Date
2017-June-14
Dealt with by, telephone
Anders Ahlström, +46 240 7834 56
E-mail
anders.ahlstrom@se.abb.com
Fax
+46 240 78 38 91
Our ref.
17BG365611
Project
CEZ Razpredelenie Bulgaria AD tender for replacement and modernization of 110kV cable line "Dragalevtzi" in Sofia

CERTIFICATE OF CONFORMITY WITH STANDARDS AND ORIGIN

To Whom it May Concern,

We ABB AB, Ludvika, Sweden, hereby declare under our sole responsibility, that all our surge arresters type PEXLIM P096-XV123 are designed, manufactured and tested in accordance and in compliance with the following standards, directives or other normative documents:

Directive: EMC directive 2004/108/EC

Applied EC IEC 60099-4, Surge arresters – Part 4 – Metal oxide Harmonized surge arresters without gaps for a.c. systems.

ANSI/IEEE C62.11 and the requirements laid down in our proposal for the above mentioned project.

The equipment is manufactured in our factory ABB in Ludvika, Sweden.

The Process of Engineering, Manufacturing and Testing of the mentioned goods will be accomplished according to our Quality and Management Systems as certified by ISO 9001/ISO 14001.

This has been issued for any purpose it may serve.

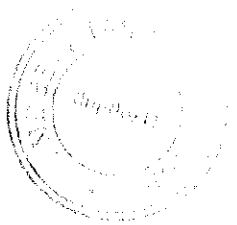
Yours faithfully,

Anders Ahlström
Area Marketing Manager
ABB AB
High Voltage Products

ДЗЗД „ЕИК ДРАГАЛЕВЦИ" Пловдив

ВЯРНО С ОРИГИНАЛА ИНТЕРКОМПЛЕКС ПЛОВДИВ ООД

996



Превод от английски език, извършен от Даниела Кирилова Тодорова:

ДЕКЛАРАЦИЯ ЗА СЕ СЪОТВЕТСТВИЕ

Реф. №.:

Ние, **КАБЕЛОВНА Дечин Подмокли, с.р.о.**
ул. Устечка 840/33, 405 33 Дечин, Чешка Република

декларираме, че
продукт: **Кабели с оптични влакна за закрит и открит монтаж с буфер**

тип: **съгласно приложението**
производител: **КАБЕЛОВНА Дечин Подмокли, с.р.о.**
ул. Устечка 840/33, 405 33 Дечин, Чешка Република

за които се отнася настоящата декларация за съответствие, е в съответствие със следните стандарти:

Чешки Стандарти	Европейски Стандарти
ČSN EN 50266-1:2001, ČSN EN 50266-2-2:2001, ČSN EN 50267-1:1999, ČSN EN 50267-2-2:1999, ČSN EN 50267-2-3:1999, ČSN EN 61034-1.2006, ČSN EN 61034-2:2006, Изпитани в съответствие с ТП-ОК-КДП-10/003	EN 50266-1:2001, EN 50266-2-2:2001, EN 50267-1:1998, EN 50267-2-2:1998, EN 50267-2-3:1998, EN 61034-1:2005, EN 61034-2:2005, Изпитани в съответствие с ТП-ОК-КДП-10/003

съгласно разпоредбите на Директива

NV 17/2003 Sb, и измененията.	2006/95/EC с измененията

Допълнителна информация:
Сертификат № 1100844 от
2.12.2010 г.
и Протокол от типови изпитания № 003477-01/02 от 25.11.2010 г.
издаден от: Електротехнички згушебни устав, с.п.
ул. Под Лисем 129; 171 02 Прага 8 – Троя, Чешка Република

Последните две цифри на годината на СЕ маркировката:

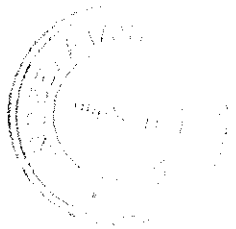
Място на издаване: Дечин

Представляващ Производителя: [*подпис – не се чете*]

Дата на издаване: 15.12.2010 г.

Длъжност: Ръководител Технология

997

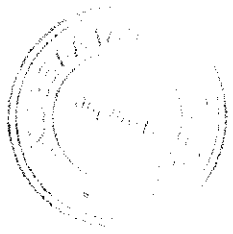


Кабели с оптични влакна за закрит и открит монтаж с буфер

J/A -	Кабел за закрит и открит монтаж
J –	Кабел за закрит монтаж
V -	Плътно фиксирани влакна
Q –	Водоблокиращ материал в ядрото на кабела
(ZN) -	Неметален твърд елемент под обвивката
(BN) -	Неметален твърд елемент под обвивката с подсилена защита срещу гризачи
H -	Безхалогенна обвивка
B -	Армировка
(RO, 63vzk)-	Диаметър на армиращата жица
(SR) -	Армировка от гофрирана стоманена лента
WBF -	Подсилено стъклено омрежение – стандартна защита срещу гризачи (без WBF - усилено арамидно омрежение)

ДЗЗД „ЕИК ДРАГАЛЕВ ДУО" Пловдив

998



CE CONFORMITY DECLARATION

Ref. No.:

We, **KABELOVNA Děčín Podmokly, s. r. o.**
Ústecká 840/33, 405 33 Děčín, Czech Republic

declare under our sole responsibility that

the product: **Fibre Optic cables for indoor and outdoor use with a tight buffer**

type: **see enclosure**

manufacturer: **KABELOVNA Děčín - Podmokly, s. r. o.**
Ústecká ul. 33, 405 33 Děčín, Czech Republic

to which this declaration relates is in conformity with the following standards:

Czech Standards	European Standards
ČSN EN 50266-1:2001, ČSN EN 50266-2-2:2001, ČSN EN 50267-1:1999, ČSN EN 50267-2-2:1999, ČSN EN 50267-2-3:1999, ČSN EN 61034-1.2006, ČSN EN 61034-2:2006, tested according to TP-OK-KDP-10/003	EN 50266-1:2001 EN 50266-2-2:2001 EN 50267-1:1998 EN 50267-2-2:1998 EN 50267-2-3:1998 EN 61034-1:2005 EN 61034-2:2005 tested according to TP-OK-KDP-10/003

following the provisions of Directive:

NV 17/2003 Sb. including amendments	2006/95/EC including amendments

Complementary information:
certificate No.: 1100844 of 2.12.2010
and Test report No.: 003477-01/02 of 25.11.2010
issued by Elektrotechnický zkušební ústav, s.p.
Pod Lisem 129; 171 02 Praha 8 - Troja, Czech Republic

„ЕИК ДРАГАЛЕВЦИ" Пловдив

The last two digits of the year in which the CE marking was affixed:

Place of issue: Děčín

Manufacturer representative:
Ing. František CEMPÍREK

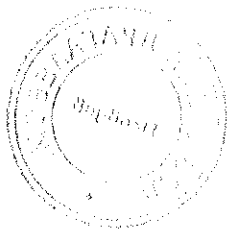
Date of issue: 15.12.2010

Position: Head of Technology

KABELOVNA Děčín Podmokly, s.r.o.
Ústecká 33, Děčín V, 405 33
IČ: 26759993, DIČ: CZ26759993

ВЯРНО С ОРИГИНАЛА

999



Enclosure to CE Conformity Declaration

Fibre Optic cables for indoor and outdoor use with a tight buffer

J/A - Cable for indoor and outdoor use

J - Cable for indoor use

V - Tight buffered fibre

Q - Dry water blocking material in cable core

(ZN) - Non-metallic strength member under sheath

(BN) - Non-metallic strength member under sheath with improved rodent protection

H - Halogen free jacket

B – Armouring

(R0,63vzk) - Diameter of the armouring wire

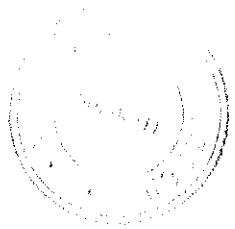
(SR) - Corrugated steel tape armouring

WBF - Strength member glass yarns - standard rodent protection (without WBF - strength member Aramid yarns)

ДЗЗД „ЕИК ДРАГАЛЕВ" Пловдив

ВЯРНО С ОРИГИНАЛА

1000



Превод от руски език, извършен от Даниела Кирилова Тодорова:

СИСТЕМА СЕРТИФИКАЦИЯ ГОСТ Р

ФЕДЕРАЛНА АГЕНЦИЯ ПО ТЕХНИЧЕСКИ КОНТРОЛ И МЕТРОЛОГИЯ

СЕРТИФИКАТ ЗА СЪОТВЕТСТВИЕ

[лого-не се чете] № РОСС RU. АГ42.Н00316

Срок на валидност: от 08.06.2016 г. **до** 07.06.2019 г.

№ 1924902

СЕРТИФИЦИРАЩ ОРГАН на продукция Дружество ограничена отговорност „Център научни изследвания, изпитания и сертификации". Адрес: 115191, Русия, гр. Москва, ул. Болшая Тулская, дом 2, помещение XV, ком.1. Адрес за кореспонденция: 115093, гр. Москва, Партийнии пер, д. 1, корп. 58, стр. 1. Телефон: +7 (495) 642-96-26, факс: + 7 (495) 642-96-26, адрес на електронна поща: info@cniis.su. Атестат на акредитацията рег. № РОСС RU. 0001.11АГ42, издаден на 17.05.2013 г. от Федералната служба по акредитация

ПРОДУКЦИЯ: Силови кабели марка: ПвП, ПвПу, ПвПуг, ПвПу2г, ПвПи, ПвППу, ПвППуг, ПвППу2г, ПвВнг, ПвВнгг, ПвВнг2г, ПвПнг-HF, ПвПнгг-HF, ПвПнгуг-HF, ПвПнг2г-HF, ПвПнгу2г-HF, ПвППнг-HF, ПвППнгг-HF, ПвППнг2г-HF, АПвП, АПвПу, АПвПуг, АПвПу2г, АПвПп, АПвППу, АПвППуг, АПвППу2г, АПвВнг, АПвВнг, АПвВнгг, АПвВнг2г, АПвПнг -HF, АПвПнгг -HF, АПвПнгуг -HF, АПвПнг2г -HF, АПвПнгу2г -HF, АПвППнг -HF, АПвППнгг -HF, АПвППнг2г -HF, в това число с вграден модул с оптовлакно (ов) в екран от меден проводник, алуминий (А) или алуминиева сплав (Ас), с броня от проводник от алуминева сплав (Ка) или от лента от алуминева сплав (Ба), с оловна обвивка (С), с кръгли или сегментирани (с), херметизирани (гж) или нехерметизирани жила с номинално сечение 185-2000 кв.чч, с категория на пожарна безопасност А или В, за напрежение 64/110 кВ.
ТУ 3530-003-42747015-2007
Серийно производство

код ОК 005 (ОКП): 35 3000

код ТН ВЕД Русия:

СЪОТВЕТСТВАТ НА ИЗИСКВАНИЯТА НА НОРМАТИВНИТЕ ДОКУМЕНТИ
ГОСТ Р IEC 60840-2011, ТУ 3530-003-42747015-2007
(п.п.1.1, 1.2.1, 1.2.2, 1.3.1-1.3.13, 1.4.1-1.4.12, 1.5.1-1.5.5, 1.6.1-1.6.3)

ПРОИЗВОДИТЕЛ: ООО „ЕСТРАЛИН ЗВК"
Адрес: 111024, гр. Москва, ул. 2-ра Кабелная, д.2
ИНН: 7722690035

СЕРТИФИКАТА Е ИЗДАДЕН НА: ООО „ЕСТРАЛИН ЗВК"
Адрес: 111024, гр. Москва, ул. 2-ра Кабелная, д.2
Тел.: (495) 956 66 99, факс: (495) 234 32 94
ИНН: 7722690035

НА ОСНОВАНИЕ: протокол за изпитване № 6327-2015-09 от 08.09.2015 г. на Изпитвателна лаборатория Дружество с ограничена отговорност „Център научни изследвания, изпитания и сертификации", атестат на акредитацията рег. № РОСС RU. 0001.21АВ67, валиден до 21.07.2016 г.

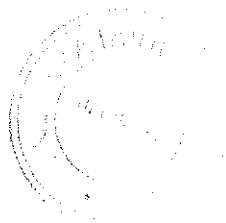
ДОПЪЛНИТЕЛНА ИНФОРМАЦИЯ Схема на сертификацията: 3

[печат-не се чете] **Ръководител на органа:** *[подпис-не се чете]* (подпис) В.В. Попов (инициали, фамилия)

[печат-не се чете] **Експерт:** *[подпис-не се чете]* (подпис) А.Р.Хаметова (инициали, фамилия)

Сертификата не се прилага при задължителна сертификация
[бланка]

1002



ESTRALIN PS

ДЕКЛАРАЦИЯ ЗА СЪОТВЕТСТВИЕ

We, Estralin PS LLC, as reputable manufacturer of HV cables, cable systems, cable joints & terminations, cable accessories,

Hereby declare our own responsibity that:

Cable 110 kV, Al-PE, A2X(FL)2Y,1x1600mm^2,110(123) kV and its accessories

is in conformity to the following standard:

IEC 60840 and its amendments

Ourquality control performance determinesthe compliance of all designed and produced cables and their accessories parameters with the established norms.

Quality control of power cables with extruded insulation and cable accessories is performed according to the International Electrotechnical Commission (IEC), which specifies testing methods of cable and its accessories, as well as requirements to them: IEC 60840 – for rated voltage from 30 kV up to 150 kV (including).

15th June 2017

Pavel Vetkhov
General Manager
Estralin PS LLC
111024, Moscow, 2nd Kabelnaya, Str., 2, bld. 24

DECLARATION OF CONFORMITY

Ние, Естралин ПС, реномиран производител на високоволтови кабели, кабелни системи, кабелна арматура (глави и муфи),

С настоящото декларираме, че

Кабел 110 kV, Al-PE, A2X(FL)2Y,1x1600mm^2,110(123) kV и кабелната арматура

Съответстват на стандарт:

IEC 60840 и неговите допълнения

Нашата система за качество определя съответствието на параметрите на всички проектирани и произведени кабели с ектрудирана изолация и тяхната арматура с приложимите норми.

Качественият контрол на силовите кабели с екструдирана изолация и кабелната арматура се извършва в съответствие с Международна Електротехническа Комисия (IEC), която определя тестовите методи на кабела и неговата арматура, както и изискванията към тях: IEC 60840 – за номинално напрежение от 30 kV до 150 kV (включително).

15 юни 2017 г.

Павел Ветков
Генерален директор
Естралин ПС
111024, Москва, ул.2-ра Кабелная, д.2, стр. 24

ДЗЗД „ЕИК ДРАГАЛЕВЦИ" Пловдив

ВЯРНО С ОРИГИНАЛА

КОМПЛЕКС ООД * ПЛОВДИВ

1001

СИСТЕМА СЕРТИФИКАЦИИ ГОСТ Р

ФЕДЕРАЛЬНОЕ АГЕНТСТВО ПО ТЕХНИЧЕСКОМУ РЕГУЛИРОВАНИЮ И МЕТРОЛОГИИ

СЕРТИФИКАТ СООТВЕТСТВИЯ

№ РОСС RU.АГ42.Н00316

Срок действия с 08.06.2016 по 07.06.2019

№ 1924902

ОРГАН ПО СЕРТИФИКАЦИИ продукции Общество с ограниченной ответственностью «Центр научных исследований, испытаний и сертификации». Место нахождения: 115191, Россия, г. Москва, ул. Большая Тульская, дом 2, помещение XV, ком. 1. Фактический адрес: 115093, г. Москва, Партийный пер., д. 1, корп. 58, стр. 1. Телефон: +7 (495) 642-96-26, факс: +7 (495) 642-96-26, адрес электронной почты: info@cniis.su. Аттестат аккредитации регистрационный № РОСС.RU.0001.11АГ42 выдан 17.05.2013 года Федеральной службой по аккредитации

ПРОДУКЦИЯ Силовой кабель марок: ПвП, ПвПу, ПвПуг, ПвПу2г, ПвПп, ПвПпу, ПвПпуг, ПвПпу2г, ПвВиг, ПвВиг, ПвВиг2г, ПвПиг-HF, ПвПиг-HF, ПвПиг-HF, ПвПиг2г-HF, ПвПиг2г-HF, ПвПпиг-HF, ПвПпиг-HF, ПвПпиг2г-HF, АПвП, АПвПу, АПвПуг, АПвПу2г, АПвПп, АПвПпу, АПвПпуг, АПвПпу2г, АПвВиг, АПвВиг, АПвВиг2г, АПвПиг-HF, АПвПиг-HF, АПвПиг-HF, АПвПиг2г-HF, АПвПиг2г-HF, АПвПпиг-HF, АПвПпиг-HF, АПвПпиг2г-HF, в том числе с встроенными оптоволоконными модулями(ов) в экран из медных проволок, алюминия(А) или алюминиевого сплава(Ас), с броней из проволок из алюминиевого сплава (Ка) или из лент из алюминиевого сплава(Ба) , со свинцовой оболочкой(С), с круглыми или сегментированными(с), герметизированными(г,ж) или негерметизированными жилами с номинальным сечением 185 - 2000 кв. мм, с категорией пожарной безопасности А или В, на напряжение 64/110 кВ
ТУ 3530-003-42747015-2007
Серийный выпуск

код ОК 005 (ОКП): 35 3000

СООТВЕТСТВУЕТ ТРЕБОВАНИЯМ НОРМАТИВНЫХ ДОКУМЕНТОВ
ГОСТ Р МЭК 60840-2011, ТУ 3530-003-42747015-2007
(п.п. 1.1, 1.2.1, 1.2.2, 1.3.1-1.3.13, 1.4.1-1.4.12, 1.5.1-1.5.5, 1.6.1-1.6.3)

код ТН ВЭД России:

ИЗГОТОВИТЕЛЬ ООО «Эстралин ЗВК»
Адрес: 111024, г. Москва, 2-ая Кабельная ул., д. 2
ИНН: 7722690035

СЕРТИФИКАТ ВЫДАН ООО «Эстралин ЗВК»
Адрес: 111024, г. Москва, 2-ая Кабельная ул., д. 2
Телефон: (495) 956 66 99, Факс: (495) 234 32 94
ИНН: 7722690035

НА ОСНОВАНИИ протокола испытаний № 6327-2015-09 от 08.09.2015 г. Испытательная лаборатория Общество с ограниченной ответственностью «Центр научных исследований, испытаний и сертификации», аттестат аккредитации регистрационный № РОСС RU.0001.21АВ67 действителен до 21.07.2016 года

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ Схема сертификации: 3

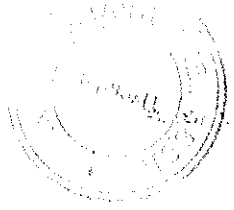
Руководитель органа _____ В.В. Попов
подпись инициалы, фамилия

Эксперт _____ А.Р. Хаметова
подпись инициалы, фамилия

Сертификат не применяется при обязательной сертификации

ВЕРНО ОРИГИНАЛ

1003



Превод от руски език, извършен от Даниела Кирилова Торорова:

СИСТЕМА СЕРТИФИКАЦИЯ ГОСТ Р

ФЕДЕРАЛНА АГЕНЦИЯ ПО ТЕХНИЧЕСКИ КОНТРОЛ И МЕТРОЛОГИЯ

СЕРТИФИКАТ ЗА СЪОТВЕТСТВИЕ

[лого-не се чете] № РОСС RU. АВ51.Н00531

Срок на валидност: от 12.03.2015 г. **до** 11.03.2018 г.

№ 1806298

СЕРТИФИЦИРАЩ ОРГАН

рег.№ РОСС RU.0001.11АВ51

Продукция ООО" ГОСТЕКСПЕРТСЕРВИС"
Юридически адрес: РФ, 109599, гр. Москва, ул. Краснодарская д.74, корп. 2, пом. XII
Адрес за кореспонденция: РФ, 109599, гр. Москва, ул. Краснодарская д.74, корп. 2, пом. XII
Тел.: (495) 991-45-42, факс: (499) 372-01-67

ПРОДУКЦИЯ:
Муфи за кабели с изолация за омрежен полиетилен напрежение 127/220 кВ.
Серийно производство по ТУ 3599-002-65235642-2014

код ОК 005 (ОКП):
35 9914

код ТН ВЕД Русия:
8535 90 000 9

СЪОТВЕТСТВАТ НА ИЗИСКВАНИЯТА НА НОРМАТИВНИТЕ ДОКУМЕНТИ
ТУ 3599-002-65235642-2014

ПРОИЗВОДИТЕЛ:
ООО „АРКАСИЛ Силови Компоненти"
111250, гр. Москва, Проезд Завода „Серп и Молот", д.6, к.1,
Тел.: + 7 495 78 76 76 0

НА ОСНОВАНИЕ:
Протокол от сертификационни изпитания № TR.15-2512, № TR.5-2514, издаден от Изпитвателен Център ООО "ОМАКС", атестат на акредитация РОСС RU.0001.21МЮ59, със срок на действие до 19.03.2018 г.

ДОПЪЛНИТЕЛНА ИНФОРМАЦИЯ
Маркировката на продукцията със знака за съответствие се извършва съгласно с ГОСТ Р 50460-92. Място на нанасяне на знака за съответствие е на опаковката и в придружаващата документация.
Схема на сертификацията: 3

[печат-не се чете] **Ръководител на органа:** *[подпис-не се чете]* _____ подпис — В.Е. Мелников _____ инициали, фамилия

[печат-не се чете] **Експерт:** *[подпис-не се чете]* _____ подпис — Д.В.Баскаков _____ инициали, фамилия

Сертификата не се прилага при задължителна сертификация
[бланка]

1004

СИСТЕМА СЕРТИФИКАЦИИ ГОСТ Р

ФЕДЕРАЛЬНОЕ АГЕНТСТВО ПО ТЕХНИЧЕСКОМУ РЕГУЛИРОВАНИЮ И МЕТРОЛОГИИ

СЕРТИФИКАТ СООТВЕТСТВИЯ

№ РОСС RU.АВ51.Н00531

Срок действия с 12.03.2015 по 11.03.2018

№ 1806298

ОРГАН ПО СЕРТИФИКАЦИИ рег. № РОСС RU.0001.11АВ51

ПРОДУКЦИИ ООО "ГОСТЭКСПЕРТСЕРВИС"

Юридический адрес: РФ, 109599, г. Москва, ул. Краснодарская д. 74, корп. 2, пом. XII

Фактический адрес: РФ, 109599, г. Москва, ул. Краснодарская д. 74, корп. 2, пом. XII

тел. (495) 991-45-42, факс: (499) 372-01-67

ПРОДУКЦИЯ

Муфты для кабелей с изоляцией из сшитого полиэтилена на напряжение 127/220 кВ. Серийный выпуск по ТУ 3599-002-65235642-2014.

код ОК 005 (ОКП): 35 9914

код ТН ВЭД России: 8535 90 000 9

СООТВЕТСТВУЕТ ТРЕБОВАНИЯМ НОРМАТИВНЫХ ДОКУМЕНТОВ

ТУ 3599-002-65235642-2014

ИЗГОТОВИТЕЛЬ

ООО "АРКАСИЛ Силовые Компоненты",
111250, Москва, Проезд Завода "Серп и Молот", д.6, к.1.

СЕРТИФИКАТ ВЫДАН

ООО "АРКАСИЛ Силовые Компоненты", ОГРН: 1107746098470, ОКПО: 65235642, ИНН: 7722709166
111250, Москва, Проезд Завода "Серп и Молот", д.6, к.1,
Тел: +7 495 78 76 76 0

НА ОСНОВАНИИ

Протокол сертификационных испытаний № TR.15-2512, № TR.15-2514 выданный Испытательным Центром ООО "ОМАКС", аттестат аккредитации РОСС RU.0001.21МЮ59 сроком действия по 19.03.2018 года.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Маркировка продукции знаком соответствия производится по ГОСТ Р 50460-92. Место нанесения знака соответствия на упаковке и в сопроводительной документации.
Схема сертификации 3.

М.П.

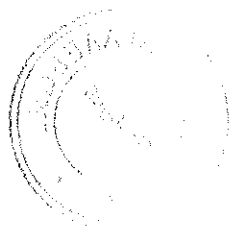
Руководитель органа _____ (подпись) В.Е. Мельников (инициалы, фамилия)

Эксперт _____ (подпись) Д.В. Баскаков (инициалы, фамилия)

Сертификат не применяется при обязательной сертификации

ВЯРНО С ОРИГИНАЛА

1005



Превод от английски език, извършен от Даниела Кирилова Тодорова:

ДЕКЛАРАЦИЯ ЗА СЪОТВЕТСТВИЕ

[Лого – не се чете]

Идентификация на документа
1MRK 000 612-110
Ревизия A

Декларация

Ние АББ, АБ, Продукти за автоматизация на подстанции, SE-721 59 Вастерас, Швеция, декларираме, съгласно нашата отговорност, че серията апаратура:

Надлъжна диференциална защита	**Тип:** **RED670, Вер. 2.1** **съгл. Продуктов каталог** **1MRK 505341-BEN**

Към която се отнася настояща декларация, е в съответствие със следните директиви

Директива	**EMC Directive 2014/30/EU** **Low Voltage Directive 2014/35/EU**

Нашата система за вътрешен качествен контрол осигурява съответствието между произведените продукти и техническата документация.

Година на CE-маркировката	**2015**

Приложение на продуктите

Серията е предназначена за приложение в индустриални условия и за защита на високоволтова и високомощностна апаратура, и се използва в екстремна електромагнитна среда в близост до високоволтова апаратура.

Съответствие

Стандарти	**EN 60 255-26: 2013** **EN 60 255-27: 2014**

Оторизация

Подпис	*[подпис-не се чете]* *2016-03-30* Йозеф Менезес, ПМ Дата

1006

ABB AB
Substation Automation Products

Postal Address
SE-721 59 Västerås / Sweden

Telephone +46 21 32 50 00
Fax +46 21 14 69 18

Declaration of Conformity

Document identity

1MRK 000 612-110

Revision A

Declaration

We **ABB AB, Substation Automation Products, SE-721 59 Västerås, Sweden,** declare under our sole responsibility that the family of apparatus:

Line Differential Protection	**Type:** **RED670, Ver. 2.1** **acc. to Product Guide** **1MRK 505341-BEN**

to which this declaration relates is in conformity with the following directives

Directive	**EMC Directive 2014/30/EU** **Low Voltage Directive 2014/35/EU**

Our internal quality control system ensures compliance between the manufactured products and the technical documentation.

Year of affixed CE-marking	**2015**

Application of the objects

The family is intended for use in the industrial environment and to protect high voltage or high power apparatus, and thus normally used in a harsh electromagnetic environment near high voltage apparatus.

References

Standards	**EN 60 255-26: 2013** **EN 60 255-27: 2014**

Authorisation

Signed by	Joseph Menezes, PM — Date: -03-30

ВЯРНО С ОРИГИНАЛА

1007

DNV·GL

ATTESTATION OF CONFORMITY

No. 10004038-OPE/INC 15-3092

Issued to:
ABB
SA Products
Nätverksgatan 3, B391, Finnslätten
721 59 Västeras
Sweden

For the client system:
REL 670
Type: Slave station
Product version 2.1.0
Firmware version 2.1.0.17

With the implemented communication protocol:

IEC 60870-5-103 (IS 1998)

Companion Standard for the informative interface of protection equipment and the ABB Relion 650 and 670 series version 2.1 IEC 60870-5-103, Interoperability, dated August 28, 2015.

The product has not been shown to be non-conforming to the specified protocol standard, including the interface requirements.

End-to-End data element tests for the information and control points as described in manufacturer Protocol Implementation Conformance Statement (PICS) have been performed on the product's protocol implementation. Functional tests in controlled mode are performed for the following levels:

• *Station initialization in Unbalanced mode* • *Cyclic data transmission* • *Acquisition of events* • *General Interrogation*	• *General command* • *Clock synchronisation* • *Transmission of Disturbance records* • *Test mode and local parameter setting*

The test campaign did not reveal any errors in the product's protocol implementation.

This Attestation is granted on account of tests made at location of ABB in Västerås, Sweden and performed with UnIECim version 3.0.3 (2014) running CS103 Test Suite version CS103MasterNormal 2.4. The results, including remarks and limitations, are laid down in our report no. 10004038-OPE/INC 15-3086.

The tests have been carried out on one single specimen of the product, submitted by ABB. The Attestation does not include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by DNV GL is not the responsibility of DNV GL.

Arnhem, November 18, 2015

Issued by:

DNV·GL
DNV KEMA is now DNV GL

P. Cioci
Head of Section
Operational Excellence

G. Webber
Test Consultant

IMPORTANT: Remarks apply to this implementation. See the resulting report for full details. Publication of this document is allowed. Publication in total or in part and/or reproduction in whatsoever way of the contents of the above mentioned report(s) is not allowed unless permission has been explicitly given either in the report(s) or by previous letter

KEMA Nederland B.V. Utrechtseweg 310, 6812 AR Arnhem, P.O. Box 9035, 6800 ET Arnhem, the Netherlands
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ВЯРНО С ОРИГИНАЛА

1008

IEC 61850 Certificate Level A[1]

No. 10004038-OPE/INC 15-2826

Issued to:
ABB AB
SA Products
S-721 59 Västerås
Sweden

For the server product:
REC670 Bay Control
Software version: 2.1.0.23
S/N: REC670 2.1.0.16

The server product has not been shown to be non-conforming to:

IEC 61850 Edition 2 Parts 6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems for power utility automation

The conformance test has been performed according to IEC 61850-10 Edition 2, the UCA International Users Group Edition 2 Server Test Procedures version 1.0 with TPCL[2] 1.0.2 with product's protocol, model and technical issue implementation conformance statements: "Protocol Implementation Conformance Statement for the IEC 61850 interface in ABB 650 and 670 series version 2.1 – IEC 61850 Edition 2, 1MRG021052", "Model Implementation Conformance Statement for the IEC 61850 Ed2 interface in ABB 650 and 670 series version 2.1, 1MRG021098" and "TISSUES Implementation Conformance Statement for the IEC 61850 Ed2 interface in ABB 650 and 670 series version 2.1, 1MRG021051" and the extra information for testing: "Protocol Implementation eXtra Information for Testing (PIXIT) for the IEC 61850 interface in ABB 650 and 670 series version 2.1 – IEC 61850 Edition 2, 1MRG021053".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases):

1 Basic Exchange (22/26)	9a GOOSE Publish (8/13)
2 Data Sets (4/7)	9b GOOSE Subscribe (13/14)
3 Substitution (3/3)	12a Direct Control (12/18)
4 Setting Group Selection (4/4)	12d Enhanced SBO Control (19/28)
4+ Setting Group Definition (12/13)	13 Time Synchronization (6/7)
5 Unbuffered Reporting (17/20)	14 File Transfer (7/8)
6 Buffered Reporting (25/29)	15 Service Tracking (12/17)

This certificate includes a summary of the test results as carried out at ABB in Sweden with UniCA 61850 Client Simulator 4.29.03 with test suite Ed2 3.29.05 and UniCA 61850 Analyzer 5.29.02. This document has been issued for information purposes only, and the original paper copy of the DNV GL verification report No. 74108086-OPE/INC 15-2824 will prevail.

