with an average operating speed during the initial 2.5 cm (1.0 in) of travel of 89 cm/s ±13 cm/s (35 in/s ±5 in/s). The force shall be applied to the operating eye of the connector using a suitable live-line tool or equivalent device.

Results

The product tested were 1, 2 of the Product List on page 1.

All samples of each product withstood Operating interface ac withstand test, without any separation of the interfaces or impairing the connector’s ability to meet the other requirements of IEEE Standard 386-2016.