The test has been carried out on one single specimen of the product as referred above and submitted to DNV GL by ABB. The manufacturer's production process has not been assessed. This certificate does not imply that DNV GL has approved any product other than the specimen tested.

Arnhem, October 1, 2015

M. Adriaensen
Head of Department
Operational Excellence

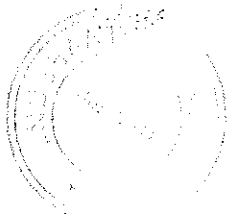
Issued by:

DNV·GL
DNV KEMA is now DNV GL

R. Schimmel
Verification Manager

[1] Level A - Independent test lab with certified ISO 9001 Quality System
[2] TPCL - Test procedures change list

KEMA Nederland B.V. Utrechtseweg 310, 6812 AR Arnhem, P.O. Box 9035, 6800 ET Arnhem, the Netherlands
T +31 26 356 2025 F +31 26 351 36 83 safesdesk@dnvgl.com www.dnvgl.com



UCA International Users Group

IEC 61850 Certificate Level A

No. 10004038-DPE/INC 15-2826

Applicable Test Procedures from the UCA International Users Group Edition 2 Server Test Procedures version 1.0 with TPCL 1.0.2

Conformance Block	Mandatory	Conditional
1: Basic Exchange	sAss1, sAss2, sAss3, sAssN2, sAssN3, sAssN4, sAssN5, sSrv1, sSrv2, sSrv3, sSrv4, sSrv5, sSrvN1abcd, sSrvN4	sSrv6, sSrv8, sSrv11, sSrv12, sSrv13, sSrvN1e, sSrvN1f, sSrvN3
2: Data Sets	sDs1, sDs10a, sDsN1ae	sDs15
3: Substitution	sSub1, sSub2, sSub3	
4: Setting Group Selection	sSg1, sSg3, sSgN1	sSg11
4+: Setting Group Definition	sSg2, sSg4, sSg7, sSg8, sSg10, sSg12, sSgN2, sSgN3, sSgN4, sSgN5	sSg5, sSg9
5: Unbuffered Reporting	sRp1, sRp2, sRp3, sRp4, sRp9, sRp14, sRpN1, sRpN2, sRpN3, sRpN4, sRpN8	sRp5, sRp8, sRp10, sRp11, sRp12, sRp13
6: Buffered Reporting	sBr1, sBr2, sBr3, sBr4, sBr9, sBr14, sBr20, sBr21, sBr22, sBr25, sBr26, sBr27, sBr28, sBrN1, sBrN2, sBrN3, sBrN4, sBrN5, sBrN8	sBr5, sBr8, sBr10, sBr11, sBr12, sBr13
9a: GOOSE publish	sGop2a, sGop3, sGop4, sGop7, sGop9, sGop10, sGop11	sGop1
9b: GOOSE subscribe	sGos1, sGos2, sGos3, sGos5, sGos6a, sGos7, sGosN1, sGosN2, sGosN3, sGosN4, sGosN5, sGosN6	sGos6b
12a: Direct control	sCtl5, sCtl10, sDOns1, sDOns2	sCtl7, sCtl13, sCtl15, sCtl16, sCtl17, sCtl18, sCtl19, sCtl21
12d: Enhanced SBO Control	sCtl5, sCtl8, sCtl9, sCtl10, sCtl11, sCtl25, sSBOes1, sSBOes2, sSBOes6, sSBOes8	sCtl4, sCtl6, sCtl7, sCtl15, sCtl16, sCtl17, sCtl18, sCtl19, sCtl26
13: Time sync	sTm1, sTm2, sTmN1	sTm3, sTm4, sTm5
14: File transfer	sFt1, sFt2ab, sFt4, sFt5, sFtN1ab	sFt2c, sFtN1c
15: Service tracking		sTrk1, sTrk2, sTrk4, sTrk7, sTrk8, sTrk9, sTrk10, sTrk11, sTrk12, sTrk13, sTrk14, sTrk17

All configuration file and data model tests have been successfully performed for the product variants using the same communication hardware and software version:

- REB650 Busbar Protection
- REC650 Bay Control
- RED650 Line Differential Protection
- REL650 Line Distance Protection
- REQ650 Breaker Protection
- RET650 Transformer Protection
- REB670 Busbar Protection
- RED670 Line Differential Protection
- REG670 Generator Protection
- REL670 Line Distance Protection
- RER670 Railway Protection
- RES670 Phasor Measurement
- RET670 Transformer Protection

ВЯРНО С ОРИГИНАЛА

KEMA Nederland B.V. Utrechtseweg 310, 6812 AR Arnhem, P.O. Box 9035, 6800 ET Arnhem, the Netherlands
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1010

UCA International Users Group

1KHL050078

IEC 61850 Conformance Certificate Level B[1]

Issued to:
ABB AB
SA Products
S-721 59 Västeras
Sweden

For the product:
REC670 Bay Control
Firmware version 2.1
S/N T1537006

Issued by: ABB Switzerland Ltd, Power Systems, SVC Baden

The server product has not been shown to be non-conforming to:

IEC 61850 First Edition Parts 6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems in substations

The conformance test has been performed according to IEC 61850-10, the UCA International Users Group Server Device Test Procedures version 2.3 with TPCL[2] version 1.8, the product's protocol, model and technical issue implementation conformance statements: " 1MRG021055_ABB 650 & 670 Series version 2.1 Ed.1 - PICS ", "1MRG021087 ABB 670 and 650 series version 2.1 Ed1 - MICS","1MRG021063_ABB 650 & 670 Series version 2.1 Ed.1 – TICS" and the extra information for testing: "1MRG021064_ABB 650 & 670 Series version 2.1 Ed.1 – PIXIT"

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases):

1	Basic Exchange (20/24)	9a	GOOSE Publish (9/12)
2	Data Sets (3/6)	9b	GOOSE Subscribe (11/11)
3	Substitution (4/4)	12a	Direct Control (7/11)
4	Setting Group Selection (3/3)	12d	Enhanced SBO Control (14/19)
5	Unbuffered Reporting (16/19)	13	Time Synchronization (4/5)
6	Buffered Reporting (24/28)	14	File Transfer (6/7)

This Certificate includes a summary of the test results as carried out at the SVC Baden in Switzerland with UniCAsim 61850 version 4.29.03 with test suite 3.29.00 and UniCA Analyzer 5.27.04. This document has been issued for information purposes only, and the original paper copy of the SVC Baden report: No. 1KHL050077 will prevail. The test has been carried out on one single specimen of the product as referred above and submitted to SVC Baden by ABB AB, SA Products. The manufacturer's production process has not been assessed. This certificate does not imply that SVC Baden has approved any product other than the specimen tested.

Baden, 2015-12-17

S.Gerspach
Certification Manager

C. Zehnder
Test engineer

1 Level B - Tester with ISO 9001 Quality System
2 TPCL - Test procedures change list

ABB Switzerland Ltd
Power Systems, System Verification and Validation Center, SVC Baden
Bruggerstrasser 72, CH-5400 Baden

1011

UCA International Users Group

1KHL050078

Applicable Test Procedures from the UCA International Users Group Device Test Procedures version 2.3 with TPCL version 1.8

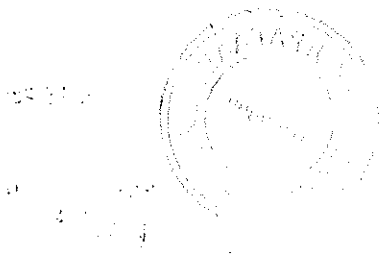
Conformance Block		Mandatory	Conditional
1	Basic Exchange	Ass1, Ass2, Ass3, AssN2, AssN4, AssN5 Srv1, Srv2, Srv3, Srv4, Srv5, SrvN1abcd, SrvN4	AssN3, Srv6, Srv7, Srv8, SrvN1e, SrvN1f, SrvN3
2	Data Sets	Dset1, Dset10a, DsetN1ae	
3	Substitution	Sub1, Sub2, Sub3, SubN1	
4	Setting Group Selection	Sg1, SgN1a, Sg3	
5	Unbuffered Reports	Rp1, Rp2, Rp3, Rp4, Rp9, Rp15, RpN1, RpN2, RpN3, RpN4, RpN8	Rp5, Rp8, Rp10, Rp11, Rp12,
6	Buffered Reports	Br1, Br2, Br3, Br4, Br9, Br15, Br20, Br21, Br22, Br25, Br26, Br27, Br28 BrN1, BrN2, BrN3, BrN4, BrN5, BrN8	Br5, Br8, Br10, Br11, Br12
9a	GOOSE publish	Gop2, Gop3, Gop4, Gop9, Gop10a	Gop1, Gop7, Gop10b, GopN2
9b	GOOSE subscribe	Gos1a, Gos2, Gos3, GosN1, GosN2, GosN3, GosN4, GosN5, GosN6	Gos1b, Gos4
12a	Direct Control	CtlN3, CtlN8, DOns1	Ctl2, Ctl7, CtlN10, CtlN11
12d	Enhanced SBO control	Ctl3, CtlN1, CtlN2, CtlN3, CtlN4, CtlN9 SBOes1, SBOes2, SBOes3	Ctl2, Ctl7, CtlN6, CtlN10, CtlN11,
13	Time Synchronization	Tm1, Tm2,	Tm3, TmN1
14	File Transfer	Ft1, Ft2ab, Ft4, FtN1ab	Ft2c, FtN1c

All configuration file and data model tests have been successfully performed for the product variants using the same hardware and software version:

- REB650 Busbar Protection
- REC650 Bay Control
- RED650 Line Differential Protection
- REL650 Line Distance Protection
- REQ650 Breaker Protection
- RET650 Transformer Protection
- REB670 Busbar Protection
- RED670 Line Differential Protection
- REG670 Generator Protection
- REL670 Line Distance Protection
- RES670 Phasor Measurement
- RET670 Transformer Protection

ABB Switzerland Ltd
Power Systems, System Verification and Validation Center, Sv/o Baden
Bruggerstrasser 72, CH-5400 Baden

1012



Превод от английски език, извършен от Даниела Кирилова Тодорова:

ДЕКЛАРАЦИЯ ЗА СЪОТВЕТСТВИЕ

[Лого – не се чете]

Идентификация на документа
1MRK 000 612-95
Ревизия B

Декларация

Ние АББ, АБ, Продукти за автоматизация на подстанции, SE-721 59 Вастерас, Швеция, декларираме, съгласно нашата отговорност, че серията апаратура:

Максималнотокова защита	**Тип:** **REQ650** **съгл. Продуктов каталог** **1MRK 505294-BEN, -BUS**

Към която се отнася настояща декларация, е в съответствие със следните директиви

Директива	**EMC Directive 2014/30/EU** **Low Voltage Directive 2014/35/EU**

Нашата система за вътрешен качествен контрол осигурява съответствието между произведените продукти и техническата документация.

Година на CE-маркировката	**2013**

Приложение на продуктите

Серията е предназначена за приложение в индустриални условия и за защита на високоволтова и високомощностна апаратура, и се използва в екстремна електромагнитна среда в близост до високоволтова апаратура.

Съответствие

Стандарти	**EN 60 255-26: 2013** **EN 60 255-27: 2014**

Оторизация

Подпис	*[подпис-не се чете]* *30/3-2016* Кристер Хагман, ПМ Дата

1013

ABB AB
Substation Automation Products

Postal Address
SE-721 59 Västerås / Sweden

Telephone +46 21 32 50 00
Fax +46 21 14 69 18

Declaration of Conformity

Document identity
1MRK 000 612-95

Revision

Declaration

We **ABB AB, Substation Automation Products, SE-721 59 Västerås, Sweden,** declare under our sole responsibility that the family of apparatus:

Breaker protection	**Type:** **REQ650** **acc. to Product Guide** **1MRK 505294-BEN, -BUS**

to which this declaration relates is in conformity with the following directives

Directive	**EMC Directive 2014/30/EU** **Low Voltage Directive 2014/35/EU**

Our internal quality control system ensures compliance between the manufactured products and the technical documentation.

Year of affixed CE-marking	**2013**

Application of the objects

The family is intended for use in the industrial environment and to protect high voltage or high power apparatus, and thus normally used in a harsh electromagnetic environment near high voltage apparatus.

References

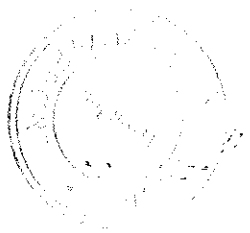
Standards	**EN 60 255-26: 2013** **EN 60 255-27: 2014**

Authorisation

Signed by	Krister Hagman, PM — Date: 30/3-2016

ВЯРНО С ОРИГИНАЛА

1014



"ФИЛМАР-74" ООД

София, бул."Цар Борис III" № 23, 0888 215348
БУЛСТАТ 130749405; e-mail: tracable@abv.bg

ДЕКЛАРАЦИЯ ЗА СЪОТВЕТСТВИЕ

Декларираме, че предлаганите от нас материали: кабели, аксесоари и арматура, производство на описаните по-долу фирми от Европейския съюз, са в съотвтствие с изискванията на съответните европейски стандарти , а именно:

Продукт	*Производител*	*Съответствие със стандарт*
Оптични м.з.в. тип OPGW	AFL Telecommunications GmbH, Moenchengladbach, Germany	IEC 60793 standards
Оптични кабели тип OPUG	Pengg Kabel GmbH, Austria	IEC 60793, IEC 60974
Оптични влакна	AFL Telecommunications GmbH, Germany; Pengg Kabel GmbH, Austria	Non-Zero Dispersion-Shifted Fibre по спецификация на ITU-T.G652, ITU-T.G655 и ITU-T.G656 EIA/TIA 598: Colour Coding of Fiber Optic Cables
Арматура за монтаж на OPGW на опъвателни и носителни стълбове и вибро гасители	SAPREM s.a., Navarra, Spain	EN ISO 1461
Панели за оптична дистрибуция ODF; адаптери; конектори; пигтейли	OPTOKON a.s., Czech Repubic	ISO/IEC 17025
Съединителни кутии	RIBE – Richard Bergner Elektroarmaturen GmbH, Schwabach, Germany	IEC 61284, DIN EN 60529, IEC 60794

При монтажа и приложението на кабелите и аксесоарите е необходимо да се спазват всички технологични изисквания за монтаж и експлоатация.

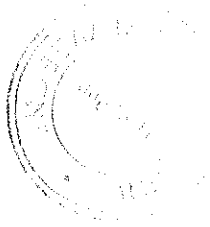
София, 12.06.2017 г.

УПРАВИТЕЛ:

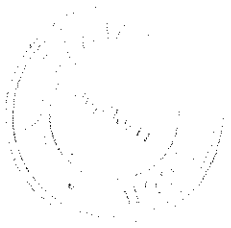
/Филип Марков/

ВЯРНО С ОРИГИНАЛА

1015



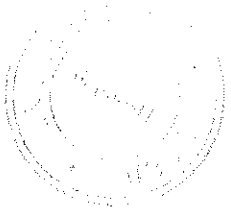
Приложение № 3 към Предложение за изпълнение на поръчката – Заверени копия на протоколи от типови изпитвания



Приложение № 3 към Предложение за изпълнение на поръчката – Заверени копия на протоколи от типови изпитвания на: 3.1. Сух силов кабел 110 kVAL 1600 mm2, проведени от независима изпитвателна лаборатория – заверени копия, с приложен списък на отделните изпитвания на български език

ДЗЗД „ЕИК ДРАГАЛЕВЦИ" Пловдив

1017



KEMA

Report

TIC 3181-13

Type tests on a 64/110 (123) kV cable system

Manufacturer cable
Estralin HVC LLC,
Moscow, Russia

Manufacturer accessories
ARKASIL SK LLC,
Moscow, Russia

Arnhem, 19 December 2013

Experience you can trust.

1018

S: EL

INSPECTION REPORT

TIC 3181-13

OBJECT	Power cable system consisting of 1-core power cable, 2 terminations, and 1 joint 64/110 (123) kV – 1x2000 mm^2 – Cu – XLPE	
CLIENT	OMACS LLC, Moscow, Russia	
MANUFACTURERS	Cable	Estralin HVC LLC, Moscow, Russia
	Accessory 1	ARKASIL SK LLC, Moscow, Russia
	Accessory 2	ARKASIL SK LLC, Moscow, Russia
	Accessories	See section 1.1.3 Characteristics of the accessories
REFERENCE	72130463	
INSPECTED BY	KEMA Nederland B.V., Arnhem, The Netherlands	
TEST LOCATION	OMACS LLC, Moscow, Russia	
DATE(S) OF TESTS	1 March untill 30 September 2013	
TEST SPECIFICATION	The tests have been carried out based on IEC 60840 (2011).	
SUMMARY AND CONCLUSION	The cable system passed the tests.	

PL ■ GC ■ MT ■

This report applies only to the object tested. The responsibility for conformity of any object having the same type references as that tested rests with the manufacturer.

This report consists of 61 pages in total.

O: 72130463

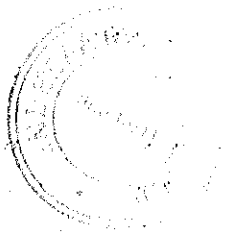
KEMA Nederland B.V.

S.A.M. Verhoeven
Director Testing, Inspections & Certification The Netherlands

Arnhem, 19 December 2013

ВЯРНО С ОРИГИНАЛА

1013



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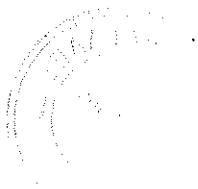

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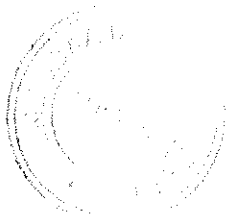


1 IDENTIFICATION OF THE OBJECT TESTED

1.1 Ratings/characteristics of the object tested

1.1.1 Characteristics of the cable system

Rated voltage, U_0/U (U_m)	64/110 (123) kV
Rated maximum conductor temperature	90 °C
Rated conductor cross-section	2000 mm^2
Composition of the cable system:	
– Cable	2XS(FL)2Y 1x2000RMS/185-64/110 kV
– Accessory 1	MKB 126
– Accessory 2	MCB 126 X

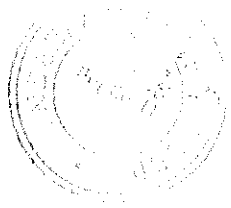
The test voltages and calculated nominal field stresses were based on U_0 test = 64 kV.

1.1.2 Characteristics of the cable

Standard	IEC 60840, Clause 6
Manufacturer	Estralin HVC LLC, Moscow, Russia
Type	U_0 = 64 kV 1x2000 mm^2 XLPE CABLE
Manufacturing date	2013
Sampling procedure	by the manufacturer
Rated voltage, U_0/U (U_m)	64/110 (123) kV
No. of cores (core identification)	1
Overall diameter (D)	100,7 mm
Calculated nominal electrical stress at conductor screen at U_0 = 64 kV (E_i)	7,09 kV/mm
Calculated nominal electrical stress at insulation screen at U_0 = 64 kV (E_o)	5,28 kV/mm
Nominal capacitance between conductor and metal screen	0,44 µF/km
Embossing on the oversheath	ЭСТРАЛИН ЗВК ПвП2г - 1×2000сгж/185-64/110кВ 2012г + length marking
Construction	see List of drawings

ВЯРНО С ОРИГИНАЛА

1022



RAAD VOOR ACCREDITATIE

Dutch Accreditation Council RvA
PO Box 2768 NL-3500 GT Utrecht

The Dutch Accreditation Council RvA, by law appointed as the national accreditation body for The Netherlands, hereby declares that accreditation has been granted to:

KEMA Nederland B.V.
Inspection Services
Arnhem

The organisation has demonstrated to be able to perform inspections, as type A inspection body, in a competent, consistent and independent way.

This accreditation is based on an assessment against the requirements as laid down in ISO/IEC 17020:1998

The accreditation covers the activities as specified in the authorized annex bearing the registration number.

The accreditation is valid provided that the organisation continues to meet the requirements.

The accreditation with registration number:

I 049

is granted on 26 March 2014

This declaration is valid until

1 April 2018

The accreditation has been granted for the first time on

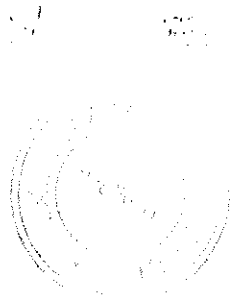
17 November 1994

The Chief Executive

Ir. J.C. van der Poel

ВЯРНО С ОРИГИНАЛА

1023



Annex to ISO/IEC 17020:1998 declaration of accreditation for registration number: **I 049, type A**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
Inspection Services
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2012**

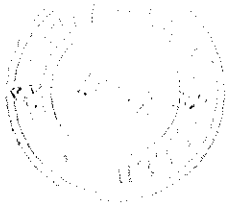
No.	Field of inspection	Type and Range of Inspection	Methods and Procedures[1]
	Rotating electrical machines, Transformers, Capacitors, Reactors		
1	Rotating electrical machines	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60034
2	Power transformers		IEC 60076 – 1,2,3,4,5,7,8,10,11,13, 15 NEMA 107 CISPR 16 EN 60076-11
3	Current transformers		IEC 60044 – 1,3,6,8
4	Voltage transformers		IEC 60044 – 2,3,7
5	Capacitors		IEC 60358 IEC 60831-1/-2 IEC 60871-1/-2
6	Reactors		IEC 60076-6

This annex has been approved by:

Ir. J.C. van der Poel
Chief Executive

ВЯРНО С ОРИГИНАЛА

1024



Annex to ISO/IEC 17020:1998 declaration of accreditation for registration number: **I 049, type A**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
Inspection Services
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2012**

No.	Field of Inspection	Type and Range of Inspection	Methods and Procedures[1]
		Switchgear	
7	Metal-enclosed AC switchgear 1-52 kV resp. ≥ 52 kV	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 62271-200 IEC 62271-1 IEC 60265 –1 IEC 62271-104 IEC 62271-105
8	Insulation-enclosed AC switchgear		IEC 62271-201
9	Gas insulated metal-enclosed AC switchgear (GIS)		IEC 62271-203 IEC 62271-1
10	High Voltage AC circuit breakers		IEC 62271-100
11	High-voltage AC disconnectors and earthing switches		IEC 62271-102
		Insulators, Arresters	
12	Insulators and insulated bushings	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60137 IEC 60168 IEC 60383 –1,2 IEC 60507 IEC 60660 IEC 61109 IEC 60815 ANSI C29 CAN/CSA C411.1-M89
13	Surge arresters		IEC 60099 –1,3,4,5,6,7 IEEE Std C62.11

ВЯРНО С ОРИГИНАЛА

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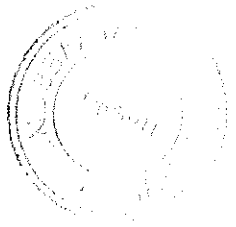

Annex to ISO/IEC 17020:1998 declaration of accreditation for registration number: **I 049, type A**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
Inspection Services
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2012**

No.	Field of inspection	Type and Range of Inspection	Methods and Procedures[1]
		Cables	
14	Cables	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60055 –1,2 IEC 60141-1 IEC 60502 –1,2,4 IEC 60840 NEN 3620 NEN 3172 BS 6622 HD 620 S2 NEN 3616 NEN 3619 NEN 3630 IEC 62067 CSA C49 NF C34-125 IEC 61089
15	Cable accessories		IEC 60055 –1,2 IEC 60502 –1,2,4 VDE 278 IEEE Std 404 IEEE Std 48 IEC 62271-209
		Electrical Energy Meters	
16	Electricity metering equipment (a.c.)	European directive 2004/22/EC: - Annex B: EC type examination - Annex F: Product verification Taking into account the requirements of EA-2/17	Directive 2004/22/EC: Annex I, B, F, MI-003

ВЯРНО С ОРИГИНАЛА

1026

RAAD VOOR ACCREDITATIE

Dutch Accreditation Council RvA
PO Box 2768 NL-3500 GT Utrecht

The Dutch Accreditation Council RvA, by law appointed as the national accreditation body for The Netherlands, hereby declares that accreditation has been granted to:

KEMA Nederland B.V.
High-Power Laboratory
Arnhem

The organisation has demonstrated to be able to generate technical valid results in a competent way and work according to a management system.

This accreditation is based on an assessment against the requirements as laid down in ISO/IEC 17025:2005.

The accreditation covers the activities as specified in the authorized annex bearing the registration number.

The accreditation is valid provided that the organisation continues to meet the requirements.

The accreditation with registration number:

L 020

is granted on 26 March 2014

This declaration is valid until

1 April 2018

The accreditation has been granted for the first time on

30 October 1990

The Chief Executive

Ir. J.C. van der Poel

ВЯРНО С ОРИГИНАЛА

1027

Annex to ISO/IEC 17025:2005 declaration of accreditation
for registration number: **L 020**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Power Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2012**

No.	Material or product	Type of activity	Internal reference number
		Transformers, Reactors, Line traps	
1	Power transformers	Short-circuit tests	IEC 60076-5 IEC 60076-11 STL Guide to IEC 60076 EN 60076-5 EN 50464-1 NEN-EN 50541-1 IEEE Std C57.12.90
2	Current transformers	Short-time current tests Transient instantaneous error measurement	IEC 60044-1 IEC 60044 -6 STL Guide to IEC 60044-1 STL Guide to IEC 60044-6 IEEE Std C57.13
3	Reactors	Short-time current tests	IEC 60076-6 IEEE Std C57.21
4	Line traps for A.C. power systems	Short-time current tests	IEC 60353
		Switchgear	
5	Metal-enclosed A.C. switchgear 1 - 52 kV resp. > 1 kV and prefabricated substations	Short-time current tests Verification of making and breaking capacities Mechanical operation tests Arcing due to internal fault	IEC 62271-200 IEC 62271-202 STL Guide to IEC 62271-200 IEEE Std C37.20.2 IEEE C37.21 ANSI C37.54 ANSI C37.55
6	Metal-enclosed A.C. switchgear ≥ 72,5 kV resp. ≥ 52 kV	Short-time current tests Verification of making and breaking capacities Mechanical operation tests Arcing due to internal fault	IEC 62271-203 STL Guide to IEC 60517 IEEE Std C37.122

This annex has been approved by:

Ir. J.C. van der Poel
Chief Executive

1028

Annex to ISO/IEC 17025:2005 declaration of accreditation
for registration number: **L 020**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Power Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2012**

No.	Material or product	Type of activity	Internal reference number
7	Low-voltage A.C. switchgear and control gear assemblies	Short-time current tests	IEC 61439-1 IEC 61439-2 IEC 60439-2 EN 61439-1 EN 61439-2 EN 60439-2 ANSI C37.20.2
8	Insulation-enclosed A.C. switchgear 1 - 52 kV	Short-time current tests Verification of making and breaking capacities Mechanical operation test Arcing due to internal fault	IEC 62271-201
9	High-voltage AC circuit breakers	Short-time current tests Making and breaking tests Switching tests Mechanical and environmental tests	NEN-EN-IEC 62271-100 IEC 62271-110 IEC 62271-101 STL Guide to IEC 62271-100 STL Guide to IEC 62271-101 ANSI/IEEE C37.09 ANSI/IEEE C37.081 IEEE Std C37.013 NEN-EN 50152-1
10	High-voltage A.C. switches	Short-time current tests Making and breaking tests Mechanical endurance tests Operation under severe ice conditions	NEN-EN-IEC 62271-103 IEC 62271-104 STL Guide to IEC 60265-1 IEEE Std C37.74
11	High-voltage A.C. disconnectors and earthing switches	Short-time current tests Switching tests Short-circuit making performance Operating and mechanical endurance tests Operation under severe ice conditions Operation at the temperature limits Contact zone tests	IEC 62271-102 STL Guide to IEC 62271-102 IEEE Std C37.34 IEEE Std C37.41
12	High-voltage A.C. contactors and motor starters	Making and breaking capacities Coordination with short-circuit protective device	NEN-EN-IEC 62271-106
13	Automatic circuit reclosers and fault interrupters	Interruption tests Operating duty tests	IEC 62271-111 / IEEE Std C37.60

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Annex to ISO/IEC 17025:2005 declaration of accreditation
for registration number: **L 020**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Power Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2012**

No.	Material or product	Type of activity	Internal reference number
		Arresters	
14	Surge arresters	Pressure-relief tests	IEC 60099-1 IEC 60099-4 IEEE Std C62.11
		Fuses	
15	High-voltage A.C. switch-fuse combinations	Making and breaking tests Tests on the mechanism	IEC 62271-105 IEEE Std C37.41 IEEE Std C37.74
16	High-voltage A.C. fuses	Breaking tests	NEN-EN-IEC 60282-1 IEC 60282-2 IEC 60549 NEN-EN-IEC 60644 STL Guide to IEC 60282-1 STL Guide to IEC 60282-2 IEEE Std C37.41 ANSI C37.44
		Cables/Networks	
17	Equipment for networks for transmission and distribution of electrical power	Test as mentioned above (1-16)	In accordance with or equivalent to the reference methods as mentioned above (1-16).

ВЯРНО С ОРИГИНАЛА

1030

RAAD VOOR ACCREDITATIE

Dutch Accreditation Council RvA
PO Box 2768 NL-3500 GT Utrecht

The Dutch Accreditation Council RvA, by law appointed as the national accreditation body for The Netherlands, hereby declares that accreditation has been granted to:

KEMA Nederland B.V.
High-Voltage Laboratory
Arnhem

The organisation has demonstrated to be able to generate technical valid results in a competent way and work according to a management system.

This accreditation is based on an assessment against the requirements as laid down in ISO/IEC 17025:2005.

The accreditation covers the activities as specified in the authorized annex bearing the registration number.

The accreditation is valid provided that the organisation continues to meet the requirements.

The accreditation with registration number:

L 218

is granted on 26 March 2014

This declaration is valid until
1 April 2018

The accreditation has been granted for the first time on
17 November 1994

The Chief Executive

Ir. J.C. van der Poel

ВЯРНО С ОРИГИНАЛА

1031

Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
1	Coils and/or windings of rotating electrical machines	AC voltage test Lightning impulse voltage test	IEC 60034
2	Power transformers	AC voltage test Lightning impulse voltage test Temperature-rise test Capacitance and tan δ measurement Power measurement DC resistance measurement Temperature measurement Sound level measurement R.I.V. measurement Partial discharge measurement SFRA measurement Verification of voltage ratio and phase displacement Low ambient test on dry-type transformer Thermal shock test on dry type transformer Condensation test on dry-type transformer Humidity penetration test on dry-type transformer Inspection of the active part	IEC 60076-1, -2, -3, -10, -11, -13, -15, -16, -18 CISPR 16 STL Guide to IEC 60076 NEN-EN 50464-1 NEN-EN 50541-1 IEEE Std. C57.12.00 IEEE Std. C57.12.90 IEEE Std. C57.12.91
3	AC Metal-enclosed switchgear and controlgear above 1 kV and ≤ 52 kV and prefabricated substations	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection R.I.V. measurement	IEC 62271-200 STL Guide to IEC 62271-200 IEC 62271-202 STL Guide to IEC 62271-202 IEEE C37.20.2 IEEE C37.21 ANSI C37.54 ANSI C37.55 IEC 60529

This annex has been approved by:

Ir. J.C. van der Poel
Chief Executive

ВЯРНО С ОРИГИНАЛА

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Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
4	AC Insulation-enclosed switchgear and controlgear above 1 kV and ≤ 52 kV	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection R.I.V. measurement	IEC 62271-201 IEC 60529
5	Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	AC voltage test Lightning impulse voltage test Switching impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement R.I.V. measurement	IEC 62271-203 STL Guide to IEC 60517 IEEE Std C37.122
6	High-voltage AC circuit breakers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement R.I.V. measurement Test under wet conditions	NEN-EN-IEC 62271-100 STL Guide to IEC 62271-100 IEEE Std C37.09 IEEE Std C37.013 NEN-EN 50152-1
7	High-voltage AC disconnectors and earthing switches	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Partial discharge measurement DC resistance measurement R.I.V. measurement Test under wet conditions Temperature measurement	IEC 62271-102 STL Guide to IEC 62271-102 IEEE Std C37.34 IEEE Std C37.41
8	High-voltage AC switches	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	NEN-EN-IEC 62271-103 STL Guide to IEC 60265-1 NEN-EN-IEC 62271-104 IEEE Std C37.74

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This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
9	High-voltage AC contactors	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	NEN-EN-IEC 62271-106
10	Automatic circuit reclosers and fault interrupters	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEC 62271-111/ IEEE Std C37.60
11	Busducts	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEEE Std C37.23
12	High-voltage AC switch-fuse combinations and high-voltage AC fuses	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEC 62271-105 IEEE Std C37.41 IEEE Std C37.74 NEN-EN-IEC 60282-1 IEC 60282-2 STL Guide to IEC 60282-1 STL Guide to IEC 60282-2

ВЯРНО С ОРИГИНАЛА

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Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

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This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
13	Insulators and insulated bushings	AC voltage test Lightning impulse voltage test Partial discharge measurement Test under wet conditions Thermal-mechanical performance test Electro-mechanical failing load test R.I.V. measurement Pollution tests Temperature measurement Visible corona test Steep front wave flashover test Porosity test Visual and dimensional test Galvanizing test Thermal shock test Thermal cycle test Water absorption test Impact test Test of housing: tracking and erosion tests	IEC 60137 IEEE Std C57.19.00 IEEE Std C57.19.01 IEC 60168 IEC 60383 IEC 60507 IEC 60660 IEC 61109 IEC 62217 ANSI C29.1, -2, -6, -7, -12, -13 CAN/CSA C411.1
14	Cables	AC voltage test DC voltage test Lightning impulse test Heat cycle voltage test Capacitance and tan δ measurement Partial discharge measurement Insulation resistance measurement DC resistance measurement Temperature measurement Condition test of XLPE cable Water penetration test Bending test	IEC 60055 IEC 60141 IEC 60502 IEC 60840 IEC 62067 NEN-HD 620 NEN-HD 632 NEN 3619 BS 6622 BS 7835 BS 7870 BS 7912 BS 7970
15	Cable accessories	AC voltage test DC voltage test Lightning impulse voltage test Heat cycle voltage test Temperature measurement Partial discharge measurement Insulation resistance measurement Test under wet conditions Pollution tests R.I.V. measurement Water penetration test Impact test	IEC 60502-4 IEC 60055 IEC 60840 IEC 62067 HD 629-1 HD 629-2 NEN-HD 632 IEEE Std 48 IEEE Std 404

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Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

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This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
16	Current transformers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Capacitance and tan δ measurement Partial discharge measurement Accuracy test Test under wet conditions Temperature measurement Inspection of active part	NEN-EN-IEC 60044-1 NEN-EN-IEC 60044-6 IEC 60044-8
17	Voltage transformers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Capacitance and tan δ measurement Partial discharge measurement Temperature measurement Accuracy test Test under wet conditions Leakage test Inspection of active part	IEC 61869-1 IEC 61869-3 IEC 61869-5 IEC 60044-7
18	Capacitors	AC voltage test Lightning impulse voltage test Capacitance and tan δ measurement Temperature measurement Test under wet conditions Thermal stability test Short-circuit discharge test Endurance test Sealing test Self-healing test Destruction test Ageing test	IEC 60358 IEC 60831 IEC 60871
19	Surge arresters	AC voltage test Lightning impulse voltage test Switching impulse voltage test Current impulse test Pollution tests Partial discharge measurement Temperature measurement Ageing test R.I.V. measurement	IEC 60099 IEEE Std C62.11

ВЯРНО С ОРИГИНАЛА

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Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

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This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
20	Reactors	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Impedance measurement AC resistance measurement Power measurement DC resistance measurement Temperature measurement Acoustic sound level measurement Verification of voltage ratio and phase displacement check	IEC 60076-6 IEEE Std C57.21
21	Compression and mechanical connectors	Temperature-rise test Temperature measurement DC resistance measurement Mechanical tests	IEC 61238-1
22	Protection relays & substation automation equipment	Functional requirements	IEC 60255-1 IEC 60255-8 IEC 60255-12 IEC 60255-13 IEC 60255-16 IEC 60255-127 IEC 60255-151 IEEE C37.112
		Product safety requirements	IEC 60255-1 IEC 60255-27
		EMC requirements	IEC 60255-1 IEC 60255-26 IEC 60255-22 series IEC 60255-11 IEC 61000-4-2 IEC 61000-4-3 IEC 61000-4-4 IEC 61000-4-5 IEC 61000-4-6 IEC 61000-4-8 IEC 61000-4-9 IEC 61000-4-10 IEC 61000-4-11 IEC 61000-4-16 (only 50 Hz) IEC 61000-4-17 IEC 61000-4-18 IEC 61000-4-29 IEEE C37.90 IEEE C37.90.1 IEEE C37.90.2 IEEE C37.90.3

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Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

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This annex is valid from: **26-03-2014** to **01-04-2018**

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No.	Material or product	Type of activity	Internal reference number
	Protection relays & substation automation equipment	Energizing quantities	IEC 60255-1
		Climatic environmental tests	IEC 60255-1 IEC 60068-2-2 tests Bd, Bb IEC 60068-2-1 tests Ad, Ab IEC 60068-2-14 test Nb IEC 60068-2-78 test Cab IEC 60068-2-30 test Db
		Mechanical environmental tests	IEC 60255-1 IEC 60255-21 series
23	Electrical Energy Meters	Tests of - insulation properties, - accuracy requirements, - disturbances of long duration, - electrical requirements, - electromagnetic compatibility, - the effect of climatic environments, - mechanical requirements.	IEC 62052-11 and IEC 62053-11/21/22/23 EN 50470-1/2/3 - Directive 2004/22/EC, annex I, B, F and MI-003

Remark
"in accordance with" is applicable for all standards.

ВЯРНО С ОРИГИНАЛА

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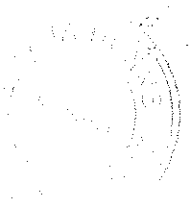

Отчет инспекционен

TIC 3181-13

Списък на типовите изпитания

1. Електрически изпитвания на типа на пълна кабелна система

1.1 Частичен тест разряд при стайна температура

1.2 Tan δ измерване тест

1.3 Частичен тест разряд при стайна температура

1.4 Частичен тест разряд при висока температура

1.5 Тест импулсно напрежение

1.6 Тест при напрежение с промишлена честота

1.7 Тест на кабел с дължина с прилагана метална лента или фолио свързани към обвивката

1.8 Тест на съпротивление на полупроводникови екрани

2.0 Неелектрични типови изпитания за пълна кабелна система и прилежащи компоненти

2.1 Проверка на кабелната констукция

2.2 Тестове за определяне на механичните свойства на изолацията преди и след стареене

2.3 Тестове за определяне на механичните свойства на екранировката преди и след стареене

2.4 Тестове за стареене върху части от цял кабел, за да се провери съвместимостта на материалите тест

2.5 Тест за налягане при висока температура на Обвивката

2.6 Комплексен тест по нагряване на XLPE изолацията

2.7 Измерване на сажди съдържанието на сажди във външната PE обвивка

2.8 Тест за водонепропускливост.

O: 72130463

KEMA

KEMA Nederland B.V.

S.A.M. Verhoeven
Director Testing, Inspections &
Certification The Netherlands
Arnhem, 19 December 2013

ВЯРНО С ОРИГИНАЛА

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превод от английски език,
извършен от Даниела Ангелова Тодорова

ESTRALIN HVC

ЕИК ДРАГАЛЕВСКИ Пловдив

Тестове	
Рутинни тестове	
Измерване на удължение и съпротивление на въжето	
Измерване на електрическото съпротивление на проводника	
Измерване на геометричните параметри на кабелната сърцевина	
Тест на нагряване на XLPE изолация	
Проверка за дефекти по изолацията	
Тестове за допуск на продукцията	
Ел. тест на външната обвивка на кабела	
Проверка на маркировката на външната обвивка	
Проверка на адхезията на металното фолио	
Measurement of attenuation of FIMT	
Измерване на капацитет	
Измерване на електрическото съпротивление на проводника	
Частични разряди	
Тест по напрежение	
Проверка на кабелната конструкция	

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Tests	Frequency of tests
routine tests	
Measurement of elongation and resistance of wire	one length from each batch (manufacturing series)
Conductor examination, measurement of electrical resistance of conductor	one length from each batch (manufacturing series)
Measurement of geometric parameters of cable core	from both ends of each production length
Hot-set test for XLPE insulations	from one end of each production length
Check for inclusions or contaminants in the insulation	from one end of each production length
acceptance tests	
Electrical test on over sheath of the cable	each cable length
Check of outer sheath marking	each cable length
Measurement of adhesion of metal foil	one length from each batch (manufacturing series)
Measurement of attenuation of FIMT	each cable length
Measurement of capacitance	each cable length
Measurement of electrical resistance of conductor	each cable length
Partial discharge test	each cable length
Voltage test	each cable length
Check of cable construction	from both ends of each cable length

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160342**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0319 Cable drum № **27Д5874**

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10 nom 49,60 max 50,10	min 49,13 avg 49,30 max 49,46	min 49,11 avg 49,25 max 49,36
Conductor screen			
thickness, mm	min 1,00 nom 1,50 max 2,50	min 1,83 avg 2,02 max 2,20	min 1,81 avg 2,11 max 2,41
max-min point difference, mm	≤ 1,0	0,37	0,60
Insulation			
thickness, mm	min 13,5 nom 15,0 max 16,0	min 14,30 avg 15,03 max 15,75	min 14,37 avg 15,01 max 15,65
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	9	8
diameter over insulation, mm	min 83,2 nom 84,2 max 85,2	min 83,20 avg 83,80 max 84,39	min 83,23 avg 83,81 max 84,38
Insulation screen			
thickness, mm	min 0,5 nom 1,1 max 1,7	min 0,92 avg 1,25 max 1,58	min 0,94 avg 1,13 max 1,31
max-min point difference, mm	≤ 1,0	0,66	0,37
diameter over insulation screen, mm	min 85,2 nom 86,4 max 87,6	min 85,37 avg 85,97 max 86,56	min 85,40 avg 86,00 max 86,59
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,40	112,40
Outer sheath			
thickness, mm	min 3,3 nom 4,0	min 4,08 avg 5,08 max 6,07	min 4,11 avg 4,69 max 5,27
diameter over outer sheath, mm		min 100,29 max 100,67	min 100,14 max 100,68

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЭВК
СЫЛКИН С.В.

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 2

Serial number **160342**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0319 Cable drum № 27Д5874

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	57
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the Insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0183
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5809 kg Gross weight 7209 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН
Сыпин С.В.

QD:

ДЗЗД "ЕИК ДРАГАЛЕВЦИ" Пловдив

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FACTORY ACCEPTANCE TEST REPORT

Serial number **160343**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0320 Cable drum № 27Д5875

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,23	min 49,11
	nom 49,60	avg 49,32	avg 49,23
	max 50,10	max 49,41	max 49,34
Conductor screen			
thickness, mm	min 1,00	min 1,76	min 1,72
	nom 1,50	avg 1,96	avg 2,09
	max 2,50	max 2,15	max 2,45
max-min point difference, mm	≤ 1,0	0,39	0,73
Insulation			
thickness, mm	min 13,5	min 14,63	min 14,60
	nom 15,0	avg 15,16	avg 15,03
	max 18,0	max 15,68	max 15,45
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	7	6
diameter over insulation, mm	min 83,2	min 83,23	min 83,22
	nom 84,2	avg 83,69	avg 83,73
	max 85,2	max 84,15	max 84,23
Insulation screen			
thickness, mm	min 0,5	min 0,92	min 0,98
	nom 1,1	avg 1,11	avg 1,16
	max 1,7	max 1,29	max 1,34
max-min point difference, mm	≤ 1,0	0,37	0,36
diameter over insulation screen, mm	min 85,2	min 85,51	min 85,43
	nom 86,4	avg 85,94	avg 85,93
	max 87,6	max 86,37	max 86,42
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,67	112,67
Outer sheath			
thickness, mm	min 3,3	min 3,62	min 3,74
	nom 4,0	avg 4,35	avg 4,54
		max 5,07	max 5,33
diameter over outer sheath, mm		min 100,36	min 100,42
		max 100,93	max 101,03

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК СЫЧИН С.В.

ДЗЗД "ЕИК ДРАГАЛЕВСКИ" Пловдив

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160343**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0320 Cable drum № 27Д5875

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	57
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 mln.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5809 kg Gross weight 7209 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК СЫВИН С.В.

ВЕРНО С ОРИГИНАЛА

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FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160344**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0821 Cable drum № 27Д5876

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,16	min 49,27
	nom 49,60	avg 49,29	avg 49,40
	max 50,10	max 49,39	max 49,53
Conductor screen			
thickness, mm	min 1,00	min 1,43	min 1,72
	nom 1,50	avg 1,79	avg 1,91
	max 2,50	max 2,14	max 2,09
max-min point difference, mm	≤ 1,0	0,71	0,37
Insulation			
thickness, mm	min 13,5	min 14,57	min 14,79
	nom 15,0	avg 15,02	avg 15,09
	max 18,0	max 15,47	max 15,38
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	4
diameter over insulation, mm	min 83,2	min 83,21	min 83,33
	nom 84,2	avg 83,69	avg 83,86
	max 85,2	max 84,17	max 84,39
Insulation screen			
thickness, mm	min 0,5	min 0,94	min 0,70
	nom 1,1	avg 1,26	avg 1,14
	max 1,7	max 1,58	max 1,58
max-min point difference, mm	≤ 1,0	0,64	0,88
diameter over insulation screen, mm	min 85,2	min 85,35	min 85,20
	nom 86,4	avg 85,86	avg 85,85
	max 87,6	max 86,37	max 86,50
ratio ø min/ø max	≥ 0,95	0,99	0,98
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,20	min 5,02
	nom 4,0	avg 4,65	avg 5,41
		max 5,10	max 5,79
diameter over outer sheath, mm		min 102,30	min 101,80
		max 102,65	max 102,03

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЗВК
СЫЧЕВ С.Б.

ВЯРНО С ОРИГИНАЛА

1046

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160344**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0321 Cable drum № 27Д5876

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	57
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5809 kg **Gross weight 7209 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЗВК
СЫЛИН С.В.

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160351**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0322 Cable drum № **27Д5877**

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,10
	nom 49,60	avg 49,15	avg 49,17
	max 50,10	max 49,19	max 49,23
Conductor screen			
thickness, mm	min 1,00	min 1,69	min 1,81
	nom 1,50	avg 1,93	avg 1,96
	max 2,50	max 2,16	max 2,11
max-min point difference, mm	≤ 1,0	0,47	0,30
Insulation			
thickness, mm	min 13,5	min 14,77	min 14,83
	nom 15,0	avg 15,21	avg 15,16
	max 18,0	max 15,65	max 15,48
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	4
diameter over insulation, mm	min 83,2	min 83,23	min 83,45
	nom 84,2	avg 83,97	avg 83,85
	max 85,2	max 84,71	max 84,25
Insulation screen			
thickness, mm	min 0,5	min 0,95	min 0,98
	nom 1,1	avg 1,13	avg 1,14
	max 1,7	max 1,30	max 1,29
max-min point difference, mm	≤ 1,0	0,35	0,31
diameter over insulation screen, mm	min 85,2	min 85,73	min 85,67
	nom 86,4	avg 86,34	avg 86,08
	max 87,6	max 86,94	max 86,49
ratio Ø min/Ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,67	112,67
Outer sheath			
thickness, mm	min 3,3	min 3,99	min 3,98
	nom 4,0	avg 4,52	avg 4,54
		max 5,04	max 5,10
diameter over outer sheath, mm		min 100,52	min 100,24
		max 101,17	max 101,15

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК Сийчи С.В.

ВЯРНО С ОРИГИНАЛА

1048

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160351**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0322 Cable drum № 27Д5877

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	57
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 4932 kg **Gross weight 6332 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
in accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК СЫРКИН С.В.

ВЯРНО С ОРИГИНАЛА

1049

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160352**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0323 Cable drum № 27Д5878

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10 nom 49,60 max 50,10	min 49,16 avg 49,47 max 49,78	min 49,22 avg 49,57 max 49,92
Conductor screen			
thickness, mm	min 1,00 nom 1,50 max 2,50	min 1,47 avg 1,82 max 2,17	min 1,64 avg 1,88 max 2,11
max-min point difference, mm	≤ 1,0	0,70	0,47
Insulation			
thickness, mm	min 13,5 nom 15,0 max 18,0	min 14,66 avg 15,16 max 15,66	min 14,50 avg 15,24 max 15,97
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	9
diameter over insulation, mm	min 83,2 nom 84,2 max 85,2	min 83,68 avg 84,09 max 84,49	min 83,40 avg 83,96 max 84,51
Insulation screen			
thickness, mm	min 0,5 nom 1,1 max 1,7	min 0,92 avg 1,14 max 1,35	min 0,93 avg 1,12 max 1,30
max-min point difference, mm	≤ 1,0	0,43	0,37
diameter over insulation screen, mm	min 85,2 nom 86,4 max 87,6	min 85,95 avg 86,36 max 86,77	min 85,50 avg 86,05 max 86,59
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,40	112,40
Outer sheath			
thickness, mm	min 3,3 nom 4,0	min 4,12 avg 4,31 max 4,49	min 4,35 avg 4,68 max 5,01
diameter over outer sheath, mm		min 100,65 max 101,23	min 100,84 max 101,83

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified in accordance with the requirements of: TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЗВК
СЫЕЕН С.В.

1050

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160352**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0323 Cable drum № 27Д5878

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation elongation under load, % permanent elongation, %	≤ 175 ≤ 15	50 0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil) peel strength of overlapped foil, N/mm adhesion strength of foil, N/mm Al tape thickness, mm overlaping, mm	≥ 1,0 ≥ 1,0 ≥ 0,1 ≥ 15	1,3 1,8 0,15 16,1
Electrical tests electrical resistance of conductor, Ω/km Voltage Test (160 kV, 30 min.) Partial Discharge Test noise level at voltage of 160 kV, pC noise level at voltage of 96 kV, pC cable capacity, μF/km	≤ 0,0186 No breakdown ≤ 10 ≤ 5 ≤ 0,32	0,0184 No breakdown ≤ 10 ≤ 5 0,31
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 4932 kg Gross weight 6332 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» Сычев С.В.

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160353**

Date 26.07.2016

Marking АПвП2г 1х1600(сж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0324 Cable drum № **27Д5879**

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10 nom 49,60 max 50,10	min 49,10 avg 49,39 max 49,67	min 49,10 avg 49,42 max 49,74
Conductor screen			
thickness, mm	min 1,00 nom 1,50 max 2,50	min 1,62 avg 1,88 max 2,14	min 1,62 avg 1,89 max 2,16
max-min point difference, mm	≤ 1,0	0,52	0,54
Insulation			
thickness, mm	min 13,5 nom 15,0 max 18,0	min 15,02 avg 15,32 max 15,61	min 14,76 avg 15,19 max 15,62
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	4	6
diameter over insulation, mm	min 83,2 nom 84,2 max 85,2	min 83,77 avg 84,21 max 84,65	min 83,65 avg 83,95 max 84,25
Insulation screen			
thickness, mm	min 0,5 nom 1,1 max 1,7	min 0,95 avg 1,13 max 1,31	min 0,87 avg 1,15 max 1,43
max-min point difference, mm	≤ 1,0	0,36	0,56
diameter over insulation screen, mm	min 85,2 nom 86,4 max 87,6	min 86,05 avg 86,46 max 86,87	min 85,87 avg 86,22 max 86,56
ratio Ø min/Ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3 nom 4,0	min 3,95 avg 4,43 max 4,90	min 3,90 avg 4,46 max 5,01
diameter over outer sheath, mm		min 100,82 max 101,47	min 100,38 max 101,10

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: ISO 9001

QD:

ВЯРНО С ОРИГИНАЛА

1052

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160353**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0324 Cable drum № 27Д5879

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	50
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 4932 kg **Gross weight 6332 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of:

TUV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЗВК
СЫЧЕВ С.В.

ВЯРНО С ОРИГИНАЛА

1053

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160345**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0325

Length 485 m

Cable drum № 27Д5880

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10 nom 49,60 max 50,10	min 49,19 avg 49,52 max 49,85	min 49,10 avg 49,45 max 49,79
Conductor screen			
thickness, mm	min 1,00 nom 1,50 max 2,50	min 1,55 avg 1,81 max 2,07	min 1,65 avg 2,03 max 2,41
max-min point difference, mm	≤ 1,0	0,52	0,76
Insulation			
thickness, mm	min 13,5 nom 15,0 max 18,0	min 15,05 avg 15,32 max 15,58	min 15,11 avg 15,54 max 15,97
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	3	5
diameter over insulation, mm	min 83,2 nom 84,2 max 85,2	min 83,64 avg 84,24 max 84,84	min 84,25 avg 84,50 max 84,75
Insulation screen			
thickness, mm	min 0,5 nom 1,1 max 1,7	min 0,95 avg 1,13 max 1,30	min 0,98 avg 1,12 max 1,26
max-min point difference, mm	≤ 1,0	0,35	0,28
diameter over insulation screen, mm	min 85,2 nom 86,4 max 87,6	min 85,88 avg 86,46 max 87,04	min 86,61 avg 86,79 max 86,96
ratio ø min/ø max	≥ 0,95	0,99	1,00
Copper screen			
cross-section, mm²	≥ 110	112,40	112,40
Outer sheath			
thickness, mm	min 3,3 nom 4,0	min 4,10 avg 4,40 max 4,70	min 4,20 avg 4,41 max 4,62
diameter over outer sheath, mm		min 100,84 max 101,51	min 99,45 max 100,36

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЗВК
СЫЩИН С.В.

QD:

ВЯРНО С ОРИГИНАЛА

1054

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160345**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0325 Cable drum № 27Д5880

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	72
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5316 kg **Gross weight 6716 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747016-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» Сынин С.В.

ВЯРНО С ОРИГИНАЛА

1055

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160346**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0326

Cable drum № **27Д5881**

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,11	min 49,22
	nom 49,60	avg 49,35	avg 49,27
	max 50,10	max 49,59	max 49,31
Conductor screen			
thickness, mm	min 1,00	min 1,52	min 1,66
	nom 1,50	avg 1,97	avg 1,94
	max 2,50	max 2,42	max 2,21
max-min point difference, mm	≤ 1,0	0,90	0,55
Insulation			
thickness, mm	min 13,5	min 14,88	min 14,61
	nom 15,0	avg 15,36	avg 15,08
	max 18,0	max 15,84	max 15,54
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	6
diameter over insulation, mm	min 83,2	min 83,96	min 83,47
	nom 84,2	avg 84,35	avg 84,08
	max 85,2	max 84,73	max 84,68
Insulation screen			
thickness, mm	min 0,5	min 0,90	min 0,97
	nom 1,1	avg 1,10	avg 1,14
	max 1,7	max 1,30	max 1,31
max-min point difference, mm	≤ 1,0	0,40	0,34
diameter over insulation screen, mm	min 85,2	min 86,08	min 85,72
	nom 86,4	avg 86,51	avg 86,31
	max 87,6	max 86,93	max 86,89
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,54	112,54
Outer sheath			
thickness, mm	min 3,3	min 3,72	min 4,10
	nom 4,0	avg 4,38	avg 4,45
		max 5,03	max 4,80
diameter over outer sheath, mm		min 100,32	min 100,49
		max 101,09	max 101,30

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК Сыпин С.В.

ВЯРНО С ОРИГИНАЛА

1056

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160346**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0326 Cable drum № 27Д5881

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	71
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5316 kg **Gross weight 6716 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО «ЭСТРАЛИН ЗВК»
СИПИН С.В.

1057

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160347**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0327

Cable drum № 27Д5882

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,11	min 49,11
	nom 49,60	avg 49,35	avg 49,23
	max 50,10	max 49,58	max 49,35
Conductor screen			
thickness, mm	min 1,00	min 1,84	min 1,79
	nom 1,50	avg 1,98	avg 1,93
	max 2,50	max 2,12	max 2,07
max-min point difference, mm	≤ 1,0	0,28	0,28
Insulation			
thickness, mm	min 13,5	min 14,80	min 14,79
	nom 15,0	avg 15,17	avg 15,26
	max 18,0	max 15,54	max 15,72
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	5	6
diameter over insulation, mm	min 83,2	min 83,90	min 83,63
	nom 84,2	avg 84,25	avg 84,09
	max 85,2	max 84,60	max 84,54
Insulation screen			
thickness, mm	min 0,5	min 0,92	min 0,94
	nom 1,1	avg 1,11	avg 1,12
	max 1,7	max 1,29	max 1,29
max-min point difference, mm	≤ 1,0	0,37	0,35
diameter over insulation screen, mm	min 85,2	min 86,14	min 86,26
	nom 86,4	avg 86,45	avg 86,48
	max 87,6	max 86,75	max 86,70
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 3,60	min 4,45
	nom 4,0	avg 4,33	avg 4,78
		max 5,05	max 5,10
diameter over outer sheath, mm		min 101,98	min 100,66
		max 102,81	max 101,81

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЭВК
СЫПКИН С.В.

QD:

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160347**

DATE 26.07.2016

Marking АПвП2г 1х1600(сж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0327 Cable drum № 27Д5882

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	71
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5316 kg **Gross weight 6716 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of:

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК Сынин С.В.

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160348**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0329 Cable drum № **27Д5884**

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,11
	nom 49,60	avg 49,25	avg 49,33
	max 50,10	max 49,40	max 49,54
Conductor screen			
thickness, mm	min 1,00	min 1,63	min 1,49
	nom 1,50	avg 1,96	avg 1,83
	max 2,50	max 2,29	max 2,16
max-min point difference, mm	≤ 1,0	0,66	0,67
Insulation			
thickness, mm	min 13,5	min 14,88	min 14,65
	nom 15,0	avg 15,18	avg 15,17
	max 18,0	max 15,47	max 15,69
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	4	7
diameter over insulation, mm	min 83,2	min 83,70	min 83,45
	nom 84,2	avg 84,20	avg 84,03
	max 85,2	max 84,70	max 84,60
Insulation screen			
thickness, mm	min 0,5	min 0,97	min 0,95
	nom 1,1	avg 1,14	avg 1,15
	max 1,7	max 1,30	max 1,34
max-min point difference, mm	≤ 1,0	0,33	0,39
diameter over insulation screen, mm	min 85,2	min 86,04	min 85,78
	nom 86,4	avg 86,44	avg 86,30
	max 87,6	max 86,84	max 86,82
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 3,90	min 3,90
	nom 4,0	avg 4,45	avg 4,18
		max 5,00	max 4,46
diameter over outer sheath, mm		min 100,76	min 100,38
		max 101,80	max 101,09

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЗВК
СЫЧИН С.В.

QD:

ВЕРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160348**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0329 Cable drum № 27Д5884

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	64
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5152 kg Gross weight 6552 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD: _____

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160349**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0330 Cable drum № 27Д5885

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10 nom 49,60 max 50,10	min 49,10 avg 49,34 max 49,58	min 49,17 avg 49,30 max 49,43
Conductor screen			
thickness, mm	min 1,00 nom 1,50 max 2,50	min 1,53 avg 1,84 max 2,15	min 1,86 avg 1,98 max 2,10
max-min point difference, mm	≤ 1,0	0,62	0,24
Insulation			
thickness, mm	min 13,5 nom 15,0 max 18,0	min 14,41 avg 15,08 max 15,75	min 14,79 avg 15,26 max 15,73
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	9	6
diameter over insulation, mm	min 83,2 nom 84,2 max 85,2	min 83,57 avg 83,92 max 84,27	min 83,51 avg 84,00 max 84,49
Insulation screen			
thickness, mm	min 0,5 nom 1,1 max 1,7	min 0,91 avg 1,27 max 1,62	min 0,63 avg 1,08 max 1,53
max-min point difference, mm	≤ 1,0	0,71	0,90
diameter over insulation screen, mm	min 85,2 nom 86,4 max 87,6	min 85,87 avg 86,34 max 86,80	min 85,60 avg 85,93 max 86,25
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3 nom 4,0	min 3,95 avg 4,11 max 4,27	min 4,02 avg 4,55 max 5,07
diameter over outer sheath, mm		min 100,36 max 102,20	min 100,40 max 101,15

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК Сынгин С.В.

ВЕРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160349**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0330 Cable drum № 27Д5885

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	64
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5152 kg Gross weight 6552 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «СТРАЖИН ЭВК» Сидей С.В.

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160354**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0328

Cable drum № **27Д5883**

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,17	min 49,38
	nom 49,60	avg 49,35	avg 49,49
	max 50,10	max 49,52	max 49,60
Conductor screen			
thickness, mm	min 1,00	min 1,75	min 1,80
	nom 1,50	avg 2,10	avg 2,02
	max 2,50	max 2,44	max 2,24
max-min point difference, mm	≤ 1,0	0,69	0,44
Insulation			
thickness, mm	min 13,5	min 14,69	min 14,72
	nom 15,0	avg 15,17	avg 15,15
	max 18,0	max 15,65	max 15,58
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	6
diameter over insulation, mm	min 83,2	min 83,52	min 83,79
	nom 84,2	avg 83,97	avg 83,99
	max 85,2	max 84,41	max 84,19
Insulation screen			
thickness, mm	min 0,5	min 0,94	min 0,65
	nom 1,1	avg 1,26	avg 1,08
	max 1,7	max 1,58	max 1,51
max-min point difference, mm	≤ 1,0	0,64	0,86
diameter over insulation screen, mm	min 85,2	min 85,79	min 85,85
	nom 86,4	avg 86,23	avg 86,27
	max 87,6	max 86,67	max 86,69
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,25	min 4,44
	nom 4,0	avg 4,61	avg 4,73
		max 4,97	max 5,02
diameter over outer sheath, mm		min 100,65	min 101,70
		max 101,38	max 102,08

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «СТРАЛИН ЭВК» С.В.

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160354**

DATE 26.07.2016

Marking АПвП2г 1х1600(сж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0328 Cable drum № 27Д5883

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	71
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5152 kg Gross weight 6552 kg

Notes: all tests were passed successfully, cable meets ТУ 3630-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК Сыпин С.В.

ВЯРНО С ОРИГИНАЛА

1065

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160355**

Date 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0331 Cable drum № **27ДТ5898**

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,18	min 49,47
	nom 49,60	avg 49,39	avg 49,65
	max 50,10	max 49,60	max 49,83
Conductor screen			
thickness, mm	min 1,00	min 1,70	min 1,63
	nom 1,50	avg 2,07	avg 1,92
	max 2,50	max 2,44	max 2,20
max-min point difference, mm	≤ 1,0	0,74	0,57
Insulation			
thickness, mm	min 13,5	min 14,80	min 14,66
	nom 15,0	avg 15,07	avg 15,00
	max 18,0	max 15,34	max 15,34
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	4	4
diameter over insulation, mm	min 83,2	min 83,35	min 83,20
	nom 84,2	avg 83,70	avg 83,67
	max 85,2	max 84,04	max 84,13
Insulation screen			
thickness, mm	min 0,5	min 0,93	min 0,94
	nom 1,1	avg 1,22	avg 1,21
	max 1,7	max 1,50	max 1,48
max-min point difference, mm	≤ 1,0	0,57	0,54
diameter over insulation screen, mm	min 85,2	min 85,86	min 85,20
	nom 86,4	avg 86,22	avg 85,78
	max 87,6	max 86,57	max 86,35
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,26	min 4,12
	nom 4,0	avg 4,61	avg 4,46
		max 4,95	max 4,80
diameter over outer sheath, mm		min 101,18	min 100,67
		max 101,79	max 101,00

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЭВХ Сынев С.В.

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160355**

DATE 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0331 Cable drum № 27ДТ5898

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	68
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) In the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test		
(160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5864 kg **Gross weight 7264 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» СЫЧЕВ С.Г.

ВЯРНО С ОРИГИНАЛА

1067

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160356**

Date 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0333 **Cable drum № 27ДТ5900**

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,12	min 49,23
	nom 49,60	avg 49,32	avg 49,43
	max 50,10	max 49,52	max 49,62
Conductor screen			
thickness, mm	min 1,00	min 1,64	min 1,71
	nom 1,50	avg 1,91	avg 1,96
	max 2,50	max 2,18	max 2,21
max-min point difference, mm	≤ 1,0	0,54	0,50
Insulation			
thickness, mm	min 13,5	min 14,69	min 14,59
	nom 15,0	avg 15,21	avg 15,17
	max 18,0	max 15,72	max 15,75
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	7	7
diameter over Insulation, mm	min 83,2	min 83,59	min 83,43
	nom 84,2	avg 83,87	avg 84,11
	max 85,2	max 84,15	max 84,79
Insulation screen			
thickness, mm	min 0,5	min 0,93	min 0,58
	nom 1,1	avg 1,22	avg 0,93
	max 1,7	max 1,50	max 1,28
max-min point difference, mm	≤ 1,0	0,57	0,70
diameter over Insulation screen, mm	min 85,2	min 85,73	min 85,31
	nom 86,4	avg 86,06	avg 86,16
	max 87,6	max 86,39	max 87,00
ratio ø min/ø max	≥ 0,95	0,99	0,98
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,98	min 4,79
	nom 4,0	avg 5,22	avg 5,06
		max 5,45	max 5,32
diameter over outer sheath, mm		min 102,37	min 101,27
		max 102,62	max 101,66

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: ISO 9001

QD: ОТДЕЛ КАЧЕСТВА

ВЗЯТО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160356**

DATE 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0333 **Cable drum № 27ДТ5900**

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	68
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5864 kg Gross weight 7264 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» СЫЧКИН С.В.

ВЯРНО С ОРИГИНАЛА

1065

Ltd «Estralin HVC»
111024, Moscow, 2-nd Kabelnaya st.(2, bld. 2)
www.estralin.com

ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160364**

Date 03.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0332 **Cable drum № 27ДТ5899**

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The Inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,20
	nom 49,60	avg 49,17	avg 49,33
	max 50,10	max 49,24	max 49,45
Conductor screen			
thickness, mm	min 1,00	min 1,45	min 1,76
	nom 1,50	avg 1,94	avg 1,99
	max 2,50	max 2,42	max 2,22
max-min point difference, mm	≤ 1,0	0,97	0,46
Insulation			
thickness, mm	min 13,5	min 14,83	min 14,75
	nom 15,0	avg 15,24	avg 15,19
	max 18,0	max 15,65	max 15,62
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	5	6
diameter over insulation, mm	min 83,2	min 83,74	min 83,51
	nom 84,2	avg 84,16	avg 84,05
	max 85,2	max 84,58	max 84,58
Insulation screen			
thickness, mm	min 0,5	min 0,94	min 0,93
	nom 1,1	avg 1,14	avg 1,11
	max 1,7	max 1,34	max 1,29
max-min point difference, mm	≤ 1,0	0,40	0,36
diameter over insulation screen, mm	min 85,2	min 86,08	min 85,87
	nom 86,4	avg 86,40	avg 86,36
	max 87,6	max 86,72	max 86,84
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,24	min 3,63
	nom 4,0	avg 4,44	avg 4,35
		max 4,64	max 5,06
diameter over outer sheath, mm		min 100,25	min 100,55
		max 101,43	max 101,18

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified in accordance with the requirements of: TÜV NORD ISO 9001

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ВЕРНО С ОРИГИНАЛА

1070

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160364**

DATE 03.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0332 Cable drum № 27ДТ5899

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	68
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5864 kg **Gross weight 7264 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК

1071

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111024, Moscow, 2-nd Kabelnaya str, 2, bld. 24
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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160357**

Date 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0334 Cable drum № **25Д5901**

Length 300 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,15
	nom 49,60	avg 49,17	avg 49,25
	max 50,10	max 49,24	max 49,35
Conductor screen			
thickness, mm	min 1,00	min 1,70	min 1,88
	nom 1,50	avg 1,95	avg 2,00
	max 2,50	max 2,20	max 2,11
max-min point difference, mm	≤ 1,0	0,50	0,23
Insulation			
thickness, mm	min 13,5	min 14,79	min 14,32
	nom 15,0	avg 15,17	avg 15,06
	max 18,0	max 15,54	max 15,80
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	5	9
diameter over Insulation, mm	min 83,2	min 83,61	min 83,40
	nom 84,2	avg 84,08	avg 84,11
	max 85,2	max 84,55	max 84,81
Insulation screen			
thickness, mm	min 0,5	min 0,96	min 0,95
	nom 1,1	avg 1,17	avg 1,26
	max 1,7	max 1,37	max 1,56
max-min point difference, mm	≤ 1,0	0,41	0,61
diameter over Insulation screen, mm	min 85,2	min 85,82	min 85,86
	nom 86,4	avg 86,28	avg 86,50
	max 87,6	max 86,74	max 87,13
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 3,95	min 4,05
	nom 4,0	avg 4,31	avg 4,38
		max 4,66	max 4,71
diameter over outer sheath, mm		min 101,85	min 100,93
		max 102,30	max 101,65

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

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1072

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 2

Serial number **160357**

DATE 01.08.2016

Marking: АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0334 Cable drum № **25Д5901**

Length 300 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation elongation under load, % permanent elongation, %	≤ 175 ≤ 15	68 0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil) peel strength of overlapped foil, N/mm adhesion strength of foil, N/mm Al tape thickness, mm overlaping, mm	≥ 1,0 ≥ 1,0 ≥ 0,1 ≥ 15	1,3 1,8 0,15 16,1
Electrical tests electrical resistance of conductor, Ω/km Voltage Test (160 kV, 30 min.) Partial Discharge Test noise level at voltage of 160 kV, pC noise level at voltage of 96 kV, pC cable capacity, μF/km	≤ 0,0186 No breakdown ≤ 10 ≤ 5 ≤ 0,32	0,0184 No breakdown ≤ 10 ≤ 5 0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 3288 kg **Gross weight 4588 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» СЫЧЁВ С.В.

ВЯРНО С ОРИГИНАЛА

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Приложение № 3 към Предложение за изпълнение на поръчката– Заверени копия на протоколи от типови изпитвания на: 3.2. Цифрови защити (ЦЗ ВКЕЛ 110 kV) за въводно поле „Драгалевци" 110 kv: Основна цифрова надлъжна диференциална защита (комплект от две релета), Резервна цифрова максималнотокова защита на КЕЛ 110 kV - Протоколи от типови изпитвания на български или английски език, проведени от независима изпитвателна лаборатория – заверени копия, с приложен списък на отделните изпитвания на български език

Списък на типовите изпитания на устройствата от серията 670 и в частност RED670 съгласно съответните приложими международни стандарти

Таблица 17: Електромагнитна съвместимост

Тест/изпитване	Стойности при типови изпитания	Референтен стандарт
1 MHz бързо смущение	2.5 kV	IEC 60255-26
100 kHz бавно затихващо смущение с осцилираща вълна	2.5 kV	IEC 61000-4-18, клас III
Изпитания при смущение с кръгова вълна, 100 kHz	2-4 kV	IEC 61000-4-12, клас IV
Изпитания за издръжливост при смущения от пренапрежения	2.5 kV, осцилиращо 4.0 kV, бърз преходен процес	IEEE/ANSI C37.90.1
Електростатичен разряд Директно приложение Индиректно проложение	15 kV въздушен разряд 8 kV контактен разряд 8 kV контактен разряд	IEC 60255-26 IEC 61000-4-2, клас IV
Електростатичен разряд Директно приложение Индиректно проложение	15 kV въздушен разряд 8 kV контактен разряд 8 kV контактен разряд	IEEE/ANSI C37.90.1
Бързо преходно смущение	4 kV	IEC 60255-26, зона A
Изпитание при смущения от пренапрежение	2-4 kV, 1.2/50 ms голяма енергия	IEC 60255-26, зона A
Изпитание при смущения с промишлена честота	150-300 V, 50 Hz	IEC 60255-26, зона A
Изпитание за проведено смущение от общ вид	15 Hz-150 kHz	IEC 61000-4-16, клас IV
Изпитания при смущения с магнитно поле с промишлена честота	1000 A/m, 3 s 100 A/m, продължително	IEC 61000-4-8, клас V
Изпитание при смущения с пулсиращо магнитно поле	1000 A/m	IEC 61000–4–9, клас V
Изпитание при смущения от затихващо осцилиращо магнитно поле	100 A/m	IEC 61000-4-10, клас V
Излъчвания на електромагнитно поле с радио честоти	20 V/m, 80-1000 MHz 1.4-2.7 GHz	IEC 60255-26
Излъчвания на електромагнитно поле с радио честоти	20 V/m 80-1000 MHz	IEEE/ANSI C37.90.2
Проведено смущение на електромагнитно поле	10 V, 0.15-80 MHz	IEC 60255-26
Радио смущения	30-5000 MHz	IEC 60255-26
Радио смущения	30-5000 MHz	IEEE/ANSI C63.4, FCC
Проведени емисии	0.15-30 MHz	IEC 60255-26

ВЯРНО С ОРИГИНАЛА

ИНТЕРКОМПЛЕКС ООД ПЛОВДИВ

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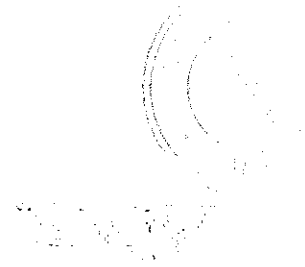


Таблица 18: Изолация

Тест/изпитване	Стойности при типови изпитания	Референтен стандарт
Диелектрични изпитания	2.0 kV AC, 1 мин.	IEC 60255-27 ANSI C37.90
Изпитания с импулсно напрежение	5 kV, 1.2/50 ms, 0.5 J	
Изолационно съпротивление	>100 МОм при 500 VDC	

Таблица 19: Изпитания за околна среда

Тест/изпитване	Стойности при типови изпитания	Референтен стандарт
Работа при студ	Тест Ad за 16 часа при -25°C	IEC 60068-2-1
Изпитание при съхранение на студ	Тест Ab за 16 часа при -40°C	IEC 60068-2-1
Изпитание при работа на суха топлина	Тест Bd за 16 часа при +70°C	IEC 60068-2-2
Изпитание при съхранение на суха топлина	Тест Bb за 16 часа при +85°C	IEC 60068-2-2
Изпитание при промяна на температурата	Тест Nb за 5 цикъла при условия от -25°C до +70°C	IEC 60068-2-14
Изпитание при влажна топлина, стабилно състояние	Тест Ca за 10 дни при условия +40°C и влажност 93%	IEC 60068-2-78
Изпитание при влажна топлина, цикличен тест	Тест Db за 6 цикъла при условия от +25 до +55°C и влажност 93 до 95% (1 цикъл = 24 часа)	IEC 60068-2-30

Таблица 20: CE съответствие

Тест/изпитване	Референтен стандарт
Смущения	EN 60255–26
Излъчване	EN 60255–26
Директива ниско напрежение	EN 60255–27

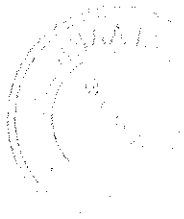
Таблица 21: Механични тестове

Тест/изпитване	Стойности при типови изпитания	Референтен стандарт
Тест за реакция при вибрации	клас II	IEC 60255-21-1
Тест за износване при вибрации	клас I	IEC 60255-21-1
Тест за реакция удар	клас I	IEC 60255-21-2
Тест за издържане на удар	клас I	IEC 60255-21-2
Тест при друсане	клас I	IEC 60255-21-2
Сеизмични изпитания	клас II	IEC 60255-21-3

ВЯРНО С ОРИГИНАЛА

ИНТЕРКОМПЛЕКС ООД

1076



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Line differential protection RED670 2.1 IEC
Type test certificate

Power and productivity
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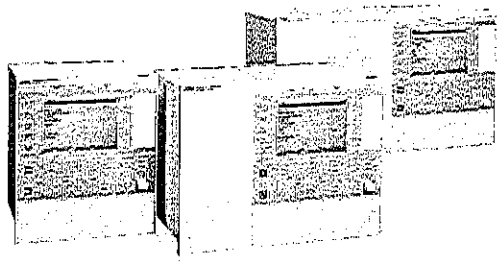

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Product version: 2.1

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Warranty

Please inquire about the terms of warranty from your nearest ABB representative.

Disclaimer

The data, examples and diagrams in this manual are included solely for the concept or product description and are not to be deemed as a statement of guaranteed properties. All persons responsible for applying the equipment addressed in this manual must satisfy themselves that each intended application is suitable and acceptable, including that any applicable safety or other operational requirements are complied with. In particular, any risks in applications where a system failure and/or product failure would create a risk for harm to property or persons (including but not limited to personal injuries or death) shall be the sole responsibility of the person or entity applying the equipment, and those so responsible are hereby requested to ensure that all measures are taken to exclude or mitigate such risks.

This document has been carefully checked by ABB but deviations cannot be completely ruled out. In case any errors are detected, the reader is kindly requested to notify the manufacturer. Other than under explicit contractual commitments, in no event shall ABB be responsible or liable for any loss or damage resulting from the use of this manual or the application of the equipment.

Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standard EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series.

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Section 1 General

1.1 Type test data

This document certifies that the product described below is in accordance with, and conforms to the data stated in this Type Test Certificate and corresponding data in the Type Test Report and Product Guide.

The product has been tested according to relevant parts of the standards stated below.

Product/Type	Line differential protection IED Type RED670 v2.1
Product Guide	1MRK 505 346-BEN
User's Manuals	1MRK 500 123-UEN 1MRK 505 343-UEN 1MRK 505 344-UEN 1MRK 505 345-UEN 1MRK 514 024-UEN
Function	Line differential protection
Manufactured by	ABB AB, Sweden
Author/department	Rune Östlund, TP/TD
Date of issue	2015-09-15
Approved by	ABB AB Product Manager Joseph Menezes
Standards	IEC 60068, IEC 60255, IEC 60529, IEC 60870, IEC 61000, IEC 61810, IEC 61850, ANSI C37.90, ANSI C37.99, ANSI C37.112, ANSI C63.4, SS 4351503

1.2 Definitions

Reference value

The specified value of an influencing factor to which are referred the characteristics of the equipment.

Nominal range

The range of values of an influencing quantity (factor) within which, under specified conditions, the equipment meets the specified requirements.

Operative range

The range of values of a given energizing quantity for which the equipment, under specified conditions, is able to perform its intended functions according to the specified requirements.

Section 2 Energizing quantities, rated values and limits

2.1 Analog inputs

Table 1: TRM - Energizing quantities, rated values and limits for protection transformer modules

Quantity	Rated value	Nominal range
Current	I_r = 1 or 5 A	(0.2-40) × I_r
Operative range	(0-100) x I_r	
Permissive overload	4 × I_r cont. 100 × I_r for 1 s *)	
Burden	< 150 mVA at I_r = 5 A < 20 mVA at I_r = 1 A	
Ac voltage	U_r = 110 V	0.5–288 V
Operative range	(0–340) V	
Permissive overload	420 V cont. 450 V 10 s	
Burden	< 20 mVA at 110 V	
Frequency	f_r = 50/60 Hz	±5%
*) max. 350 A for 1 s when COMBITEST test switch is included.		

Table 2: TRM - Energizing quantities, rated values and limits for measuring transformer modules

Quantity	Rated value	Nominal range
Current	I_r = 1 or 5 A	(0–1.8) × I_r at I_r = 1 A (0–1.6) × I_r at I_r = 5 A
Permissive overload	1.1 × I_r cont. 1.8 × I_r for 30 min at I_r = 1 A 1.6 × I_r for 30 min at I_r = 5 A	
Burden	< 350 mVA at I_r = 5 A < 200 mVA at I_r = 1 A	
Ac voltage	U_r = 110 V	0.5–288 V
Operative range	(0–340) V	
Permissive overload	420 V cont. 450 V 10 s	
Burden	< 20 mVA at 110 V	
Frequency	f_r = 50/60 Hz	±5%

Table 3: MIM - mA input module

Quantity:	Rated value:	Nominal range:
Input resistance	R_{in} = 194 Ohm	-
Input range	±5, ±10, ±20mA 0-5, 0-10, 0-20, 4-20mA	-
Power consumption each mA-board each mA input	 ≤ 2 W ≤ 0.1 W	-

Table 4: OEM - Optical ethernet module

Quantity	Rated value
Number of channels	1 or 2 (port A, B for IEC 61850-8-1 / IEEE C37.118 and port C, D for IEC 61850-9-2LE / IEEE C37.118) 1 or 2 (port A, B for IEC 61850-8-1 / IEEE C37.118)
Standard	IEEE 802.3u 100BASE-FX
Type of fiber	62.5/125 µm multimode fibre
Wave length	1300 nm
Optical connector	Type ST
Communication speed	Fast Ethernet 100 Mbit/s

2.2 Auxiliary DC voltage

Table 5: PSM - Power supply module

Quantity	Rated value	Nominal range
Auxiliary dc voltage, EL (input)	EL = (24 - 60) V EL = (90 - 250) V	EL ±20% EL ±20%
Power consumption	50 W typically	-
Auxiliary DC power in-rush	< 10 A during 0.1 s	-

2.3 Binary inputs and outputs

Table 6: BIM - Binary input module

Quantity	Rated value	Nominal range
Binary inputs	16	-
DC voltage, RL	24/30 V 48/60 V 110/125 V 220/250 V	RL ±20% RL ±20% RL ±20% RL ±20%
Power consumption 24/30 V, 50mA 48/60 V, 50mA 110/125 V, 50mA 220/250 V, 50mA 220/250 V, 110mA	 max. 0.05 W/input max. 0.1 W/input max. 0.2 W/input max. 0.4 W/input max. 0.5 W/input	-
Counter input frequency	10 pulses/s max	-
Oscillating signal discriminator	Blocking settable 1–40 Hz Release settable 1–30 Hz	
Debounce filter	Settable 1–20ms	

Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

Table 7: BIM - Binary input module with enhanced pulse counting capabilities

Quantity	Rated value	Nominal range
Binary inputs	16	-
DC voltage, RL	24/30 V 48/60 V 110/125 V 220/250 V	RL ±20% RL ±20% RL ±20% RL ±20%
Power consumption 24/30 V 48/60 V 110/125 V 220/250 V	 max. 0.05 W/input max. 0.1 W/input max. 0.2 W/input max. 0.4 W/input	-
Counter input frequency	10 pulses/s max	-
Balanced counter input frequency	40 pulses/s max	-
Oscillating signal discriminator	Blocking settable 1–40 Hz Release settable 1–30 Hz	
Debounce filter	Settable 1-20 ms	

Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

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Table 8: IOM - Binary input/output module

Quantity	Rated value	Nominal range
Binary inputs	8	-
DC voltage, RL	24/30 V 48/60 V 110/125 V 220/250 V	RL ±20% RL ±20% RL ±20% RL ±20%
Power consumption 24/30 V, 50 mA 48/60 V, 50 mA 110/125 V, 50 mA 220/250 V, 50 mA 220/250 V, 110 mA	 max. 0.05 W/input max. 0.1 W/input max. 0.2 W/input max. 0.4 W/input max. 0.5 W/input	-
Counter input frequency	10 pulses/s max	
Oscillating signal discriminator	Blocking settable 1-40 Hz Release settable 1-30 Hz	
Debounce filter	Settable 1-20 ms	

Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

Table 9: IOM - Binary input/output module contact data (reference standard: IEC 61810-2)

Function or quantity	Trip and signal relays	Fast signal relays (parallel reed relay)
Binary outputs	10	2
Max system voltage	250 V AC, DC	250 V DC
Test voltage across open contact, 1 min	1000 V rms	800 V DC
Current carrying capacity Per relay, continuous Per relay, 1 s Per process connector pin, continuous	 8 A 10 A 12 A	 8 A 10 A 12 A
Making capacity at inductive load with L/R>10 ms 0.2 s 1.0 s	 30 A 10 A	 0.4 A 0.4 A
Making capacity at resistive load 0.2 s 1.0 s	 30 A 10 A	 220–250 V/0.4 A 110–125 V/0.4 A 48–60 V/0.2 A 24–30 V/0.1 A
Breaking capacity for AC, cos φ > 0.4	250 V/8.0 A	250 V/8.0 A
Breaking capacity for DC with L/R < 40 ms	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A
Maximum capacitive load	-	10 nF

Maximum 72 outputs may be activated simultaneously with influencing factors within nominal range. After 6 ms an additional 24 outputs may be activated. The activation time for the 96 outputs must not exceed 200 ms. 48 outputs can be activated during 1 s. Continued activation is possible with respect to current consumption but after 5 minutes the temperature rise will adversely affect the hardware life. Maximum two relays per BOM/IOM/SOM should be activated continuously due to power dissipation.

Table 10: IOM with MOV and IOM 220/250 V, 110mA - contact data (reference standard: IEC 61810-2)

Function or quantity	Trip and Signal relays	Fast signal relays (parallel reed relay)
Binary outputs	IOM: 10	IOM: 2
Max system voltage	250 V AC, DC	250 V DC
Test voltage across open contact, 1 min	250 V rms	250 V rms
Current carrying capacity Per relay, continuous Per relay, 1 s Per process connector pin, continuous	 8 A 10 A 12 A	 8 A 10 A 12 A
Making capacity at inductive load with L/R>10 ms 0.2 s 1.0 s	 30 A 10 A	 0.4 A 0.4 A
Making capacity at resistive load 0.2 s 1.0 s	 30 A 10 A	 220–250 V/0.4 A 110–125 V/0.4 A 48–60 V/0.2 A 24–30 V/0.1 A
Breaking capacity for AC, cos φ>0.4	250 V/8.0 A	250 V/8.0 A
Breaking capacity for DC with L/R < 40 ms	48 V/1 A 110 V/0.4 A 220 V/0.2 A 250 V/0.15 A	48 V/1 A 110 V/0.4 A 220 V/0.2 A 250 V/0.15 A
Maximum capacitive load	-	10 nF

Maximum 72 outputs may be activated simultaneously with influencing factors within nominal range. After 6 ms an additional 24 outputs may be activated. The activation time for the 96 outputs must not exceed 200 ms. 48 outputs can be activated during 1 s. Continued activation is possible with respect to current consumption but after 5 minutes the temperature rise will adversely affect the hardware life. Maximum two relays per BOM/IOM/SOM should be activated continuously due to power dissipation.

Table 11: SOM - Static Output Module (reference standard: IEC 61810-2): Static binary outputs

Function of quantity	Static binary output trip	
Rated voltage	48 - 60 VDC	110 - 250 VDC
Number of outputs	6	6
Impedance open state	~300 kΩ	~810 kΩ
Test voltage across open contact, 1 min	No galvanic separation	No galvanic separation
Current carrying capacity: Continuous 1.0s	 5A 10A	 5A 10A
Making capacity at capacitive load with the maximum capacitance of 0.2 µF : 0.2s 1.0s	 30A 10A	 30A 10A
Breaking capacity for DC with L/R ≤ 40ms	48V / 1A 60V / 0.75A	110V / 0.4A 125V / 0.35A 220V / 0.2A 250V / 0.15A
Operating time	<1ms	<1ms

Table 12: SOM - Static Output module data (reference standard: IEC 61810-2): Electromechanical relay outputs

Function of quantity	Trip and signal relays
Max system voltage	250V AC/DC
Number of outputs	6
Test voltage across open contact, 1 min	1000V rms
Current carrying capacity: Continuous 1.0s	 8A 10A
Making capacity at capacitive load with the maximum capacitance of 0.2 µF: 0.2s 1.0s	 30A 10A
Breaking capacity for DC with L/R ≤ 40ms	48V / 1A 110V / 0.4A 125V / 0.35A 220V / 0.2A 250V / 0.15A

Maximum 72 outputs may be activated simultaneously with influencing factors within nominal range. After 6 ms an additional 24 outputs may be activated. The activation time for the 96 outputs must not exceed 200 ms. 48 outputs can be activated during 1 s. Continued activation is possible with respect to current consumption but after 5 minutes the temperature rise will adversely affect the hardware life. Maximum two relays per BOM/IOM/SOM should be activated continuously due to power dissipation.

Table 13: BOM - Binary output module contact data (reference standard: IEC 61810-2)

Function or quantity	Trip and Signal relays
Binary outputs	24
Max system voltage	250 V AC, DC
Test voltage across open contact, 1 min	1000 V rms
Current carrying capacity Per relay, continuous Per relay, 1 s Per process connector pin, continuous	 8 A 10 A 12 A
Making capacity at inductive load with L/R>10 ms 0.2 s 1.0 s	 30 A 10 A
Breaking capacity for AC, cos φ>0.4	250 V/8.0 A
Breaking capacity for DC with L/R < 40 ms	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A

Maximum 72 outputs may be activated simultaneously with influencing factors within nominal range. After 6 ms an additional 24 outputs may be activated. The activation time for the 96 outputs must not exceed 200 ms. 48 outputs can be activated during 1 s. Continued activation is possible with respect to current consumption but after 5 minutes the temperature rise will adversely affect the hardware life. Maximum two relays per BOM/IOM/SOM should be activated continuously due to power dissipation.

2.4 Influencing factors

Table 14: Temperature and humidity influence

Parameter	Reference value	Nominal range	Influence
Ambient temperature, operate value	+20°C	-10 °C to +55°C	0.02% / °C
Relative humidity Operative range	10%-90% 0%-95%	10%-90%	-
Storage temperature	-	-40 °C to +70 °C	-

Table 15: Auxiliary DC supply voltage influence on functionality during operation

Dependence on	Reference value	Within nominal range	Influence
Ripple, in DC auxiliary voltage Operative range	max. 2% Full wave rectified	15% of EL	0.01% / %
Auxiliary voltage dependence, operate value		±20% of EL	0.01% / %
Interrupted auxiliary DC voltage		24-60 V DC ± 20% 90-250 V DC ±20%	
Interruption Interval 0-50 ms 0-∞ s			No restart Correct behaviour at power down
Restart time			<300 s

Table 16: Frequency influence (reference standard: IEC 60255-1)

Dependence on	Within nominal range	Influence
Frequency dependence, operate value	f_r ±2.5 Hz for 50 Hz f_r ±3.0 Hz for 60 Hz	±1.0% / Hz
Frequency dependence for distance protection operate value	f_r ±2.5 Hz for 50 Hz f_r ±3.0 Hz for 60 Hz	±2.0% / Hz
Harmonic frequency dependence (20% content)	2nd, 3rd and 5th harmonic of f_r	±2.0%
Harmonic frequency dependence for distance protection (10% content)	2nd, 3rd and 5th harmonic of f_r	±10.0%
Harmonic frequency dependence for high impedance differential protection (10% content)	2nd, 3rd and 5th harmonic of f_r	±10.0%
Harmonic frequency dependence for overcurrent protection	2nd, 3rd and 5th harmonic of f_r	±3.0% / Hz

Section 3 Type tests according to standards

Table 17: Electromagnetic compatibility

Test	Type test values	Reference standards
1 MHz burst disturbance	2.5 kV	IEC 60255-26
100 kHz slow damped oscillatory wave immunity test	2.5 kV	IEC 61000-4-18, Class III
Ring wave immunity test, 100 kHz	2-4 kV	IEC 61000-4-12, Class IV
Surge withstand capability test	2.5 kV, oscillatory 4.0 kV, fast transient	IEEE/ANSI C37.90.1
Electrostatic discharge Direct application Indirect application	15 kV air discharge 8 kV contact discharge 8 kV contact discharge	IEC 60255-26 IEC 61000-4-2, Class IV
Electrostatic discharge Direct application Indirect application	15 kV air discharge 8 kV contact discharge 8 kV contact discharge	IEEE/ANSI C37.90.1
Fast transient disturbance	4 kV	IEC 60255-26, Zone A
Surge immunity test	2-4 kV, 1.2/50 µs high energy	IEC 60255-26, Zone A
Power frequency immunity test	150-300 V, 50 Hz	IEC 60255-26, Zone A
Conducted common mode immunity test	15 Hz-150 kHz	IEC 61000-4-16, Class IV
Power frequency magnetic field test	1000 A/m, 3 s 100 A/m, cont.	IEC 61000-4-8, Class V
Pulse magnetic field immunity test	1000 A/m	IEC 61000-4-9, Class V
Damped oscillatory magnetic field test	100 A/m	IEC 61000-4-10, Class V
Radiated electromagnetic field disturbance	20 V/m, 80-1000 MHz 1.4-2.7 GHz	IEC 60255-26
Radiated electromagnetic field disturbance	20 V/m 80-1000 MHz	IEEE/ANSI C37.90.2
Conducted electromagnetic field disturbance	10 V, 0.15-80 MHz	IEC 60255-26
Radiated emission	30-5000 MHz	IEC 60255-26
Radiated emission	30-5000 MHz	IEEE/ANSI C63.4, FCC
Conducted emission	0.15-30 MHz	IEC 60255-26

Table 18: Insulation

Test	Type test values	Reference standard
Dielectric test	2.0 kV AC, 1 min.	IEC 60255-27 ANSI C37.90
Impulse voltage test	5 kV, 1.2/50 µs, 0.5 J	
Insulation resistance	>100 MΩ at 500 VDC	

Table 19: Environmental tests

Test	Type test value	Reference standard
Cold operation test	Test Ad for 16 h at -25°C	IEC 60068-2-1
Cold storage test	Test Ab for 16 h at -40°C	IEC 60068-2-1
Dry heat operation test	Test Bd for 16 h at +70°C	IEC 60068-2-2
Dry heat storage test	Test Bb for 16 h at +85°C	IEC 60068-2-2
Change of temperature test	Test Nb for 5 cycles at -25°C to +70°C	IEC 60068-2-14
Damp heat test, steady state	Test Ca for 10 days at +40°C and humidity 93%	IEC 60068-2-78
Damp heat test, cyclic	Test Db for 6 cycles at +25 to +55°C and humidity 93 to 95% (1 cycle = 24 hours)	IEC 60068-2-30

Table 20: CE compliance

Test	According to
Immunity	EN 60255-26
Emissivity	EN 60255-26
Low voltage directive	EN 60255-27

Table 21: Mechanical tests

Test	Type test values	Reference standards
Vibration response test	Class II	IEC 60255-21-1
Vibration endurance test	Class I	IEC 60255-21-1
Shock response test	Class I	IEC 60255-21-2
Shock withstand test	Class I	IEC 60255-21-2
Bump test	Class I	IEC 60255-21-2
Seismic test	Class II	IEC 60255-21-3

Section 4 Control

Table 22: Synchronizing, synchrocheck and energizing check SESRSYN

Function	Range or value	Accuracy
Phase shift, $\varphi_{line} - \varphi_{bus}$	(-180 to 180) degrees	-
Voltage high limit for synchronizing and synchrocheck	(50.0-120.0)% of UBase	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Reset ratio, synchrocheck	> 95%	-
Frequency difference limit between bus and line for synchrocheck	(0.003-1.000) Hz	±2.5 mHz
Phase angle difference limit between bus and line for synchrocheck	(5.0-90.0) degrees	±2.0 degrees
Voltage difference limit between bus and line for synchronizing and synchrocheck	(0.02-0.5) p.u	±0.5% of U_r
Time delay output for synchrocheck when angle difference between bus and line jumps from "PhaseDiff" + 2 degrees to "PhaseDiff" - 2 degrees	(0.000-60.000) s	±0.2% or ±35 ms whichever is greator
Frequency difference minimum limit for synchronizing	(0.003-0.250) Hz	±2.5 mHz
Frequency difference maximum limit for synchronizing	(0.050-0.500) Hz	±2.5 mHz
Breaker closing pulse duration	(0.050-60.000) s	±0.2% or ±15 ms whichever is greator
tMaxSynch, which resets synchronizing function if no close has been made before set time	(0.000-6000.00) s	±0.2% or ±35 ms whichever is greater
Minimum time to accept synchronizing conditions	(0.000-60.000) s	±0.2% or ±35 ms whichever is greater
Voltage high limit for energizing check	(50.0-120.0)% of UBase	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Reset ratio, voltage high limit	> 95%	-
Voltage low limit for energizing check	(10.0-80.0)% of UBase	±0.5% of U_r
Reset ratio, voltage low limit	< 105%	-
Maximum voltage for energizing	(50.0-180.0)% of UBase	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r

Table continues on next page

Function	Range or value	Accuracy
Time delay for energizing check when voltage jumps from 0 to 90% of Urated	(0.000-60.000) s	±0.2% or ±100 ms whichever is greater
Operate time for synchrocheck function when angle difference between bus and line jumps from "PhaseDiff" + 2 degrees to "PhaseDiff" - 2 degrees	Min. = 15 ms Max. = 30 ms	-
Operate time for energizing function when voltage jumps from 0 to 90% of Urated	Min. = 70 ms Max. = 90 ms	-

Table 23: Autoreclosor SMBRREC

Function	Range or value	Accuracy
Number of autoreclosing shots	1 - 5	-
Autoreclosing open time: shot 1 - t1 1Ph shot 1 - t1 2Ph shot 1 - t1 3PhHS shot 1 - t1 3Ph	(0.000-120.000) s	±0.2% or ±35 ms whichever is greater
shot 2 - t2 3Ph shot 3 - t3 3Ph shot 4 - t4 3Ph shot 5 - t5 3Ph	(0.00-6000.00) s	±0.2% or ±35 ms whichever is greater
Extended autorecloser open time	(0.000-60.000) s	±0.2% or ±35 ms whichever is greater
Minimum time CB must be closed before AR becomes ready for autoreclosing cycle	(0.00-6000.00) s	±0.2% or ±35 ms whichever is greater
Maximum operate pulse duration	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Reclaim time	(0.00-6000.00) s	±0.2% or ±15 ms whichever is greater
Circuit breaker closing pulse length	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Wait for master release	(0.00-6000.00) s	±0.2% or ±15 ms whichever is greater
Inhibit reset time	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater
Autoreclosor maximum wait time for sync	(0.00-6000.00) s	±0.2% or ±45 ms whichever is greator
CB check time before unsuccessful	(0.00-6000.00) s	±0.2% or ±45 ms whichever is greater
Wait time after close command before proceeding to next shot	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater

Section 5 Differential protection

Table 24: 1Ph High impedance differential protection HZPDIF

Function	Range or value	Accuracy
Operate voltage	(10-900) V I=U/R	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio	>95% at (30-900) V	-
Maximum continuous power	U>Trip²/SeriesResistor ≤200 W	-
Operate time at 0 to 10 x U_d	Min. = 5 ms Max. = 15 ms	
Reset time at 10 to 0 x U_d	Min. = 75 ms Max. = 95 ms	
Critical impulse time	2 ms typically at 0 to 10 x U_d	-
Operate time at 0 to 2 x U_d	Min. = 25 ms Max. = 35 ms	
Reset time at 2 to 0 x U_d	Min. = 50 ms Max. = 70 ms	
Critical impulse time	15 ms typically at 0 to 2 x U_d	-

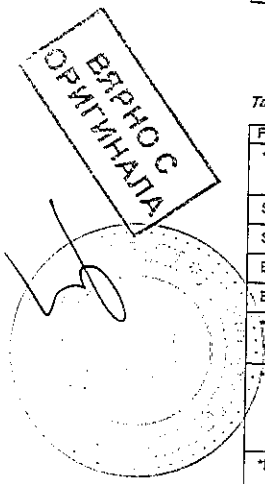

Table 25: Line differential protection L3CPDIF,L6CPDIF,LT3CPDIF,LT6CPDIF

Function	Range or value	Accuracy
*Minimum operate current	(20-200)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
SlopeSection2	(10.0-50.0)%	-
SlopeSection3	(30.0-100.0)%	-
EndSection 1	(20–150)% of *IBase*	-
EndSection 2	(100–1000)% of *IBase*	-
*Unrestrained limit function	(100–5000)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
*Second harmonic blocking	(5.0–100.0)% of fundamental	±1.0% of I_r Note: fundamental magnitude = 100% of I_r
*Fifth harmonic blocking	(5.0–100.0)% of fundamental	±2.0% of I_r Note: fundamental magnitude = 100% of I_r

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Function	Range or value	Accuracy
*Inverse characteristics, see table 135, 137 and table 137	16 curve types	See table 136, 137 and table 138
Critical impulse time	2ms typically at 0 to 10 x I_d	-
Charging current compensation	On/Off	-
LT3CPDIF and LT6CPDIF:		
*Operate time, restrained function at 0 to 10 x I_d	Min. = 25 ms Max. = 35 ms	-
*Reset time, restrained function at 10 to 0 x I_d	Min. = 5 ms Max. = 15 ms	-
*Operate time, unrestrained function at 0 to 10 x I_d	Min. = 5 ms Max. = 15 ms	-
*Reset time, unrestrained function at 10 to 0 x I_d	Min. = 15 ms Max. = 25 ms	-
L3CPDIF and L6CPDIF:		
*Operate time, restrained function at 0 to 10 x I_d	Min. = 10 ms Max. = 25 ms	-
*Reset time, restrained function at 10 to 0 x I_d	Min. = 15 ms Max. = 25 ms	-
*Operate time, unrestrained function at 0 to 10 x I_d	Min. = 5 ms Max. = 15 ms	-
*Reset time, unrestrained function at 10 to 0 x I_d	Min. = 15 ms Max. = 25 ms	-
*Note: Data valid for a single IED with two local current input groups		

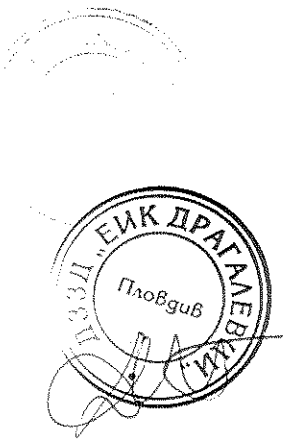

Table 26: Additional security logic for differential protection LDRGFC

Function	Range or value	Accuracy
Operate current, zero sequence current	(1-100)% of IBase	±1.0% of I_r
Operate current, low current operation	(1-100)% of IBase	±1.0% of I_r
Operate voltage, phase to neutral	(1-100)% of UBase	±0.5% of U_r
Operate voltage, phase to phase	(1-100)% of UBase	±0.5% of U_r
Independent time delay, zero sequence current at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Independent time delay, low current operation at 2 x I_{set} to 0	(0.000-60.000) s	±0.2% or ± 40 ms whichever is greater
Independent time delay, low voltage operation at 2 x U_{set} to 0	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Reset time delay for startup signal at 0 to 2 x U_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater

Section 6 Impedance protection

Table 27: Distance measuring zone, Quad ZMQPDIS

Function	Range or value	Accuracy
Number of zones	Max 5 with selectable direction	-
Minimum operate residual current, zone 1	(5-1000)% of IBase	-
Minimum operate current, phase-to-phase and phase-to-earth	(10-1000)% of IBase	-
Positive sequence reactance	(0.10-3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Positive sequence resistance	(0.01-1000.00) Ω/phase	
Zero sequence reactance	(0.10-9000.00) Ω/phase	
Zero sequence resistance	(0.01-3000.00) Ω/phase	
Fault resistance, phase-to-earth	(0.10-9000.00) Ω/loop	
Fault resistance, phase-to-phase	(0.10-3000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5<SIR<30	-
Definite time delay Ph-Ph and Ph-E operation	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Operate time	25 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.1 to 2 x Zreach	Min. = 20 ms Max. = 35 ms	-

Table 28: Distance measuring zone, quadrilateral characteristic for series compensated lines ZMCPDIS, ZMCAPDIS

Function	Range or value	Accuracy
Number of zones	Max 5 with selectable direction	-
Minimum operate residual current, zone 1	(5-1000)% of *IBase*	-
Minimum operate current, Ph-Ph and Ph-E	(10-1000)% of *IBase*	-

Table continues on next page

Function	Range or value	Accuracy
Positive sequence reactance	(0.10-3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Positive sequence resistance	(0.10-1000.00) Ω/phase	
Zero sequence reactance	(0.01-9000.00) Ω/phase	
Zero sequence resistance	(0.01-3000.00) Ω/phase	
Fault resistance, Ph-E	(0.10-9000.00) Ω/loop	
Fault resistance, Ph-Ph	(0.10-3000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CCVT's and 0.5<SIR<30	-
Definite time delay Ph-Ph and Ph-E operation	(0.000-60.000) s	±0.2% or ± 35 ms whichever is greater
Operate time	25 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.1 to 2 x Zreach	Min. = 20 ms Max. = 35 ms	-

Table 29: Phase selection, quadrilateral characteristic with fixed angle FDPSPDIS

Function	Range or value	Accuracy
Minimum operate current	(5-500)% of *IBase*	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reactive reach, positive sequence	(0.50–3000.00) Ω/phase	±2.5% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Resistive reach, positive sequence	(0.10–1000.00) Ω/phase	
Reactive reach, zero sequence	(0.50–9000.00) Ω/phase	
Resistive reach, zero sequence	(0.50–3000.00) Ω/phase	
Fault resistance, phase-to-earth faults, forward and reverse	(1.00–9000.00) Ω/loop	
Fault resistance, phase-to-phase faults, forward and reverse	(0.50–3000.00) Ω/loop	
Load encroachment criteria: Load resistance, forward and reverse Safety load impedance angle	(1.00–3000.00) Ω/phase (5-70) degrees	
Reset ratio	105% typically	-

Table 30: Full-scheme distance protection, Mho characteristic ZMHPDIS

Function	Range or value	Accuracy
Number of zones, Ph-E	Max 5 with selectable direction	-
Minimum operate current	(10–30)% of IBase	-
Positive sequence impedance, Ph-E loop	(0.005–3000.000) Ω/phase	±2.0% static accuracy Conditions: Voltage range: (0.1–1.1) x U_r Current range: (0.5–30) x I_r Angle: 85 degrees
Positive sequence impedance angle, Ph-E loop	(10–90) degrees	
Reverse reach, Ph-E loop (Magnitude)	(0.005–3000.000) Ω/phase	
Magnitude of earth return compensation factor KN	(0.00–3.00)	
Angle for earth compensation factor KN	(-180–180) degrees	
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5<SIR<30	-
Definite time delay Ph-Ph and Ph-E operation	(0.000-60.000) s	±0.2% or ±60 ms whichever is greater
Operate time	22 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.5 to 1.5 x Zreach	Min. = 30 ms Max. = 45 ms	-

Table 31: High speed distance protection ZMFPDIS, ZMFCPDIS

Function	Range or value	Accuracy
Number of zones	3 selectable directions, 3 fixed directions	-
Minimum operate current, Ph-Ph and Ph-E	(5-6000)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Positive sequence reactance reach, Ph-E and Ph-Ph loop	(0.01 - 3000.00) ohm/phase	±2.0% of static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: At 0 degrees and 85 degrees
Positive sequence resistance reach, Ph-E and Ph-Ph loop	(0.00 - 1000.00) ohm/phase	
Zero sequence reactance reach	(0.01 - 9000.00) ohm/p	
Zero sequence resistive reach	(0.00 - 3000.00) ohm/p	
Fault resistance reach, Ph-E and Ph-Ph	(0.01 -9000.00) ohm/l	
Dynamic overreach	< 5% at 85 degrees measured with CVTs and 0.5 < SIR < 30	
Definite time delay to trip, Ph-E and Ph-Ph operation	(0.000-60.000) s	±2.0% or ±35 ms whichever is greater
Operate time	16 ms typically	IEC 60255-121
Reset time at 0.1 to 2 x Zroach	Min. = 20 ms Max. = 35 ms	-
Reset ratio	105% typically	-

Table 32: Full-scheme distance protection, quadrilateral for earth faults ZMMPDIS

Function	Range or value	Accuracy
Number of zones	Max 5 with selectable direction	-
Minimum operate current	(10-30)% of *IBase*	-
Positive sequence reactance	(0.50-3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Positive sequence resistance	(0.10-1000.00) Ω/phase	
Zero sequence reactance	(0.50-9000.00) Ω/phase	
Zero sequence resistance	(0.50-3000.00) Ω/phase	
Fault resistance, Ph-E	(1.00-9000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CCVT's and 0.5<SIR<30	-
Definite time delay Ph-Ph and Ph-E operation	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Operate time	25 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.1 to 2 x Zreach	Min. = 20 ms Max. = 35 ms	-

Table 33: Faulty phase identification with load encroachment FMPSPDIS

Function	Range or value	Accuracy
Load encroachment criteria: Load resistance, forward and reverse	(1.00–3000.00) Ω/phase (5–70) degrees	±2.0% static accuracy Conditions: Voltage range: (0.1–1.1) x U_r Current range: (0.5–30) x I_r Angle: at 0 degrees and 85 degrees

Table 34: Distance measuring zone, quadrilateral characteristic, separate settings ZMRPDIS, ZMRAPDIS

Function	Range or value	Accuracy
Number of zones	Max 5 with selectable direction	-
Minimum operate residual current, zone 1	(5-1000)% of IBase	-
Minimum operate current, phase-to-phase and phase-to-earth	(10-1000)% of IBase	-

Table continues on next page

Function	Range or value	Accuracy
Positive sequence reactance	(0.10-3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Positive sequence resistance	(0.01-1000.00) Ω/phase	
Zero sequence reactance	(0.10-9000.00) Ω/phase	
Zero sequence resistance	(0.01-3000.00) Ω/phase	
Fault resistance, phase-to-earth	(0.10-9000.00) Ω/loop	
Fault resistance, phase-to-phase	(0.10-3000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5<SIR<30	-
Definite time delay phase-phase and phase-earth operation	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Operate time	25 ms typically	IEC 60255-121
Reset ratio	105% typically	-
Reset time at 0.1 to 2 x Zreach	Min. = 20 ms Max. = 35 ms	-

Table 35: Phase selection with load encroachment, quadrilateral characteristic FRPSPDIS

Function	Range or value	Accuracy
Minimum operate current	(5-500)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reactive reach, positive sequence	(0.50–3000.00) Ω/phase	±2.0% static accuracy ±2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Resistive reach, positive sequence	(0.10–1000.00) Ω/phase	
Reactive reach, zero sequence	(0.50–9000.00) Ω/phase	
Resistive reach, zero sequence	(0.50–3000.00) Ω/phase	
Fault resistance, Ph-E faults, forward and reverse	(1.00–9000.00) Ω/loop	
Fault resistance, Ph-Ph faults, forward and reverse	(0.50–3000.00) Ω/loop	
Load encroachment criteria: Load resistance, forward and reverse Safety load impedance angle	(1.00–3000.00) Ω/phase (5-70) degrees	
Reset ratio	105% typically	-

Table 36: Power swing detection ZMRPSB

Function	Range or value	Accuracy
Reactive reach	(0.10-3000.00) Ω/phase	±2.0% static accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Resistive reach	(0.10–1000.00) Ω/loop	
Power swing detection operate time	(0.000-60.000) s	±0.2% or ±10 ms whichever is greater
Second swing reclaim operate time	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater
Minimum operate current	(5-30)% of IBase	±1.0% of I_r

Table 37: Automatic switch onto fault logic ZCVPSOF

Parameter	Range or value	Accuracy
Operate voltage, detection of dead line	(1–100)% of *UBase*	±0.5% of U_r
Operate current, detection of dead line	(1–100)% of *IBase*	±1.0% of I_r
Time delay to operate for the switch onto fault function	(0.03-120.00) s	±0.2% or ±20 ms whichever is greater
Time delay for UI detection	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater
Delay time for activation of dead line detection	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater
Drop-off delay time of switch onto fault function	(0.000-60.000) s	±0.2% or ±30 ms whichever is greater

Table 38: Power swing logic PSLPSCH

Function	Range or value	Accuracy
Permitted maximum operating time difference between higher and lower zone	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater
Delay for operation of underreach zone with detected difference in operating time	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater
Conditional timer for sending the CS at power swings	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater
Conditional timer for tripping at power swings	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater
Timer for blocking the overreaching zones trip	(0.000 — 60.0000) s	±0,2% or ±15 ms whichever is greater

Table 39: Out-of-step protection OOSPPAM

Function	Range or value	Accuracy
Impedance reach	(0.00 - 1000.00)% of Zbase	±2.0% of $U_r/(\sqrt{3} \cdot I_r)$
Rotor start angle	(90.0 - 130.0) degrees	±5.0 degrees
Rotor trip angle	(15.0 - 90.0) degrees	±5.0 degrees
Zone 1 and Zone 2 trip counters	(1 - 20)	-

Table 40: Pole slip protection PSPPPAM

Function	Range or value	Accuracy
Impedance reach	(0.00 - 1000.00)% of Zbase	±2.0% of U_r/I_r
Zone 1 and Zone 2 trip counters	(1 - 20)	-

Table 41: Phase preference logic PPLPHIZ

Function	Range or value	Accuracy
Operate value, phase-to-phase and phase-to-neutral undervoltage	(1 - 100)% of UBase	±0.5% of U_r
Reset ratio, undervoltage	< 105%	-
Operate value, residual voltage	(5 - 300)% of UBase	±0.5% of U_r at $U \leq U_r$ ±0.5% of U at $U > U_r$
Reset ratio, residual voltage	> 95%	-
Operate value, residual current	(10 - 200)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio, residual current	> 95%	-
Independent time delay for residual current at 0 to 2 x I_{set}	(0.000 - 60.000) s	±0.2% or ±25 ms whichever is greater
Independent time delay for residual voltage at 0.8 to 1.2 x U_{set}	(0.000 - 60.000) s	±0.2% or ±25 ms whichever is greater
Independent dropoff-delay for residual voltage at 1.2 to 0.8 x U_{set}	(0.000 - 60.000) s	±0.2% or ±25 ms whichever is greater
Operating mode	No Filter, NoPref Cyclic: 1231c, 1321c Acyclic: 123a, 132a, 213a, 231a, 312a, 321a	

Section 7 Current protection

Table 42: Instantaneous phase overcurrent protection PHPIOC

Function	Range or value	Accuracy
Operate current	(5-2500)% of IBase	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95% at (50–2500)% of IBase	-
Operate time at 0 to 2 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Reset time at 2 to 0 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time at 0 to 10 x I_{set}	Min. = 5ms Max. = 15ms	-
Reset time at 10 to 0 x I_{set}	Min. = 25ms Max. = 40 ms	-
Critical impulse time	2 ms typically at 0 to 10 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 43: Four-step phase overcurrent protection OC4PTOC

Function	Setting range	Accuracy
Operate current, step 1 - 4	(5-2500)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95% at (50–2500)% of *IBase*	-
Minimum operate current, step 1 - 4	(1-10000)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Relay characteristic angle (RCA)	(40.0–65.0) degrees	±2.0 degrees
Relay operating angle (ROA)	(40.0–89.0) degrees	±2.0 degrees
Second harmonic blocking	(5–100)% of fundamental	±2.0% of I_r
Independent time delay at 0 to 2 x I_{set}, step 1 - 4	(0.000-60.000) s	±0.2 % or ±35 ms whichever is greater
Minimum operate time for inverse curves , step 1 - 4	(0.000-60.000) s	±0.2 % or ±35 ms whichever is greater
Inverse time characteristics, see table 136, table 137 and table 138	16 curve types	See table 136, table 137 and table 138
Operate time, start non-directional at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-

Table continues on next page

Function	Setting range	Accuracy
Reset time, start non-directional at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start non-directional at 0 to 10 x I_{set}	Min. = 5 ms Max. = 20 ms	-
Reset time, start non-directional at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 44: Instantaneous residual overcurrent protection EFPIOC

Function	Range or value	Accuracy
Operate current	(5-2500)% of IBase	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95% at (50–2500)% of IBase	-
Operate time at 0 to 2 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Reset time at 2 to 0 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time at 0 to 10 x I_{set}	Min. = 5 ms Max. = 15 ms	-
Reset time at 10 to 0 x I_{set}	Min. = 25 ms Max. = 35 ms	-
Critical impulse time	2 ms typically at 0 to 10 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 45: Four step residual overcurrent protection EF4PTOC technical data

Function	Range or value	Accuracy
Operate current, step 1 - 4	(1-2500)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95% at (10-2500)% of *IBase*	-
Relay characteristic angle (RCA)	(-180 to 180) degrees	±2.0 degrees
Operate current for directional release	(1–100)% of *IBase*	For RCA ±60 degrees: ±2.5% of I_r at $I \le I_r$ ±2.5% of I at $I > I_r$
Independent time delay at 0 to 2 x I_{set}, step 1 - 4	(0.000-60.000) s	±0.2% or ±35 ms whichever is greater
Minimum operate time for inverse curves, step 1 - 4	(0.000 - 60.000) s	±0.2% or ±35 ms whichever is greater

Table continues on next page

Function	Range or value	Accuracy
Inverse time characteristics, see Table 136, Table 137 and Table 138	16 curve types	See Table 136, Table 137 and Table 138
Second harmonic blocking	(5–100)% of fundamental	±2.0% of I_r
Minimum polarizing voltage	(1–100)% of *UBase*	±0.5% of U_r
Minimum polarizing current	(2-100)% of *IBase*	±1.0% of I_r
Real part of source Z used for current polarization	(0.50–1000.00) Ω/phase	-
Imaginary part of source Z used for current polarization	(0.50–3000.00) Ω/phase	-
Operate time, start non-directional at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start non-directional at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start non-directional at 0 to 10 x I_{set}	Min. = 5 ms Max. = 20 ms	-
Reset time, start non-directional at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 46: Four step negative sequence overcurrent protection NS4PTOC

Function	Range or value	Accuracy
Operate current, step 1 - 4	(1-2500)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95% at (10-2500)% of *IBase*	-
Independent time delay at 0 to 2 x I_{set}, step 1 - 4	(0.000-60.000) s	±0.2% or ±35 ms whichever is greater
Minimum operate time for inverse curves, step 1 - 4	(0.000 - 60.000) s	±0.2% or ±35 ms whichever is greater
Inverse time characteristics, see table 136, table 137 and table 138	16 curve types	See table 136, table 137 and table 138
Minimum operate current, step 1 - 4	(1.00 - 10000.00)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Relay characteristic angle (RCA)	(-180 to 180) degrees	±2.0 degrees
Operate current for directional release	(1–100)% of *IBase*	For RCA ±60 degrees: ±2.5% of I_r at $I \le I_r$ ±2.5% of I at $I > I_r$
Minimum polarizing voltage	(1–100)% of *UBase*	±0.5% of U_r
Minimum polarizing current	(2-100)% of *IBase*	±1.0% of I_r
Real part of negative sequence source impedance used for current polarization	(0.50-1000.00) Ω/phase	-

Table continues on next page

Function	Range or value	Accuracy
Imaginary part of negative sequence source impedance used for current polarization	(0.50–3000.00) Ω/phase	-
Operate time, start non-directional at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start non-directional at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start non-directional at 0 to 10 x I_{set}	Min. = 5 ms Max. = 20 ms	-
Reset time, start non-directional at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-
Transient overreach	<10% at τ = 100 ms	-

Table 47: Sensitive directional residual overcurrent and power protection SDEPSDE

Function	Range or value	Accuracy
Operate level for $3I_0 \cdot \cos\varphi$ directional residual overcurrent	(0.25-200.00)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Operate level for $3I_0 \cdot 3U_0 \cos\varphi$ directional residual power	(0.25-200.00)% of *SBase*	±1.0% of S_r at $S \le S_r$ ±1.0% of S at $S > S_r$
Operate level for $3I_0$ and φ residual overcurrent	(0.25-200.00)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Operate level for non-directional overcurrent	(1.00-400.00)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Operate level for non-directional residual overvoltage	(1.00-200.00)% of *UBase*	±0.5% of U_r at $U \le U_r$ ±0.5% of U at $U > U_r$
Residual release current for all directional modes	(0.25-200.00)% of *IBase*	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Residual release voltage for all directional modes	(1.00-300.00)% of *UBase*	±0.5% of U_r at $U \le U_r$ ±0.5% of U at $U > U_r$
Operate time for non-directional residual overcurrent at 0 to 2 x Iset	Min. = 40 ms Max. = 65 ms	
Reset time for non-directional residual overcurrent at 2 to 0 x Iset	Min. = 40 ms Max. = 65 ms	
Operate time for directional residual overcurrent at 0 to 2 x Iset	Min. = 110 ms Max. = 160 ms	
Reset time for directional residual overcurrent at 2 to 0 x Iset	Min. = 20 ms Max. = 60 ms	

Table continues on next page

Function	Range or value	Accuracy
Independent time delay for non-directional residual overvoltage at 0.8 to 1.2 x Uset	(0.000 – 60.000) s	±0.2% or ± 75 ms whichever is greater
Independent time delay for non-directional residual overcurrent at 0 to 2 x Iset	(0.000 – 60.000) s	±0.2% or ± 75 ms whichever is greater
Independent time delay for directional residual overcurrent at 0 to 2 x Iset	(0.000 – 60.000) s	±0.2% or ± 170 ms whichever is greater
Inverse characteristics, see table 142, table 143 and table 144	16 curve types	See table 142, table 143 and table 144
Relay characteristic angle (RCADir)	(-179 to 180) degrees	±2.0 degrees
Relay operate angle (ROADir)	(0 to 90) degrees	±2.0 degrees

Table 48: Thermal overload protection, one time constant LCPTTR/LFPTTR

Function	Range or value	Accuracy
Reference current	(2-400)% of IBase	±1.0% of I_r
Reference temperature	(0-300)°C, (0 - 600)°F	±1.0°C, ±2.0°F
Operate time: $t = \tau \ln \left[\frac{I^2 - I_p^2}{I^2 - I_p^2 - \frac{T_{Trip} - T_{Amb}}{T_{ref}} \cdot I_{ref}^2} \right]$ (Equation 1) T_{Trip} = set operate temperature T_{Amb} = ambient temperature T_{ref} = temperature rise above ambient at I_{ref} I_{ref} = reference load current I = actual measured current I_p = load current before overload occurs	Time constant τ = (1–1000) minutes	IEC 60255-149, ±5.0% or ±200 ms whichever is greater
Alarm temperature	(0-200)°C, (0-400)°F	±2.0°C, ±4.0°F
Operate temperature	(0-300)°C, (0-600)°F	±2.0°C, ±4.0°F
Reset level temperature	(0-300)°C, (0-600)°F	±2.0°C, ±4.0°F

Table 49: Breaker failure protection CCRBRF

Function	Range or value	Accuracy
Operate phase current	(5-200)% of *IBase*	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio, phase current	> 95%	-
Operate residual current	(2-200)% of *IBase*	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio, residual current	> 95%	-
Phase current level for blocking of contact function	(5-200)% of *IBase*	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate time for current detection	10 ms typically	-
Reset time for current detection	15 ms maximum	-
Time delay for re-trip at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Time delay for back-up trip at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Time delay for back-up trip at multi-phase start at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater
Additional time delay for a second back-up trip at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater
Time delay for alarm for faulty circuit breaker	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

Table 50: Stub protection STBPTOC

Function	Range or value	Accuracy
Operating current	(5-2500)% of *IBase*	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio	> 95% at (50-2500)% of *IBase*	-
Independent time delay at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±30 ms whichever is greater
Operate time, start at 0 to 2 x I_{set}	Min. = 10 ms Max. = 20 ms	-
Reset time, start at 2 to 0 x I_{set}	Min. = 10 ms Max. = 20 ms	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 51: Pole discordance protection CCPDSC

Function	Range or value	Accuracy
Operate current	(0–100)% of *IBase*	±1.0% of I_r
Independent time delay between trip condition and trip signal	(0.000-60.000) s	±0.2% or ± 25 ms whichever is greater

Table 52: Directional underpower protection GUPPDUP

Function	Range or value	Accuracy
Power level for Step 1 and Step 2	(0.0–500.0)% of *SBase*	±1.0% of S_r at $S \leq S_r$ ±1.0% of S at $S > S_r$ where $S_r = 1.732 \cdot U_r \cdot I_r$
Characteristic angle for Step 1 and Step 2	(-180.0–180.0) degrees	±2.0 degrees
Independent time delay to operate for Step 1 and Step 2 at 2 to 0.5 x S_r and *k=0.000*	(0.01-6000.00) s	±0.2% or ±40 ms whichever is greater

Table 53: Directional overpower protection GOPPDOP

Function	Range or value	Accuracy
Power level for Step 1 and Step 2	(0.0–500.0)% of SBase	±1.0% of S_r at $S \leq S_r$ ±1.0% of S at $S > S_r$
Characteristic angle for Step 1 and Step 2	(-180.0–180.0) degrees	±2.0 degrees
Operate time, start at 0.5 to 2 x S_r and *k=0.000*	Min. =10 ms Max. = 25 ms	
Reset time, start at 2 to 0.5 x S_r and *k=0.000*	Min. = 35 ms Max. = 55 ms	
Independent time delay to operate for Step 1 and Step 2 at 0.5 to 2 x S_r and *k=0.000*	(0.01-6000.00) s	±0.2% or ±40 ms whichever is greater

Table 54: Broken conductor check BRCPTOC

Function	Range or value	Accuracy
Minimum phase current for operation	(5–100)% of *IBase*	±1.0% of I_r
Unbalance current operation	(50–90)% of maximum current	±1.0% of I_r
Independent operate time delay	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater
Independent reset time delay	(0.010-60.000) s	±0.2% or ±30 ms whichever is greater
Start time at current change from I_r to 0	Min. = 25 ms Max. = 35 ms	-
Reset time at current change from 0 to I_r	Min. = 5 ms Max. = 20 ms	-

Table 55: Voltage-restrained time overcurrent protection VRPVOC

Function	Range or value	Accuracy
Start overcurrent	(2.0 - 5000.0)% of IBase	±1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
Reset ratio, overcurrent	> 95%	-
Operate time, start overcurrent at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start overcurrent at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start overcurrent at 0 to 10 x I_{set}	Min. = 5 ms Max. = 20 ms	-
Reset time, start overcurrent at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Independent time delay to operate at 0 to 2 x I_{set}	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Inverse time characteristics, see tables 136 and 137	13 curve types	See tables 136 and 137
Minimum operate time for inverse time characteristics	(0.00 - 60.00) s	±0.2% or ±35 ms whichever is greater
High voltage limit, voltage dependent operation	(30.0 - 100.0)% of UBase	±1.0% of U_r
Start undervoltage	(2.0 - 100.0)% of UBase	±0.5% of U_r
Reset ratio, undervoltage	< 105%	-
Operate time start undervoltage at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time start undervoltage at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Independent time delay to operate, undervoltage at 2 to 0 x U_{set}	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Internal low voltage blocking	(0.0 - 5.0)% of UBase	±0.25% of U_r
Overcurrent: Critical impulse time Impulse margin time	10 ms typically at 0 to 2 x I_{set} 15 ms typically	-
Undervoltage: Critical impulse time Impulse margin time	10ms typically at 2 to 0 x U_{set} 15 ms typically	-

Section 8 Voltage protection

Table 56: Two step undervoltage protection UV2PTUV

Function	Range or value	Accuracy
Operate voltage, low and high step	(1.0–100.0)% of *UBase*	±0.5% of U_r
Absolute hysteresis	(0.0–50.0)% of *UBase*	±0.5% of U_r
Internal blocking level, step 1 and step 2	(1–50)% of *UBase*	±0.5% of U_r
Inverse time characteristics for step 1 and step 2, see table 140	-	See table 140
Definite time delay, step 1 at 1.2 to 0 x U_{set}	(0.00-6000.00) s	±0.2% or ±40ms whichever is greater
Definite time delay, step 2 at 1.2 to 0 x U_{set}	(0.000-60.000) s	±0.2% or ±40ms whichever is greater
Minimum operate time, inverse characteristics	(0.000–60.000) s	±0.5% or ±40ms whichever is greater
Operate time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start at 1.2 to 0 x U_{set}	Min. = 5 ms Max. = 25 ms	-
Reset time, start at 0 to 1.2 x U_{set}	Min. = 15 ms Max. = 35 ms	-
Critical impulse time	5 ms typically at 1.2 to 0 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 57: Two step overvoltage protection OV2PTOV

Function	Range or value	Accuracy
Operate voltage, step 1 and 2	(1.0-200.0)% of *UBase*	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Absolute hysteresis	(0.0–50.0)% of *UBase*	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Inverse time characteristics for steps 1 and 2, see table 139	-	See table 139
Definite time delay, low step (step 1) at 0 to 1.2 x U_{set}	(0.00 - 6000.00) s	±0.2% or ±45 ms whichever is greater
Definite time delay, high step (step 2) at 0 to 1.2 x U_{set}	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater
Minimum operate time, inverse characteristics	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater
Operate time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start at 0 to 1.2 x U_{set}	Min. = 20 ms Max. = 35 ms	-
Reset time, start at 1.2 to 0 x U_{set}	Min. = 5 ms Max. = 25 ms	-
Critical impulse time	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 58: Two step residual overvoltage protection ROV2PTOV

Function	Range or value	Accuracy
Operate voltage, step 1 and step 2	(1.0-200.0)% of *UBase*	± 0.5% of U_r at U ≤ U_r ± 0.5% of U at U > U_r
Absolute hysteresis	(0.0–50.0)% of *UBase*	± 0.5% of U_r at U ≤ U_r ± 0.5% of U at U > U_r
Inverse time characteristics for low and high step, see table 141	-	See table 141
Definite time delay low step (step 1) at 0 to 1.2 x U_{set}	(0.00–6000.00) s	± 0.2% or ± 45 ms whichever is greater

Table continues on next page

Function	Range or value	Accuracy
Definite time delay high step (step 2) at 0 to 1.2 x U_{set}	(0.000–60.000) s	± 0.2% or ± 45 ms whichever is greater
Minimum operate time	(0.000-60.000) s	± 0.2% or ± 45 ms whichever is greater
Operate time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start at 0 to 1.2 x U_{set}	Min. = 20 ms Max. = 35 ms	-
Reset time, start at 1.2 to 0 x U_{set}	Min. = 5 ms Max. = 25 ms	-
Critical impulse time	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 59: Overexcitation protection OEXPVPH

Function	Range or value	Accuracy
Operate value, start	(100–180)% of ($UBase/f_{rated}$)	±0.5% of U
Operate value, alarm	(50–120)% of start level	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Operate value, high level	(100–200)% of ($UBase/f_{rated}$)	±0.5% of U
Curve type	IEEE or customer defined $IEEE: t = \frac{(0.18 \cdot k)}{(M-1)^2}$ (Equation 2) where M = (E/f)/(Ur/fr)	±5.0 % or ±45 ms, whichever is greater
Minimum time delay for inverse function	(0.000–60.000) s	±1.0% or ±45 ms, whichever is greater
Maximum time delay for inverse function	(0.00–9000.00) s	±1.0% or ±45 ms, whichever is greater
Alarm time delay	(0.00–9000.00)	±1.0% or ±45 ms, whichever is greater

Table 60: Voltage differential protection VDCPTOV

Function	Range or value	Accuracy
Voltage difference for alarm and trip	(2.0–100.0) % of *UBase*	±0.5% of U_r
Under voltage level	(1.0–100.0) % of *UBase*	±0.5% of U_r
Independent time delay for voltage differential alarm at 0.8 to 1.2 x UDAlarm	(0.000–60.000)s	±0.2% or ±40 ms whichever is greater
Independent time delay for voltage differential trip at 0.8 to 1.2 x UDTrip	(0.000–60.000)s	±0.2% or ±40 ms whichever is greater
Independent time delay for voltage differential reset at 1.2 to 0.8 x UDTrip	(0.000–60.000)s	±0.2% or ±40 ms whichever is greater

Table 61: Loss of voltage check LOVPTUV

Function	Range or value	Accuracy
Operate voltage	(1–100)% of UBase	±0.5% of U_r
Pulse timer when disconnecting all three phases	(0.050–60.000) s	±0.2% or ±15 ms whichever is greater
Time delay for enabling the functions after restoration	(0.000–60.000) s	±0.2% or ±35 ms whichever is greater
Operate time delay when disconnecting all three phases	(0.000–60.000) s	±0.2% or ±35 ms whichever is greater
Time delay to block when all three phase voltages are not low	(0.000–60.000) s	±0.2% or ±35 ms whichever is greater

Table 62: Radial feeder protection PAPGAPC

Function	Range or value	Accuracy
Residual current detection	(10 - 150)% of IBase	±1.0% of Ir at I ≤ Ir ±1.0% of I at I > Ir
Reset ratio	>95% at (50 - 150)% of IBase	-
Operate time, residual current detection at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Independent time delay to operate, residual current detection at 0 to 2 x I_{set}	(0.000 - 60.000) s	±0.2% or ±40 ms whichever is greater
Voltage based phase selection	(30 - 100)% of UBase	±1.0% of U_r
Reset ratio	<115%	-
Operate time, voltage based phase selection at 1.2 to 0.8 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Independent time delay to operate, voltage based phase selection at 1.2 to 0.8 x U_{set}	(0.000 – 60.000) s	±0.2% or ±40 ms whichever is greater

Section 9 Frequency protection

Table 63: Underfrequency protection SAPTUF

Function	Range or value		Accuracy
Operate value, start function, at symmetrical three phase voltage	(35.00-75.00) Hz		±2.0 mHz
Operate time, start at f_{set} + 0.02 Hz to f_{set} - 0.02 Hz	fn = 50 Hz	Min. = 80 ms	-
		Max. = 95 ms	
	fn = 60 Hz	Min. = 65 ms	
		Max. = 80 ms	
Reset time, start at f_{set} - 0.02 Hz to f_{set} + 0.02 Hz	Min. = 15 ms Max. = 30 ms		-
Operate time, definite time function at f_{set} + 0.02 Hz to f_{set} - 0.02 Hz	(0.000-60.000)s		±0.2% or ±100 ms whichever is greater
Reset time, definite time function at f_{set} - 0.02 Hz to f_{set} + 0.02 Hz	(0.000-60.000)s		±0.2% or ±120 ms whichever is greater
Voltage dependent time delay	Settings: UNom=(50-150)% of U_{base} UMin=(50-150)% of U_{base} Exponent=0.0-5.0 tMax=(0.010-60.000)s tMin=(0.010-60.000)s		±1.0% or ±120 ms whichever is greater

$$t = \left[\frac{U - UMin}{UNom - UMin}\right]^{Exponent} \cdot (tMax - tMin) + tMin$$

(Equation 3)

U=$U_{measured}$

Table 64: Overfrequency protection SAPTOF

Function	Range or value		Accuracy
Operate value, start function at symmetrical three-phase voltage	(35.00-90.00) Hz		±2.0 mHz
Operate time, start at f_{set} -0.02 Hz to f_{set} +0.02 Hz	fn = 50Hz	Min. = 80 ms Max. = 95 ms	-
	fn = 60 Hz	Min. = 65 ms Max. = 80 ms	

Table continues on next page

Function	Range or value	Accuracy
Reset time, start at f_{set} +0.02 Hz to f_{set} -0.02 Hz	Min. = 15 ms Max. = 30 ms	-
Operate time, definite time function at f_{set} -0.02 Hz to f_{set} +0.02 Hz	(0.000-60.000)s	±0.2% ±100 ms whichever is greater
Reset time, definite time function at f_{set} +0.02 Hz to f_{set} -0.02 Hz	(0.000-60.000)s	±0.2% ±120 ms, whichever is greator

Table 65: Rate-of-change frequency protection SAPFRC

Function	Range or value	Accuracy
Operate value, start function	(-10.00-10.00) Hz/s	±10.0 mHz/s
Operate value, restore enable frequency	(45.00-65.00) Hz	±2.0 mHz
Definite restore time delay	(0.000-60.000) s	±0.2% or ±100 ms whichever is greater
Definite time delay for frequency gradient trip	(0.200-60.000) s	±0.2% or ±120 ms whichever is greater
Definite reset time delay	(0.000-60.000) s	±0.2% or ±250 ms whichever is greater

Section 10 Multipurpose protection

Table 66: General current and voltage protection CVGAPC

Function	Range or value	Accuracy
Measuring current input	phase1, phase2, phase3, PosSeq, -NegSeq, -3*ZeroSeq, MaxPh, MinPh, UnbalancePh, phase1-phase2, phase2-phase3, phase3-phase1, MaxPh-Ph, MinPh-Ph, UnbalancePh-Ph	-
Measuring voltage input	phase1, phase2, phase3, PosSeq, -NegSeq, -3*ZeroSeq, MaxPh, MinPh, UnbalancePh, phase1-phase2, phase2-phase3, phase3-phase1, MaxPh-Ph, MinPh-Ph, UnbalancePh-Ph	-
Start overcurrent, step 1 - 2	(2 - 5000)% of IBase	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Start undercurrent, step 1 - 2	(2 - 150)% of IBase	±1.0% of I_r at $I \le I_r$ ±1.0% of I at $I > I_r$
Independent time delay, overcurrent at 0 to 2 x I_{set}, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greator
Independent time delay, undercurrent at 2 to 0 x I_{set}, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Overcurrent (non-directional):		
Start time at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Start time at 0 to 10 x I_{set}	Min. = 5 ms Max. = 20 ms	-
Reset time at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Undercurrent:		
Start time at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Overcurrent:		
Inverse time characteristics, see table 136, 137 and table 138	16 curve types	See table 136, 137 and table 138
Overcurrent:		

Table continues on next page

Function	Range or value	Accuracy
Minimum operate time for inverse curves, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Voltage level where voltage memory takes over	(0.0 - 5.0)% of UBase	±0.5% of U_r
Start overvoltage, step 1 - 2	(2.0 - 200.0)% of UBase	±0.5% of U_r at $U \le U_r$ ±0.5% of U at $U > U_r$
Start undervoltage, step 1 - 2	(2.0 - 150.0)% of UBase	±0.5% of U_r at $U \le U_r$ ±0.5% of U at $U > U_r$
Independent time delay, overvoltage at 0.8 to 1.2 x U_{set}, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Independent time delay, undervoltage at 1.2 to 0.8 x U_{set}, step 1 - 2	(0.00 - 6000.00) s	±0.2% or ±35 ms whichever is greater
Overvoltage:		
Start time at 0.8 to 1.2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time at 1.2 to 0.8 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Undervoltage:		
Start time at 1.2 to 0.8 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time at 1.2 to 0.8 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Overvoltage:		
Inverse time characteristics, see table 139	4 curve types	See table 139
Undervoltage:		
Inverse time characteristics, see table 140	3 curve types	See table 140
High and low voltage limit, voltage dependent operation, step 1 - 2	(1.0 - 200.0)% of UBase	±1.0% of U_r at $U \le U_r$ ±1.0% of U at $U > U_r$
Directional function	Settable: NonDir, forward and reverse	-
Relay characteristic angle	(-180 to +180) degrees	±2.0 degrees
Relay operate angle	(1 to 90) degrees	±2.0 degrees
Reset ratio, overcurrent	> 95%	-
Reset ratio, undercurrent	< 105%	-

Table continues on next page

Function	Range or value	Accuracy
Reset ratio, overvoltage	> 95%	-
Reset ratio, undervoltage	< 105%	-
Overcurrent:		
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-
Undercurrent:		
Critical impulse time	10 ms typically at 2 to 0 x I_{set}	-
Impulse margin time	15 ms typically	-
Overvoltage:		
Critical impulse time	10 ms typically at 0.8 to 1.2 x U_{set}	-
Impulse margin time	15 ms typically	-
Undervoltage:		
Critical impulse time	10 ms typically at 1.2 to 0.8 x U_{set}	-
Impulse margin time	15 ms typically	-

Section 11 Secondary system supervision

Table 67: Current circuit supervision CCSSPVC

Function	Range or value	Accuracy
Operate current	(10-200)% of IBase	±10.0% of I_r at $I \leq I_r$ ±10.0% of I at $I > I_r$
Reset ratio, Operate current	>90%	
Block current	(20-500)% of IBase	±5.0% of I_r at $I \leq I_r$ ±5.0% of I at $I > I_r$
Reset ratio, Block current	>90% at (50-500)% of IBase	

Table 68: Fuse failure supervision FUFSPVC

Function	Range or value	Accuracy
Operate voltage, zero sequence	(1-100)% of UBase	±0.5% of U_r
Operate current, zero sequence	(1–100)% of IBase	±0.5% of I_r
Operate voltage, negative sequence	(1-100)% of UBase	±0.5% of U_r
Operate current, negative sequence	(1–100)% of IBase	±0.5% of I_r
Operate voltage change level	(1-100)% of UBase	±10.0% of U_r
Operate current change level	(1–100)% of IBase	±10.0% of I_r
Operate phase voltage	(1-100)% of UBase	±0.5% of U_r
Operate phase current	(1–100)% of IBase	±0.5% of I_r
Operate phase dead line voltage	(1-100)% of UBase	±0.5% of U_r
Operate phase dead line current	(1–100)% of IBase	±0.5% of I_r
Operate time, start, 1 ph, at 1 to 0 x U_r	Min. = 10 ms Max. = 25 ms	-
Reset time, start, 1 ph, at 0 to 1 x U_r	Min. = 15 ms Max. = 30 ms	-

Table 69: Fuse failure supervision VDSPVC

Function	Range or value	Accuracy
Operate value, block of main fuse failure	(10.0-80.0)% of UBase	±0.5% of Ur
Reset ratio	<110%	
Operate time, block of main fuse failure at 1 to 0 x U_r	Min. = 5 ms Max. = 15 ms	–
Reset time, block of main fuse failure at 0 to 1 x U_r	Min. = 15 ms Max. = 30 ms	–

Table continues on next page

Function	Range or value	Accuracy
Operate value, alarm for pilot fuse failure	(10.0-80.0)% of UBase	±0.5% of Ur
Reset ratio	<110%	–
Operate time, alarm for pilot fuse failure at 1 to 0 x U_r	Min. = 5 ms Max. = 15 ms	–
Reset time, alarm for pilot fuse failure at 0 to 1 x U_r	Min. = 15 ms Max. = 30 ms	–

Section 12 Scheme communication

Table 70: Scheme communication logic for distance or overcurrent protection ZCPSCH

Function	Range or value	Accuracy
Scheme type	Off Intertrip Permissive UR Permissive OR Blocking DeltaBlocking	-
Operate voltage, Delta U	(0–100)% of UBase	±5.0% of ΔU
Operate current, Delta I	(0–200)% of IBase	±5.0% of ΔI
Operate zero sequence voltage, Delta 3U0	(0–100)% of UBase	±10.0% of Δ3U0
Operate zero sequence current, Delta 3I0	(0–200)% of IBase	±10.0% of Δ3I0
Co-ordination time for blocking communication scheme	(0.000-60.000) s	±0.5% ±10 ms
Minimum duration of a carrier send signal	(0.000-60.000) s	±0.5% ±10 ms
Security timer for loss of guard signal detection	(0.000-60.000) s	±0.5% ±10 ms
Operation mode of unblocking logic	Off NoRestart Restart	-

Table 71: Phase segregated scheme communication logic for distance protection ZC1PPSCH

Function	Range or value	Accuracy
Scheme type	Intertrip Permissive UR Permissive OR Blocking	-
Co-ordination time for blocking communication scheme	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Minimum duration of a carrier send signal	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

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Table 72: Current reversal and weak-end infeed logic for phase segregated communication ZC1WPSCH

Function	Range or value	Accuracy
Detection level phase to neutral voltage	(10-90)% of UBase	±0.5% of U_r
Detection level phase to phase voltage	(10-90)% of UBase	±0.5% of U_r
Reset ratio	<105% at (20-90)% of UBase	-
Operate time for current reversal	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Delay time for current reversal	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
Coordination time for weak-end infeed logic	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

Table 73: Scheme communication logic for residual overcurrent protection ECPSCH

Function	Range or value	Accuracy
Scheme type	Permissive Underreaching Permissive Overreaching Blocking	-
Communication scheme coordination time	(0.000-60.000) s	±0.2% or ±20 ms whichever is greater

Table 74: Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH

Function	Range or value	Accuracy
Operate mode of WEI logic	Off Echo Echo & Trip	-
Operate voltage 3U0 for WEI trip	(5-70)% of UBase	±0.5% of U_r
Operate time for current reversal logic	(0.000-60.000) s	±0.2% or ±30 ms whichever is greater
Delay time for current reversal	(0.000-60.000) s	±0.2% or ±30 ms whichever is greater
Coordination time for weak-end infeed logic	(0.000–60.000) s	±0.2% or ±30 ms whichever is greater

12.1 Direct transfer trip

Table 75: Low active power and power factor protection LAPPGAPC

Function	Range or value	Accuracy
Operate value, low active power	(2.0-100.0)% of SBase	±1.0% of S_r
Reset ratio, low active power	<105%	-
Operate value, low power factor	0.00-1.00	±0.02
Independent time delay to operate for low active power at 1.2 to 0.8 x P_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Independent time delay to operate for low power factor at 1.2 to 0.8 x PF_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Critical impulse time, low active power	10 ms typically at 1.2 to 0.8 x P_{set}	-
Impulse margin time, low active power	10 ms typically	-

Table 76: Compensated over- and undervoltage protection COUVGAPC

Function	Range or value	Accuracy
Operate value, undervoltage	(1-100)% of UBase	±0.5% of U_r
Absolute hysteresis	(0.00–50.0)% of UBase	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Critical impulse time, undervoltage	10 ms typically at 1.2 to 0.8x U_{set}	-
Impulse margin time, undervoltage	15 ms typically	-
Operate value, overvoltage	(1-200)% of UBase	±0.5% of U_r at U≤U_r ± 0.5% of U at U>U_r
Critical impulse time, overvoltage	10 ms typically at 0.8 to 1.2 x U_{set}	-

Table continues on next page

Function	Range or value	Accuracy
Impulse margin time, overvoltage	15 ms typically	-
Independent time delay for undervoltage functionality at 1.2 to 0.8 x U_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater
Independent time delay for overvoltage functionality at 0.8 to 1.2 x U_{set}	(0.000-60.000) s	±0.2% or ±40 ms whichever is greater

Table 77: Sudden change in current variation SCCVPTOC

Function	Range or value	Accuracy
Operate value, overcurrent	(5-100)% of IBase	±2.0% of I_r
Hold time for operate signal at 0 to 2 x Iset	(0.000-60.000) s	±0.2% or ±15 ms whichever is greator

Table 78: Carrier receive logic LCCRPTRC

Function	Range or value	Accuracy
Operation mode	1 Out Of 2 2 Out Of 2	-
Independent time delay	(0.000-60.000) s	±0.2% or ±35 ms whichever is greater

Table 79: Negative sequence overvoltage protection LCNSPTOV

Function	Range or value	Accuracy
Operate value, negative sequence overvoltage	(1-200)% of UBase	±0.5% of U_r at U≤U_r ±0.5% of U at U>U_r
Reset ratio, negative sequence overvoltage	>95% at (10–200)% of UBase	-
Operate time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-

Table continues on next page

Function	Range or value	Accuracy
Critical impulse time, negative sequence overvoltage	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time, negative sequence overvoltage	15 ms typically	-
Independent time delay to operate at 0 to 1.2 x U_{set}	(0.000-120.000) s	±0.2% or ±40 ms whichever is greater

Table 80: Zero sequence overvoltage protection LCZSPTOV

Function	Range or value	Accuracy
Operate value, zero sequence overvoltage	(1-200)% of UBase	±0.5% of U_r at U ≤ U_r ±0.5% of U at U > U_r
Reset ratio, zero sequence overvoltage	>95% at (10–200)% of UBase	-
Operate time, start at 0 to 2 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x U_{set}	Min. = 15 ms Max. = 30 ms	-
Critical impulse time, zero sequence overvoltage	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time, zero sequence overvoltage	15 ms typically	-
Independent time delay to operate at 0 to 1.2 x U_{set}	(0.000-120.000) s	±0.2% or ±40 ms whichever is greater

Table 81: Negative sequence overcurrent protection LCNSPTOC

Function	Range or value	Accuracy
Operate value, negative sequence overcurrent	(3 - 2500)% of IBase	±1.0% of Ir at I ≤ I_r ±1.0% of I at I > I_r
Reset ratio, negative sequence overcurrent	>95% at (50–2500)% of IBase	-
Operate time, start at 0 to 2 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Reset time, start at 2 to 0 x I_{set}	Min. = 15 ms Max. = 25 ms	-
Operate time, start at 0 to 10 x I_{set}	Min. = 10 ms Max. = 20 ms	-
Reset time, start at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-

Table continues on next page

Function	Range or value	Accuracy
Critical impulse time, negative sequence overcurrent	10 ms typically at 0 to 2 x I_{set} 2 ms typically at 0 to 10 x I_{set}	-
Impulse margin time, negative sequence overcurrent	15 ms typically	-
Independent time delay at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±35 ms, whichever is greater
Transient overreach, start function	<5% at τ = 100 ms	-

Table 82: Zero sequence overcurrent protection LCZSPTOC

Function	Range or value	Accuracy
Operate value, zero sequence overcurrent	(3-2500)% of IBase	±1.0% of I_r at I≤I_r ±1.0% of I at I>I_r
Reset ratio, zero sequence overcurrent	>95% at (50–2500)% of IBase	-
Operate time, start at 0 to 2 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Reset time, start at 2 to 0 x I_{set}	Min. = 15 ms Max. = 30 ms	-
Operate time, start at 0 to 10 x I_{set}	Min. = 10 ms Max. = 20 ms	-
Reset time, start at 10 to 0 x I_{set}	Min. = 20 ms Max. = 35 ms	-
Critical impulse time, zero sequence overcurrent	10 ms typically at 0 to 2 x I_{set} 2 ms typically at 0 to 10 x I_{set}	-
Impulse margin time, zero sequence overcurrent	15 ms typically	-
Independent time delay at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±35 ms whichever is greater

Table 83: Three phase overcurrent LCP3PTOC

Function	Range or value	Accuracy
Operate value, overcurrent	(5-2500)% of IBase	±1.0% of I_r at I ≤ I_r ±1.0% of I at I > I_r
Reset ratio, overcurrent	> 95% at (50-2500)% of IBase	-
Operate time at 0 to 2 x	Min. = 10 ms Max. = 25 ms	-
Reset time at 2 to 0 x	Min. = 20 ms Max. = 35 ms	-

Table continues on next page

Function	Range or value	Accuracy
Critical impulse time, overcurrent	5 ms typically at 0 to 2 x I_{set} 2 ms typically at 0 to 10 x I_{set}	-
Impulse margin time, overcurrent	10 ms typically	-
Independent time delay to operate at 0 to 2 x I_{set}	(0.000-60.000) s	±0.2% or ±30 ms whichever is greater

Table 84: Three phase undercurrent LCP3PTUC

Function	Range or value	Accuracy
Operate value, undercurrent	(1.00-100.00)% of IBase	±1.0% of I_r
Reset ratio, undercurrent	< 105% at (50.00-100.00)% of IBase	-
Start time at 2 to 0 x I_{set}	Min. ≈ 15 ms Max. ≈ 30 ms	-
Reset time at 0 to 2 x I_{set}	Min. ≈ 10 ms Max. ≈ 25 ms	-
Critical impulse time, undercurrent	10 ms typically at 2 to 0 x I_{set}	-
Impulse margin time, undercurrent	10 ms typically	-
Independent time delay to operate at 2 to 0 x I_{set}	(0.000-60.000) s	±0.2% or ±45 ms whichever is greater

Section 13 Logic

Table 85: Tripping logic common 3-phase output SMPPTRC

Function	Range or value	Accuracy
Trip action	3-ph, 1/3-ph, 1/2/3-ph	-
Minimum trip pulse length	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater
3-pole trip delay	(0.020-0.500) s	±0.2% or ±15 ms whichever is greater
Evolving fault delay	(0.000-60.000) s	±0.2% or ±15 ms whichever is greater

Table 86: Number of PULSETIMER instances

Logic block	Quantity with cycle time			Range or Value	Accuracy
	3 ms	8 ms	100 ms		
PULSETIMER	10	10	20	(0.000–90000.000) s	±0.5% ±10 ms

Table 87: Number of TIMERSET instances

Logic block	Quantity with cycle time			Range or Value	Accuracy
	3 ms	8 ms	100 ms		
TIMERSET	15	15	30	(0.000–90000.000) s	±0.5% ±10 ms

Table 88: Number of PULSETIMERQT instances

Logic block	Quantity with cycle time			Range or Value	Accuracy
	3 ms	8 ms	100 ms		
PULSETIMERQT	-	10	30	(0.000–90000.000) s	±0.5% ±10 ms

Table 89: Number of TIMERSETQT instances

Logic block	Quantity with cycle time			Range or Value	Accuracy
	3 ms	8 ms	100 ms		
TIMERSETQT	-	10	30	(0.000–90000.000) s	±0.5% ±10 ms

Table 90: Elapsed time integrator with limit transgression and overflow supervision TEIGAPC

Function	Cycle time (ms)	Range or value	Accuracy
Elapsed time integration	3	0 – 999999.9 s	±0.2% or ±20 ms whichever is greater
	8	0 – 999999.9 s	±0.2% or ±100 ms whichever is greater
	100	0 – 999999.9 s	±0.2% or ±250 ms whichever is greater

Table 91: Number of TEIGAPC instances

Function	Quantity with cycle time		
	3 ms	8 ms	100 ms
TEIGAPC	4	4	4

Table 92: Comparator for real input REALCOMP

Function	Accuracy
Operate value, EqualBandHigh and EqualBandLow	±0.5% of set value
Reset value, EqualBandHigh	> 0.1% of set RefPrefix
Reset value, EqualBandLow	< 0.1% of set RefPrefix

Table 93: Number of REALCOMP instances

Function	Quantity with cycle time		
	3 ms	8 ms	100 ms
REALCOMP	4	4	4

Section 14 Monitoring

Table 94: Measurements CVMMXN

Function	Range or value	Accuracy
Frequency	(0.95-1.05) x f_r	±2.0 mHz
Voltage	(10 to 300) V	±0.3% of U at U≤ 50 V ±0.2% of U at U> 50 V
Current	(0.1-4.0) x I_r	±0.8% of I at 0.1 x I_r< I < 0.2 x I_r ± 0.5% of I at 0.2 x I_r< I < 0.5 x I_r ±0.2% of I at 0.5 x I_r< I < 4.0 x I_r
Active power, P	(10 to 300) V (0.1-4.0) x I_r	±0.5% of S_r at S ≤0.5 x S_r ±0.5% of S at S > 0.5 x S_r
	(100 to 220) V (0.5-2.0) x I_r cos φ< 0.7	±0.2% of P
Reactive power, Q	(10 to 300) V (0.1-4.0) x I_r	±0.5% of S_r at S ≤0.5 x S_r ±0.5% of S at S > 0.5 x S_r
	(100 to 220) V (0.5-2.0) x I_r cos φ> 0.7	±0.2% of Q
Apparent power, S	(10 to 300) V (0.1-4.0) x I_r	±0.5% of S_r at S ≤0.5 x S_r ±0.5% of S at S >0.5 x S_r
	(100 to 220) V (0.5-2.0) x I_r	±0.2% of S
Power factor, cos (φ)	(10 to 300) V (0.1-4.0) x I_r	<0.02
	(100 to 220) V (0.5-2.0) x I_r	<0.01

Table 95: Phase current measurement CMMXU

Function	Range or value	Accuracy
Current at symmetrical load	(0.1-4.0) x I_r	±0.3% of I_r at I ≤ 0.5 x I_r ±0.3% of I at I > 0.5 x I_r
Phase angle at symmetrical load	(0.1-4.0) x I_r	±1.0 degrees at 0.1 x I_r < I ≤ 0.5 x I_r ±0.5 degrees at 0.5 x I_r < I ≤ 4.0 x I_r

Table 96: Phase-phase voltage measurement VMMXU

Function	Range or value	Accuracy
Voltage	(10 to 300) V	±0.5% of U at U ≤ 50 V ±0.2% of U at U > 50 V
Phase angle	(10 to 300) V	±0.5 degrees at U ≤ 50 V ±0.2 degrees at U > 50 V

Table 97: Phase-neutral voltage measurement VNMMXU

Function	Range or value	Accuracy
Voltage	(5 to 175) V	±0.5% of U at U ≤ 50 V ±0.2% of U at U > 50 V
Phase angle	(5 to 175) V	±0.5 degrees at U ≤ 50 V ±0.2 degrees at U > 50 V

Table 98: Current sequence component measurement CMSQI

Function	Range or value	Accuracy
Current positive sequence, I1 Three phase settings	(0.1–4.0) × I_r	±0.3% of I_r at I ≤ 0.5 × I_r ±0.3% of I at I > 0.5 × I_r
Current zero sequence, 3I0 Three phase settings	(0.1–1.0) × I_r	±0.3% of I_r at I ≤ 0.5 × I_r ±0.3% of I at I > 0.5 × I_r
Current negative sequence, I2 Three phase settings	(0.1–1.0) × I_r	±0.3% of I_r at I ≤ 0.5 × I_r ±0.3% of I at I > 0.5 × I_r
Phase angle	(0.1–4.0) × I_r	±1.0 degrees at 0.1 × I_r < I ≤ 0.5 × I_r ±0.5 degrees at 0.5 × I_r < I ≤ 4.0 × I_r

Table 99: Voltage sequence measurement VMSQI

Function	Range or value	Accuracy
Voltage positive sequence, U1	(10 to 300) V	±0.5% of U at U ≤ 50 V ±0.2% of U at U > 50 V
Voltage zero sequence, 3U0	(10 to 300) V	±0.5% of U at U ≤ 50 V ±0.2% of U at U > 50 V
Voltage negative sequence, U2	(10 to 300) V	±0.5% of U at U ≤ 50 V ±0.2% of U at U > 50 V
Phase angle	(10 to 300) V	±0.5 degrees at U ≤ 50 V ±0.2 degrees at U > 50 V

Table 100: Supervision of mA input signals

Function	Range or value	Accuracy
mA measuring function	±5, ±10, ±20 mA 0-5, 0-10, 0-20, 4-20 mA	±0.1 % of set value ±0.005 mA
Max current of transducer to input	(-20.00 to +20.00) mA	
Min current of transducer to input	(-20.00 to +20.00) mA	
Alarm level for input	(-20.00 to +20.00) mA	
Warning level for input	(-20.00 to +20.00) mA	
Alarm hysteresis for input	(0.0-20.0) mA	

Table 101: Insulation gas monitoring function SSIMG

Function	Range or value	Accuracy
Pressure alarm level	1.00-100.00	±10.0% of set value
Pressure lockout level	1.00-100.00	±10.0% of set value
Temperature alarm level	-40.00-200.00	±2.5% of set value
Temperature lockout level	-40.00-200.00	±2.5% of set value
Time delay for pressure alarm	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Reset time delay for pressure alarm	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Time delay for pressure lockout	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Time delay for temperature alarm	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Reset time delay for temperature alarm	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Time delay for temperature lockout	(0.000-60.000) s	±0.2% or ±250ms whichever is greater

Table 102: Insulation liquid monitoring function SSIML

Function	Range or value	Accuracy
Oil alarm level	1.00-100.00	±10.0% of set value
Oil lockout level	1.00-100.00	±10.0% of set value
Temperature alarm level	-40.00-200.00	±2.5% of set value
Temperature lockout level	-40.00-200.00	±2.5% of set value
Time delay for oil alarm	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Reset time delay for oil alarm	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Time delay for oil lockout	(0.000-60.000) s	±0.2% or ±250ms whichever is greater

Table continues on next page

Function	Range or value	Accuracy
Time delay for temperature alarm	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Reset time delay for temperature alarm	(0.000-60.000) s	±0.2% or ±250ms whichever is greater
Time delay for temperature lockout	(0.000-60.000) s	±0.2% or ±250ms whichever is greater

Table 103: Breaker monitoring SSCBR

Function	Range or value	Accuracy
Alarm level for open and close travel time	(0 – 200) ms	±3 ms
Alarm level for number of operations	(0 – 9999)	-
Independent time delay for spring charging time alarm	(0.00 – 60.00) s	±0.2% or ±30 ms whichever is greater
Independent time delay for gas pressure alarm	(0.00 – 60.00) s	±0.2% or ±30 ms whichever is greater
Independent time delay for gas pressure lockout	(0.00 – 60.00) s	±0.2% or ±30 ms whichever is greater
CB Contact Travel Time, opening and closing		±3 ms
Remaining Life of CB		±2 operations
Accumulated Energy		±1.0% or ±0.5 whichever is greater

Table 104: Disturbance report DRPRDRE

Function	Range or value	Accuracy
Pre-fault time	(0.05–9.90) s	-
Post-fault time	(0.1–10.0) s	-
Limit time	(0.5–10.0) s	-
Maximum number of recordings	100, first in - first out	-
Time tagging resolution	1 ms	See table ""
Maximum number of analog inputs	30 + 10 (external + internally derived)	-
Maximum number of binary inputs	96	-
Maximum number of phasors in the Trip Value recorder per recording	30	-
Maximum number of indications in a disturbance report	96	-
Maximum number of events in the Event recording per recording	150	-
Maximum number of events in the Event list	1000, first in - first out	-

Table continues on next page

Function	Range or value	Accuracy
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)	340 seconds (100 recordings) at 50 Hz, 280 seconds (80 recordings) at 60 Hz	-
Sampling rate	1 kHz at 50 Hz 1.2 kHz at 60 Hz	-
Recording bandwidth	(5-300) Hz	-

Table 105: Fault locator LMBRFLO

Function	Value or range	Accuracy
Reactive and resistive reach	(0.001-1500.000) Ω/phase	±2.0% static accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r
Phase selection	According to input signals	-
Maximum number of fault locations	100	-

Table 106: Event list

Function		Value
Buffer capacity	Maximum number of events in the list	1000
Resolution		1 ms
Accuracy		Depending on time synchronizing

Table 107: Indications

Function		Value
Buffer capacity	Maximum number of indications presented for single disturbance	96
	Maximum number of recorded disturbances	100

Table 108: Event recorder

Function		Value
Buffer capacity	Maximum number of events in disturbance report	150
	Maximum number of disturbance reports	100
Resolution		1 ms
Accuracy		Depending on time synchronizing

Table 109: Trip value recorder

Function		Value
Buffer capacity	Maximum number of analog inputs	30
	Maximum number of disturbance reports	100

Table 110: Disturbance recorder

Function		Value
Buffer capacity	Maximum number of analog inputs	40
	Maximum number of binary inputs	96
	Maximum number of disturbance reports	100
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)		340 seconds (100 recordings) at 50 Hz 280 seconds (80 recordings) at 60 Hz

Table 111: Limit counter L4UFCNT

Function	Range or value	Accuracy
Counter value	0-65535	-
Max. count up speed	30 pulses/s (50% duty cycle)	-

Table 112: Running hour-meter TEILGAPC

Function	Range or value	Accuracy
Time limit for alarm supervision, tAlarm	(0 - 99999.9) hours	±0.1% of set value
Time limit for warning supervision, tWarning	(0 - 99999.9) hours	±0.1% of set value
Time limit for overflow supervision	Fixed to 99999.9 hours	±0.1%

Section 15 Station communication

Table 113: IEC 61850-9-2 communication protocol

Function	Value
Protocol	IEC 61850-9-2
Communication speed for the IEDs	100BASE-FX

Table 114: LON communication protocol

Function	Value
Protocol	LON
Communication speed	1.25 Mbit/s

Table 115: SPA communication protocol

Function	Value
Protocol	SPA
Communication speed	300, 1200, 2400, 4800, 9600, 19200 or 38400 Bd
Slave number	1 to 899

Table 116: Ethernet communication

Function	Value
Protocol	Ethernet, TCP/IP
Communication speed	10/100 Mbit/s
Connectors	RJ45 shielded Ethernet connection

Table 117: IEC 60870-5-103 communication protocol

Function	Value
Protocol	IEC 60870-5-103
Communication speed	9600, 19200 Bd

Table 118: DNP 3.0 TCP/IP communication

Function	Value
Protocol	UDP, TCP/IP, Ethernet
Communication speed	100 Mbit/s
Connectors	RJ45 shielded Ethernet connection, Optical type ST Ethernet connection

Table 119: DNP 3.0 serial communication EIA-485

Function	Value
Protocol	DNP 3.0
Communication speed	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200 Bd

Table 120: SLM – LON port

Quantity	Range or value
Optical connector	Glass fiber: type ST Plastic fiber: type HFBR snap-in
Fiber, optical budget	Glass fiber: 11 dB (1000m/3000 ft typically *) Plastic fiber: 7 dB (10m/35ft typically *)
Fiber diameter	Glass fiber: 62.5/125 µm Plastic fiber: 1 mm
*) depending on optical budget calculation	

Table 121: SLM – SPA/IEC 60870-5-103/DNP3 port

Quantity	Range or value
Optical connector	Glass fiber: type ST Plastic fiber: type HFBR snap-in
Fiber, optical budget	Glass fiber: 11 dB (1000m/3000ft m typically *) Plastic fiber: 7 dB (25m/80ft m typically *)
Fiber diameter	Glass fiber: 62.5/125 µm Plastic fiber: 1 mm
*) depending on optical budget calculation	

Table 122: Galvanic X.21 line data communication module (X.21-LDCM)

Quantity	Range or value
Connector, X.21	Micro D-sub, 15-pole male, 1.27 mm (0.050") pitch
Connector, ground selection	2 pole screw terminal
Standard	CCITT X21
Communication speed	64 kbit/s
Insulation	1 kV
Maximum cable length	100 m

Table 123: Galvanic RS485 communication module

Quantity	Range or value
Communication speed	2400–19200 bauds
External connectors	RS-485 6-pole connector Soft ground 2-pole connector

Table 124: IEC 62439-3 Edition 1 and Edition 2 parallel redundancy protocol

Function	Value
Communication speed	100 Base-FX

Section 16 Remote communication

Table 125: Line data communication module

Charactoristic	Range or value		
Type of LDCM	Short range (SR)	Medium range (MR)	Long range (LR)
Type of fiber	Graded-index multimode 62.5/125 µm	Singlemode 9/125 µm	Singlemode 9/125 µm
Peak Emission Wave length Nominal Maximum Minimum	 820 nm 865 nm 792 nm	 1310 nm 1330 nm 1290 nm	 1550 nm 1580 nm 1520 nm
Optical budget Graded-index multimode 62.5/125 µm, Graded-index multimode 50/125 µm	13 dB (typical distance about 3 km/2 mile *) 9 dB (typical distance about 2 km/1 mile *)	22 dB (typical distance 80 km/50 mile *)	26 dB (typical distance 110 km/68 mile *)
Optical connector	Type ST	Type FC/PC	Type FC/PC
Protocol	C37.94	C37.94 implementation **)	C37.94 implementation **)
Data transmission	Synchronous	Synchronous	Synchronous
Transmission rate / Data rate	2 Mb/s / 64 kbit/s	2 Mb/s / 64 kbit/s	2 Mb/s / 64 kbit/s
Clock source	Internal or derived from received signal	Internal or derived from received signal	Internal or derived from received signal

*) depending on optical budget calculation
**) C37.94 originally defined just for multimode; using same header, configuration and data format as C37.94

Section 17 Hardware

17.1 IED

Table 126: Case

Material	Steel sheet
Front plate	Steel sheet profile with cut-out for HMI
Surface treatment	Aluzink preplated steel
Finish	Light grey (RAL 7035)

Table 127: Water and dust protection level according to IEC 60529

Front	IP40 (IP54 with sealing strip)
Sides, top and bottom	IP20
Rear side	IP20 with screw compression type IP10 with ring lug terminals

Table 128: Weight

Case size	Weight
6U, 1/2 x 19"	≤ 10 kg/22 lb
6U, 3/4 x 19"	≤ 15 kg/33 lb
6U, 1/1 x 19"	≤ 18 kg/40 lb

17.2 Electrical safety

Table 129: Electrical safety according to IEC 60255-27

Equipment class	I (protective earthed)
Overvoltage category	III
Pollution degree	2 (normally only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected)

17.3 Connection system

Table 130: CT and VT circuit connectors

Connector type	Rated voltage and current	Maximum conductor area
Screw compression type	250 V AC, 20 A	4 mm² (AWG12) 2 x 2.5 mm² (2 x AWG14)
Terminal blocks suitable for ring lug terminals	250 V AC, 20 A	4 mm² (AWG12)

Table 131: Auxiliary power supply and binary I/O connectors

Connector type	Rated voltage	Maximum conductor area
Screw compression type	250 V AC	2.5 mm² (AWG14) 2 × 1 mm² (2 x AWG18)
Terminal blocks suitable for ring lug terminals	300 V AC	3 mm² (AWG14)

Because of limitations of space, when ring lug terminal is ordered for Binary I/O connections, one blank slot is necessary between two adjacent IO cards. Please refer to the ordering particulars for details.

Section 18 Basic IED functions

Table 132: Self supervision with internal event list

Data	Value
Recording manner	Continuous, event controlled
List size	40 events, first in-first out

Table 133: GPS time synchronization module (GTM)

Function	Range or value	Accuracy
Receiver	-	±1µs relative UTC
Time to reliable time reference with antenna in new position or after power loss longer than 1 month	<30 minutes	-
Time to reliable time reference after a power loss longer than 48 hours	<15 minutes	-
Time to reliable time reference after a power loss shorter than 48 hours	<5 minutes	-

Table 134: GPS – Antenna and cable

Function	Value
Max antenna cable attenuation	26 db @ 1.6 GHz
Antenna cable impedance	50 ohm
Lightning protection	Must be provided externally
Antenna cable connector	SMA in receiver end TNC in antenna end
Accuracy	+/-1µs

Table 135: IRIG-B

Quantity	Rated value
Number of channels IRIG-B	1
Number of optical channels	1
Electrical connector:	
Electrical connector IRIG-B	BNC
Pulse-width modulated	5 Vpp
Amplitude modulated – low level – high level	 1-3 Vpp 3 x low level, max 9 Vpp
Supported formats	IRIG-B 00x, IRIG-B 12x
Accuracy	+/-10µs for IRIG-B 00x and +/-100µs for IRIG-B 12x

Table continues on next page

Quantity	Rated value
Input impedance	100 k ohm
Optical connector:	
Optical connector IRIG-B	Type ST
Type of fibre	62.5/125 µm multimode fibre
Supported formats	IRIG-B 00x
Accuracy	+/- 1µs

Section 19 Inverse characteristics

Table 136: ANSI Inverse time characteristics

Function	Range or value	Accuracy
Operating characteristic: $t = \left(\frac{A}{(I^P - 1)} + B\right) \cdot k + tDef$ Reset characteristic: $t = \frac{t_r}{(I^2 - 1)} \cdot k$ $I = I_{measured}/I_{set}$	$0.10 \le k \le 3.00$ $1.5 \times I_{set} \le I \le 20 \times I_{set}$	ANSI/IEEE C37.112, ±2.0% or ±40 ms whichever is greater
ANSI Extremely Inverse	A=28.2, B=0.1217, P=2.0, tr=29.1	
ANSI Very Inverse	A=19.61, B=0.491, P=2.0, tr=21.6	
ANSI Normal Inverse	A=0.0086, B=0.0185, P=0.02, tr=0.46	
ANSI Moderately Inverse	A=0.0515, B=0.1140, P=0.02, tr=4.85	
ANSI Long Time Extremely Inverse	A=64.07, B=0.250, P=2.0, tr=30	
ANSI Long Time Very Inverse	A=28.55, B=0.712, P=2.0, tr=13.46	
ANSI Long Time Inverse	A=0.086, B=0.185, P=0.02, tr=4.6	

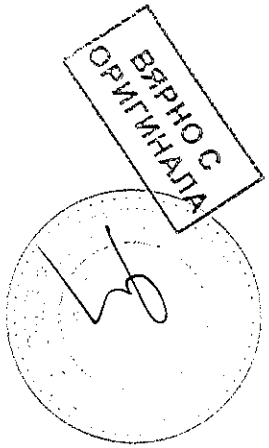

Table 137: IEC Inverse time characteristics

Function	Range or value	Accuracy
Operating characteristic: $t = \left(\frac{A}{(I^P - 1)}\right) \cdot k$ $I = I_{measured}/I_{set}$	$0.10 \le k \le 3.00$ $1.5 \times I_{set} \le I \le 20 \times I_{set}$	IEC 60255-151, ±2.0% or ±40 ms whichever is greater
IEC Normal Inverse	A=0.14, P=0.02	
IEC Very Inverse	A=13.5, P=1.0	
IEC Inverse	A=0.14, P=0.02	
IEC Extremely Inverse	A=80.0, P=2.0	
IEC Short time Inverse	A=0.05, P=0.04	
IEC Long time inverse	A=120, P=1.0	
Programmable characteristic Operate characteristic: $t = \left(\frac{A}{(I^P - C)} + B\right) \cdot k$ Reset characteristic: $t = \frac{TR}{(I^{PR} - CR)} \cdot k$ $I = I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01 A=(0.005-200.000) in steps of 0.001 B=(0.00-20.00) in steps of 0.01 C=(0.1-10.0) in steps of 0.1 P=(0.005-3.000) in steps of 0.001 TR=(0.005-100.000) in steps of 0.001 CR=(0.1-10.0) in steps of 0.1 PR=(0.005-3.000) in steps of 0.001	

Table 138: RI and RD type inverse time characteristics

Function	Range or value	Accuracy
RI type inverse characteristic $t = \frac{1}{0.339 - \frac{0.236}{I}} \cdot k$ $I = I_{measured}/I_{set}$	$0.10 \le k \le 3.00$ $1.5 \times I_{set} \le I \le 20 \times I_{set}$	IEC 60255-151, ±2.0% or ±40 ms whichever is greater
RD type logarithmic inverse characteristic $t = 5.8 - \left(1.35 \cdot ln\frac{I}{k}\right)$ $I = I_{measured}/I_{set}$		

Table 139: Inverse time characteristics for overvoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5.0% or ±45 ms whichever is greater
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0}} + 0.035$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0}} + 0.035$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $t = \frac{k \cdot A}{\left(B \cdot \frac{U - U>}{U>} - C\right)^{P}} + D$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

Table 140: Inverse time characteristics for undervoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U < -U}{U <}\right)}$ U< = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5.0% or ±45 ms whichever is greater
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U < -U}{U <} - 0.5\right)^{2.0}} + 0.055$ U< = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $t = \left[\frac{k \cdot A}{\left(B \cdot \frac{U < -U}{U <} - C\right)^{P}}\right] + D$ U< = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

Table 141: Inverse time characteristics for residual overvoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5.0% or ±45 ms whichever is greater
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0}} + 0.035$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0}} + 0.035$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $t = \frac{k \cdot A}{\left(B \cdot \frac{U - U>}{U>} - C\right)^{P}} + D$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

Table 142: ANSI Inverse time characteristics for Sensitive directional residual overcurrent and power protection

Function	Range or value	Accuracy
Operating characteristic: $t = \left(\frac{A}{(I^P - 1)} + B\right) \cdot k + tDef$ Reset characteristic: $t = \frac{t_r}{\left(I^2 - 1\right)} \cdot k$ I = $I_{measured}/I_{set}$	0.10 ≤ k ≤ 2.00 1.5 x I_{set} ≤ I ≤ 20 x I_{set}	ANSI/IEEE C37.112 , ±5.0% or ±160 ms whichever is greater
ANSI Extremely Inverse	A=28.2, B=0.1217, P=2.0 , tr=29.1	
ANSI Very Inverse	A=19.61, B=0.491, P=2.0 , tr=21.6	
ANSI Normal Inverse	A=0.0086, B=0.0185, P=0.02, tr=0.46	
ANSI Moderately Inverse	A=0.0515, B=0.1140, P=0.02, tr=4.85	
ANSI Long Time Extremely Inverse	A=64.07, B=0.250, P=2.0, tr=30	
ANSI Long Time Very Inverse	A=28.55, B=0.712, P=2.0, tr=13.46	
ANSI Long Time Inverse	A=0.086, B=0.185, P=0.02, tr=4.6	

Table 143: IEC Inverse time characteristics for Sensitive directional residual overcurrent and power protection

Function	Range or value	Accuracy
Operating characteristic: $t = \left(\frac{A}{\left(I^{P}-1\right)}\right)\cdot k$ $I = I_{measured}/I_{set}$	$0.10 \le k \le 2.00$ $1.5 \times I_{set} \le I \le 20 \times I_{set}$	IEC 60255-151, ±5.0% or ±160 ms whichever is greater
IEC Normal Inverse	A=0.14, P=0.02	
IEC Very Inverse	A=13.5, P=1.0	
IEC Inverse	A=0.14, P=0.02	
IEC Extremely Inverse	A=80.0, P=2.0	
IEC Short time inverse	A=0.05, P=0.04	
IEC Long time inverse	A=120, P=1.0	
Programmable characteristic Operate characteristic: $t = \left(\frac{A}{\left(I^{P}-C\right)}+B\right)\cdot k$ Reset characteristic: $t = \frac{TR}{\left(I^{PR}-CR\right)}\cdot k$ $I = I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01 A=(0.005-200.000) in steps of 0.001 B=(0.00-20.00) in steps of 0.01 C=(0.1-10.0) in steps of 0.1 P=(0.005-3.000) in steps of 0.001 TR=(0.005-100.000) in steps of 0.001 CR=(0.1-10.0) in steps of 0.1 PR=(0.005-3.000) in steps of 0.001	

The parameter setting *Characterist1 and 4/Reserved* shall not be used, since this parameter setting is for future use and not implemented yet.

Table 144: RI and RD type inverse time characteristics for Sensitive directional residual overcurrent and power protection

Function	Range or value	Accuracy
RI type inverse characteristic $t = \frac{1}{0.339 - \frac{0.236}{I}}\cdot k$ $I = I_{measured}/I_{set}$	$0.10 \le k \le 2.00$ $1.5 \times I_{set} \le I \le 20 \times I_{set}$	IEC 60255-151, ±5.0% or ±160 ms whichever is greater
RD type logarithmic inverse characteristic $t = 5.8 - \left(1.35 \cdot ln\frac{I}{k}\right)$ $I = I_{measured}/I_{set}$		

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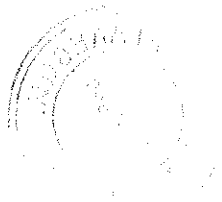
Списък на типовите изпитания на устройствата от серията 650 и в частност REQ650 и REC650 съгласно съответните приложими международни стандарти

Таблица 17: Електромагнитна съвместимост

Тест/изпитване	Стойности при типови изпитания	Референтен стандарт
Изпитания при 100kHZ и 1 MHz бързо смущение • Общ/обикновен режим • Диференциален режим	 2.5 kV 2.5 kV	IEC 61000-4-18, клас III IEC 60255-22-1 ANSI C37.90.1-2012
Електростатичен разряд • Контактен разряд • Въздушен разряд	 8 kV 15 kV	IEC 61000-4-2, клас III IEC 60255-22-6 ANSI C37.90.3-2001
Изпитания при смущения с радио честота • Проведени, общ режим • Излъчени, ампл.-модулирани	 10 V (emf), f=150kHz...80MHz 20 V/m (rms), f=150kHz...1000MHz и f=1.4...2.7 GHz	IEC 61000-4-6, клас III IEC 60255-22-6 IEC 61000-4-3, клас III IEC 60255-22-3 ANSI C37.90.2-2004
Изпитания за издръжливост при смущения от бързи преходни процеси • Комуникационни портове • Други портове	4 kV 4 kV	IEC 61000-4-4 IEC 60255-22-4, клас A ANSI C37.90.1-2012
Изпитания при смущения от пренапрежения • Комуникация • Други портове • Захранващ блок	 1kV фаза към земя 2kV фаза към земя, 1kV фаза към фаза 4kV фаза към земя, 2kV фаза към фаза	IEC 61000-4-5 IEC 60255-22-5
Изпитания за въздействие на магнитно поле с промишлена честота (50Hz) • 3 s • непрекъснато	 1000A/m 100 A/m	IEC 61000-4-8 ниво 5
Изпитания при смущения с пулсиращо магнитно поле	1000A/m	IEC 61000-4-9 ниво 5
Изпитания със затихващо осцилиращо магнитно поле	100 A/m, 100kHz и 1MHz	IEC 61000-4-10 ниво 5
Изпитания при смущения с промишлена честота • общ режим • диференциален режим	 300 V rms 150 V rms	IEC 60255-27-7 клас A IEC 61000-4-16
Изпитания при срив в напрежението DC	Пропадане: 40%/200 ms 70%/500 ms Прекъсвания:	IEC 60255-11 IEC 61000-4-11



	0-50ms; без рестартиране 0 ... ∞ s: правилно поведение при изчезване на напрежението	
Изпитания при срив в напрежението AC	Пропадане: 40% 10/12 периода при 50/60Hz 70% 10/12 периода при 50/60Hz Прекъсвания: 0 - 50ms; без рестартиране 0 ... ∞ s: правилно поведение при изчезване на напрежението	IEC 60255-11 IEC 61000-4-11
Изпитания при електромагнитни емисии • Проведени радиочестоти емисия (основни клеми) 0.15 ...0.50 MHz 0.5 ... 30 MHz • Излъчени радиочестоти емисия IEC 30 ...230 MHz 230 ... 1000 MHz	 < 79 dB(μV) квази пик < 66 dB(μV) средно < 73 dB(μV) квази пик < 60 dB(μV) средно < 40 dB(μV) квази пик, измерено на разстояние 10м. < 47 dB(μV) квази пик, измерено на разстояние 10м.	EN 55011, клас А IEC 60255-25 ANSI C63.4, FCC

Таблица 16: Изолация

Тест/изпитване	Стойности при типови изпитания	Референтен стандарт
Диелектрични изпитания • Изпитвателни напрежения	 2kV, 50Hz, 1 мин. 1kV, 50Hz, 1 мин. комуникация	IEC 60255-27 ANSI C37.90-2005
Изпитания с импулсно напрежение • Изпитвателни напрежения	5 kV еднополярни импулси, вълна с форма 1.2/50 ms, източник с енергия 0.5 J 1 kV еднополярни импулси, вълна с форма 1.2/50 ms, източник с енергия 0.5 J комуникации	IEC 60255-27 ANSI C37.90-2005
Измерване на изолационното съпротивление • Изпитвателни напрежения	>100 MΩ при 500 VDC	IEC 60255-27 ANSI C37.90-2005
Напрежение на защитното заземяване • Изпитвателни напрежения	<0.2 Ω (60сек.)	IEC 60255-27

ВЯРНО С ОРИГИНАЛА ИНТЕРКОМПЛЕКС ООД ПЛОВДИВ

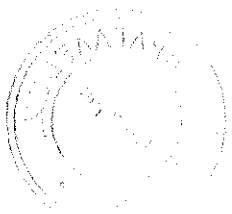


Таблица 17: Механични тестове

Тест/изпитване	Референтен стандарт	Стойности при типови изпитания
Тест за реакция при вибрации	IEC 60255-21-1	клас II
Тест за износване при вибрации	IEC 60255-21-1	клас I
Тест за реакция удар	IEC 60255-21-2	клас I
Тест за издържане на удар	IEC 60255-21-2	клас I
Тест при друсане	IEC 60255-21-2	клас I
Сеизмични изпитания	IEC 60255-21-3	клас II

Таблица 18: Продуктова безопасност

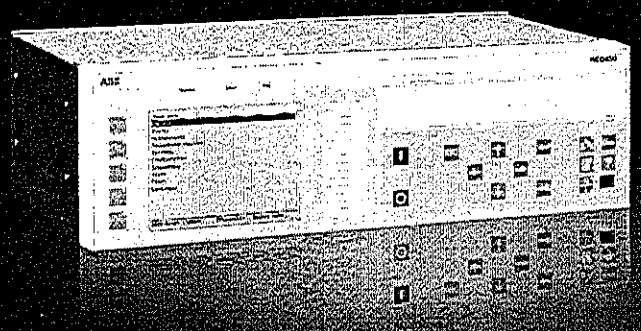
Тест/изпитване	Референтен стандарт
Директива НН	2006/95/ЕС
Стандарт	EN 60255–27 (2005)

Таблица 19: Съответствие по електромагнитна съвместимост

Тест/изпитване	Референтен стандарт
Директива НН	2004/95/ЕС
Стандарт	EN 60255–27 (2005)

ДЗЗД "ЕИК ДРАГАЛЕВЦИ" Пловдив

ВЯРНО С ОРИГИНАЛА ИНТЕРКОМПЛЕКС ООД ВИДИН



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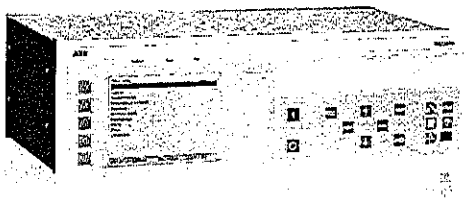

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Warranty

Please inquire about the terms of warranty from your nearest ABB representative.

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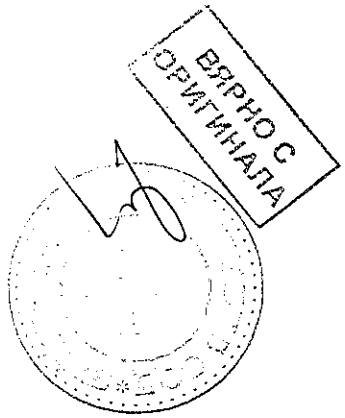
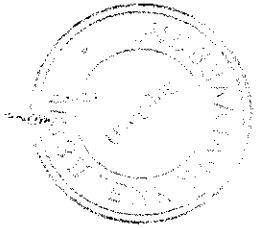


Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series.



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Type test certificate

Section 1 General

1.1 Type test data

This document certifies that the product described below is in accordance with, and conforms to the data stated in this Type Test Certificate and corresponding data in the Type Test Report and Product Guide.

The product has been tested according to relevant parts of the standards stated below.

Product/Type	Breaker protection IED Type REQ 650 V1.3
Product Guide	1MRK505294-BEN
User's Manuals	1MRK505291-UEN 1MRK505292-UEN 1MRK505293-UEN 1MRK500096-UEN 1MRK514016-UEN
Function	Breaker protection
Manufactured by	ABB AB, Sweden
Author/department	Rune Östlund, TP/TD
Date of issue	2013-03-22
Approved by	ABB AB Product Manager Joseph Menezes
Standards	IEC 60255, IEC 61000, IEC 60068, IEC 60529, IEC 61810, IEC 61850, IEC 60870, IEC 62439, ANSI C37.90, ANSI C37.112, ANSI C63.4
References	Type Test Specification 1MRK001502-238 Type test Report 1MRK001503-609

1.2 Definitions

Reference value

The specified value of an influencing factor to which are referred the characteristics of the equipment.

Nominal range

The range of values of an influencing quantity (factor) within which, under specified conditions, the equipment meets the specified requirements.

Operative range

The range of values of a given energizing quantity for which the equipment, under specified conditions, is able to perform its intended functions according to the specified requirements.

1.3 Presumptions for technical data

The technical data stated in this document are only valid under the following circumstances:

- CT and VT ratios in the IED are set in accordance with the associated main instrument transformers. Note that for functions which measure an analogue signal which do not have corresponding primary quantity, the 1:1 ratio shall be set for the used analogue inputs on the IED, For example, HZPDIF.
- Parameter IBase used by the tested function is set equal to the rated CT primary current.
- Parameter UBase used by the tested function is set equal to the rated primary phase-to-phase voltage.
- Parameter SBase used by the tested function is set equal to sqrt(3)* IBase* UBase for three-phase power system.

Section 2 Energizing quantities, rated values and limits

2.1 Analog inputs

Table 1: TRM — Energizing quantities, rated values and limits for transformer inputs

Description	Value	
Current inputs		
Rated current I_r	0.1 or 0.5 A[1]	1 or 5 A[2]
Operating range	0 – 50 A	0 – 500 A
Thermal withstand	100 A for 1 s 20 A for 10 s 8 A for 1 min 4 A continuously	500 A for 1 s *) 100 A for 10 s 40 A for 1 min 20 A continuously
Dynamic withstand	250 A one half wave	1250 A one half wave
Burden	< 1 mVA at I_r = 0.1 A < 20 mVA at I_r = 0.5 A	< 10 mVA at I_r = 1 A < 200 mVA at I_r = 5 A
*) max. 350 A for 1 s when COMBITEST test switch is included.		
Voltage inputs**)		
Rated voltage U_r	100 or 220 V	
Operating range	0 – 420 V	
Thermal withstand	450 V for 10 s 420 V continuously	
Burden	< 50 mVA at 100 V < 200 mVA at 220 V	
**) all values for individual voltage inputs		
Note! All current and voltage data are specified as RMS values at rated frequency		

1) Residual current
2) Phase currents or residual current

2.2 Auxiliary AC and DC voltage

Table 2: Power supply

Description	PSM01	PSM02	PSM03
U_{aux}nominal	24, 30V DC	48, 60, 110, 125 V DC	100, 110, 120, 220, 240 V AC, 50 and 60 Hz 110, 125, 220, 250 V DC
U_{aux}variation	80...120% of U_n (19.2...36 V DC)	80...120% of U_n (38.4...150 V DC)	80...110% of U_n (80...264 V AC) 80...120% of U_n (88...300 V DC)
Maximum load of auxiliary voltage supply	35 W for DC 40 VA for AC		
Ripple in the DC auxiliary voltage	Max 15% of the DC value (at frequency of 100 and 120 Hz)		
Maximum interruption time in the auxiliary DC voltage without resetting the IED	50 ms at U_{aux}		
Resolution of the voltage measurement in PSM module	1 bit represents 0,5 V (+/- 1 VDC)	1 bit represents 1 V (+/- 1 VDC)	1 bit represents 2 V (+/- 1 VDC)

2.3 Binary inputs and outputs

Table 3: Binary inputs

Description	Value
Operating range	Maximum input voltage 300 V DC
Rated voltage	24...250 V DC
Current drain	1.6...1.8 mA
Power consumption/input	<0.38 W
Threshold voltage	15...221 V DC (parametrizable in the range in steps of 1% of the rated voltage)

Table 4: Signal output and IRF output

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	10 A
Make and carry 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at U< 48/110/220 V DC	≤0.5 A/≤0.1 A/≤0.04 A

Table 5: Power output relays without TCS function

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at U< 48/110/220 V DC	≤1 A/≤0.3 A/≤0.1 A

Table 6: Power output relays with TCS function

Description	Value
Rated voltage	250 V DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at U< 48/110/220 V DC	≤1 A/≤0.3 A/≤0.1 A
Control voltage range	20...250 V DC
Current drain through the supervision circuit	~1.0 mA
Minimum voltage over the TCS contact	20 V DC

Table 7: Ethernet interfaces

Ethernet interface	Protocol	Cable	Data transfer rate
100BASE-TX	-	CAT 6 S/FTP or better	100 MBits/s
100BASE-FX	TCP/IP protocol	Fibre-optic cable with LC connector	100 MBits/s

Table 8: Fibre-optic communication link

Wave length	Fibre type	Connector	Permitted path attenuation[1]	Distance
1300 nm	MM 62.5/125 µm glass fibre core	LC	<8 dB	2 km

1) Maximum allowed attenuation caused by connectors and cable together

Table 9: X8/IRIG-B and EIA-485 interface

Type	Protocol	Cable
Tension clamp connection	IRIG-B	Shielded twisted pair cable Recommended: CAT 5, Belden RS-485 (9841-9844) or Alpha Wire (Alpha 6222-6230)
Tension clamp connection	IEC 68070-5-103 DNP3.0	Shielded twisted pair cable Recommended: DESCAFLEX RD-H(ST)H-2x2x0.22mm², Belden 9729, Belden 9829

Table 10: IRIG-B

Type	Value	Accuracy
Input impedance	430 Ohm	-
Minimum input voltage HIGH	4.3 V	-
Maximum input voltage LOW	0.8 V	-

Table 11: EIA-485 interface

Type	Value	Conditions
Minimum differential driver output voltage	1.5 V	-
Maximum output current	60 mA	-
Minimum differential receiver input voltage	0.2 V	-
Supported bit rates	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	-
Maximum number of 650 IEDs supported on the same bus	32	-
Max. cable length	925 m (3000 ft)	Cable: AWG24 or better, stub lines shall be avoided

Table 12: Serial rear interface

Type	Counter connector
Serial port (X9)	Optical serial port, type ST for IEC 60870-5-103 and DNP serial

Table 13: Optical serial port (X9)

Wave length	Fibre type	Connector	Permitted path attenuation[1]
820 nm	MM 62,5/125 µm glass fibre core	ST	6.8 dB (approx. 1700m length with 4 db / km fibre attenuation)
820 nm	MM 50/125 µm glass fibre core	ST	2.4 dB (approx. 600m length with 4 db / km fibre attenuation)

1) Maximum allowed attenuation caused by fibre

2.4 Influencing factors

2.4.1 Enclosure class

Table 14: Environmental tests

Description		Type test value	Reference
Cold tests	operation	96 h at -25°C 16 h at -40°C	IEC 60068-2-1/ANSI C37.90-2005 (chapter 4)
	storage	96 h at -40°C	
Dry heat tests	operation	16 h at +70°C	IEC 60068-2-2/ANSI C37.90-2005 (chapter 4)
	storage	96 h at +85°C	
Damp heat tests	steady state	240 h at +40°C humidity 93%	IEC 60068-2-78
	cyclic	6 cycles at +25 to +55°C humidity 93...95%	IEC 60068-2-30

Section 3 Type tests according to standards

Table 15: Electromagnetic compatibility tests

Description	Type test value	Reference
100 kHz and 1 MHz burst disturbance test		IEC 61000-4-18, level 3 IEC 60255-22-1 ANSI C37.90.1-2012
• Common mode	2.5 kV	
• Differential mode	2.5 kV	
Electrostatic discharge test		IEC 61000-4-2, level 4 IEC 60255-22-2 ANSI C37.90.3-2001
• Contact discharge	8 kV	
• Air discharge	15 kV	
Radio frequency interference tests		
• Conducted, common mode	10 V (emf), f=150 kHz...80 MHz	IEC 61000-4-6 , level 3 IEC 60255-22-6
• Radiated, amplitude-modulated	20 V/m (rms), f=80...1000 MHz and f=1.4...2.7 GHz	IEC 61000-4-3, level 3 IEC 60255-22-3 ANSI C37.90.2-2004
Fast transient disturbance tests		IEC 61000-4-4 IEC 60255-22-4, class A ANSI C37.90.1-2012
• Communication ports	4 kV	
• Other ports	4 kV	
Surge immunity test		IEC 61000-4-5 IEC 60255-22-5
• Communication	1 kV line-to-earth	
• Other ports	2 kV line-to-earth, 1 kV line-to-line	
• Power supply	4 kV line-to-earth, 2 kV line-to-line	
Power frequency (50 Hz) magnetic field		IEC 61000-4-8, level 5
• 3 s	1000 A/m	
• Continuous	100 A/m	

Table continues on next page

Description	Type test value	Reference
Pulse magnetic field immunity test	1000A/m	IEC 61000-4-9, level 5
Damped oscillatory magnetic field	100A/m, 100 kHz and 1MHz	IEC 6100-4-10, level 5
Power frequency immunity test		IEC 60255-22-7, class A IEC 61000-4-16
• Common mode	300 V rms	
• Differential mode	150 V rms	
Voltage dips and short interruptionsc on DC power supply	Dips: 40%/200 ms 70%/500 ms Interruptions: 0-50 ms: No restart 0...∞ s : Correct behaviour at power down	IEC 60255-11 IEC 61000-4-11
Voltage dips and interruptions on AC power supply	Dips: 40% 10/12 cycles at 50/60 Hz 70% 25/30 cycles at 50/50 Hz Interruptions: 0-50 ms: No restart 0...∞ s: Correct behaviour at power down	IEC 60255-11 IEC 61000-4-11
Electromagnetic emission tests		EN 55011, class A IEC 60255-25 ANSI C63.4, FCC
• Conducted, RF-emission (mains terminal)		
0.15...0.50 MHz	< 79 dB(µV) quasi peak < 66 dB(µV) average	
0.5...30 MHz	< 73 dB(µV) quasi peak < 60 dB(µV) average	
• Radiated RF-emission, IEC		
30...230 MHz	< 40 dB(µV/m) quasi peak, measured at 10 m distance	
230...1000 MHz	< 47 dB(µV/m) quasi peak, measured at 10 m distance	

Table 16: Insulation tests

Description	Type test value	Reference
Dielectric tests:		IEC 60255-5 ANSI C37.90-2005
• Test voltage	2 kV, 50 Hz, 1 min 1 kV, 50 Hz, 1 min, communication	
Impulse voltage test		IEC 60255-5 ANSI C37.90-2005

Table continues on next page

Description	Type test value	Reference
• Test voltage	5 kV, unipolar impulses, waveform 1.2/50 µs, source energy 0.5 J 1 kV, unipolar impulses, waveform 1.2/50 µs, source energy 0.5 J, communication	
Insulation resistance measurements • Isolation resistance	>100 MΩ, 500 V DC	IEC 60255-5 ANSI C37.90-2005
Protective bonding resistance • Resistance	<0.1 Ω (60 s)	IEC 60255-27

Table 17: Mechanical tests

Description	Reference	Requirement
Vibration response tests (sinusoidal)	IEC 60255-21-1	Class 1
Vibration endurance test	IEC60255-21-1	Class 1
Shock response test	IEC 60255-21-2	Class 1
Shock withstand test	IEC 60255-21-2	Class 1
Bump test	IEC 60255-21-2	Class 1
Seismic test	IEC 60255-21-3	Class 2

3.1 Product safety

Table 18: Product safety

Description	Reference
LV directive	2006/95/EC
Standard	EN 60255-27 (2005)

3.2 EMC compliance

Table 19: EMC compliance

Description	Reference
EMC directive	2004/108/EC
Standard	EN 50263 (2000) EN 60255-26 (2007)

Section 4 Current protection

Table 20: Instantaneous phase overcurrent protection, 3-phase output PHPIOC

Function	Range or value	Accuracy
Operate current	(5-2500)% of IBase	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate time	20 ms typically at 0 to 2 x I_{set}	-
Reset time	30 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time	10 ms typically at 0 to 5 x I_{set}	-
Reset time	40 ms typically at 5 to 0 x I_{set}	-
Critical impulse time	2 ms typically at 0 to 5 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 21: Instantaneous phase overcurrent protection, phase segregated output SPTPIOC

Function	Range or value	Accuracy
Operate current	(5-2500)% of IBase	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate time	20 ms typically at 0 to 2 x I_{set}	-
Reset time	30 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time	10 ms typically at 0 to 5 x I_{set}	-
Reset time	40 ms typically at 5 to 0 x I_{set}	-
Critical impulse time	2 ms typically at 0 to 5 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 22: Four step phase overcurrent protection, 3-phase output OC4PTOC

Function	Setting range	Accuracy
Operate current	(5-2500)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95% at (50-2500)% of *IBase*	-
Min. operating current	(5-10000)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ±1.0% of I at $I > I_r$
2nd harmonic blocking	(5-100)% of fundamental	± 2.0% of I_r

Table continues on next page

Function	Setting range	Accuracy
Independent time delay	(0.000-60.000) s	± 0.5% ±25 ms
Minimum operate time for inverse characteristics	(0.000-60.000) s	± 0.5% ±25 ms
Inverse characteristics, see table 74, table 75 and table 76	15 curve types	1) ANSI/IEEE C37.112 IEC 60255-151 ±3% or ±40 ms $0.10 \leq k \leq 3.00$ $1.5 \times I_{set} \leq I \leq 20 \times I_{set}$
Operate time, nondirectional start function	25 ms typically at 0 to 2 x I_{set}	-
Reset time, nondirectional start function	35 ms typically at 2 to 0 x I_{set}	-
Operate time, directional start function	50 ms typically at 0 to 2 x I_{set}	-
Reset time, directional start function	35 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-
1) Note: Timing accuracy only valid when 2nd harmonic blocking is turned off		

Table 23: Four step phase overcurrent protection, phase segregated output OC4SPTOC

Function	Setting range	Accuracy
Operate current	(5-2500)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Min. operating current	(5-10000)% of *IBase*	± 1.0% of I_r at $I < I_r$ ±1.0% of I at $I > I_r$
Independent time delay	(0.000-60.000) s	± 0.5% ± 25 ms
Minimum operate time for inverse characteristics	(0.000-60.000) s	± 0.5% ± 25 ms
Inverse characteristics, see table 74, table 75 and table 76	15 curve types	1) ANSI/IEEE C37.112 IEC 60255-151 ±3% or ±40 ms $0.10 \leq k \leq 3.00$ $1.5 \times I_{set} \leq I \leq 20 \times I_{set}$
Operate time, nondirectional start function	25 ms typically at 0 to 2 x I_{set}	-
Reset time, nondirectional start function	35 ms typically at 2 to 0 x I_{set}	-
Operate time, directional start function	50 ms typically at 0 to 2 x I_{set}	-
Reset time, directional start function	35 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-
1) Note: Timing accuracy only valid when 2nd harmonic blocking is turned off.		

Table 24: Instantaneous residual overcurrent protection EFPIOC

Function	Range or value	Accuracy
Operate current	(1-2500)% of IBase	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate time	20 ms typically at 0 to 2 x I_{set}	-
Reset time	30 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time	10 ms typically at 0 to 5x I_{set}	-
Reset time	40 ms typically at 5 to 0x I_{set}	-
Critical impulse time	2 ms typically at 0 to 5 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 25: Four step residual overcurrent protection EF4PTOC

Function	Range or value	Accuracy
Operate current	(1-2500)% of *IBase*	± 1.0% of I_r at $I < I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate current for directional comparison, Zero sequence	(1–100)% of *IBase*	± 2.0% of I_r
Operate current for directional comparison, Negative sequence	(1–100)% of *IBase*	± 2.0% of I_r
Min. operating current	(1-10000)% of *IBase*	± 1.0% of I_r at $I < I_r$ ± 1.0% of I at $I > I_r$
Minimum operate time for inverse characteristics	(0.000-60.000) s	± 0.5% ± 25 ms
Timers	(0.000-60.000) s	± 0.5% ±25 ms
Inverse characteristics, see table 74, table 75 and table 76	15 curve types	1) ANSI/IEEE C37.112 IEC 60255–151 ±3% or ±40 ms $0.10 \leq k \leq 3.00$ $1.5 \times I_{set} \leq I \leq 20 \times I_{set}$
Minimum polarizing voltage, Zero sequence	(1–100)% of *UBase*	± 0.5% of U_r
Minimum polarizing voltage, Negative sequence	(1–100)% of *UBase*	± 0.5% of U_r
Minimum polarizing current, Zero sequence	(2–100)% of *IBase*	±1.0% of I_r
Minimum polarizing current, Negative sequence	(2–100)% of *IBase*	±1.0% of I_r
Real part of source Z used for current polarization	(0.50-1000.00) Ω/phase	-
Imaginary part of source Z used for current polarization	(0.50–3000.00) Ω/phase	-

Table continues on next page

Function	Range or value	Accuracy
Operate time, non-directional start function	30 ms typically at 0.5 to 2 x I_{set}	-
Reset time, non-directional start function	30 ms typically at 2 to 0.5 x I_{set}	-
Operate time, directional start function	30 ms typically at 0,5 to 2 x I_N	-
Reset time, directional start function	30 ms typically at 2 to 0,5 x I_N	-
1) Note: Timing accuracy only valid when 2nd harmonic blocking is turned off.		

Table 26: Sensitive directional residual overcurrent and power protection SDEPSDE

Function	Range or value	Accuracy
Operate level for $3I_0 \cdot \cos\varphi$ directional residual overcurrent	(0.25-200.00)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$ At low setting: (0.25-1.00)% of I_r: ±0.05% of I_r (1.00-5.00)% of I_r: ±0.1% of I_r
Operate level for $3I_0 \cdot 3U_0 \cdot \cos\varphi$ directional residual power	(0.25-200.00)% of *SBase*	± 2.0% of S_r at $S \leq S_r$ ± 2.0% of S at $S > S_r$ At low setting: (0.25-5.00)% of *SBase* ± 10% of set value
Operate level for $3I_0$ and φ residual overcurrent	(0.25-200.00)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$ At low setting: (0.25-1.00)% of I_r: ±0.05% of I_r (1.00-5.00)% of I_r: ±0.1% of I_r
Operate level for non-directional overcurrent	(1.00-400.00)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$ At low setting <5% of I_r: ±0.1% of I_r
Operate level for non-directional residual overvoltage	(1.00-200.00)% of *UBase*	± 0.5% of U_r at $U \leq U_r$ ± 0.5% of U at $U > U_r$
Residual release current for all directional modes	(0.25-200.00)% of *IBase*	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$ At low setting: (0.25-1.00)% of I_r: ±0.05% of I_r (1.00-5.00)% of I_r: ±0.1% of I_r
Residual release voltage for all directional modes	(1.00 - 300.00)% of *UBase*	± 0.5% of U_r at $U \leq U_r$ ± 0.5% of U at $U > U_r$
Reset ratio	> 95%	-
Timers	(0.000-60.000) s	± 0.5% ±25 ms

Table continues on next page

Function	Range or value	Accuracy
Inverse characteristics, see table 74, table 75 and table 76	15 curve types	ANSI/IEEE C37.112 IEC 60255-151 ±3.0% or±90 ms 0.10 ≤ k ≤ 3.00 1.5 x I_{set} ≤ I ≤ 20 x I_{set}
Relay characteristic angle RCA	(-179 to 180) degrees	± 2.0 degrees
Relay open angle ROA	(0-90) degrees	± 2.0 degrees
Operate time, non-directional residual over current	60 ms typically at 0 to 2 x I_{set}	60 ms typically at 0 to 2 x I_{set}
Reset time, non-directional residual over current	65 ms typically at 2 to 0 x I_{set}	65 ms typically at 2 to 0 x I_{set}
Operate time, non-directional residual overvoltage	45 ms typically at 0.8 to 1.5 x U_{set}	45 ms typically at 0.8 to 1.5 x U_{set}
Reset time, non-directional residual overvoltage	85 ms typically at 1.2 to 0.8 x U_{set}	85 ms typically at 1.2 to 0.8 x U_{set}
Operate time, directional residual over current	140 ms typically at 0.5 to 2 x I_{set}	-
Reset time, directional residual over current	85 ms typically at 2 to 0.5 x I_{set}	-
Critical impulse time non-directional residual over current	35 ms typically at 0 to 2 x I_{set}	-
Impulse margin time non-directional residual over current	25 ms typically	-

Table 27: Thermal overload protection, one time constant LCPTTR/LFPTTR

Function	Range or value	Accuracy
Reference current	(0-400)% of *IBase*	± 1.0% of I_r
Reference temperature	(0-300)°C, (0 - 600)°F	± 2.0°C, ±2.0°F
Operate time: $t = \tau \cdot ln\left(\frac{I^2 - I_p^2}{I^2 - I_{ref}^2}\right)$ (Equation 1) I = actual measured current I_p = load current before overload occurs I_{ref} = reference load current	Time constant τ = (0-1000) minutes	IEC 60255-8, ±5% + 200 ms
Alarm temperature	(0-200)°C, (0-400)°F	± 2.0°C ± 2.0°F
Trip temperature	(0-300)°C, (0-600)°F	± 2.0°C ± 2.0°F
Reset level temperature	(0-300)°C, (0-600)°F	± 2.0°C ± 2.0°F

Table 28: Breaker failure protection, 3-phase activation and output CCRBRF

Function	Range or value	Accuracy
Operate phase current	(5-200)% of *IBase*	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
Reset ratio, phase current	> 95%	-
Operate residual current	(2-200)% of *IBase*	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
Reset ratio, residual current	> 95%	-
Phase current level for blocking of contact function	(5-200)% of *IBase*	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
Reset ratio	> 95%	-
Timers	(0.000-60.000) s	± 0.5% ±10 ms
Operate time for current detection	20 ms typically	-
Reset time for current detection	10 ms maximum	-

Table 29: Breaker failure protection, phase segregated activation and output CSPRBRF

Function	Range or value	Accuracy
Operate phase current	(5-200)% of *IBase*	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
Reset ratio, phase current	> 95%	-
Operate residual current	(2-200)% of *IBase*	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
Reset ratio, residual current	> 95%	-
Phase current level for blocking of contact function	(5-200)% of *IBase*	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
Reset ratio	> 95%	-
Timers	(0.000-60.000) s	± 0.5% ±10 ms
Operate time for current detection	20 ms typically	-
Reset time for current detection	10 ms maximum	-

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Table 30: Stub protection STBPTOC

Function	Range or value	Accuracy
Operating current	(1-2500)% of *IBase*	± 1.0% of I_r at $I < I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate time	20 ms typically at 0 to 2 x I_{set}	-
Reset time	30 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 31: Pole discordance protection CCRPLD

Function	Range or value	Accuracy
Operate value, current asymmetry level	(0-100) %	± 1.0% of I_r
Reset ratio	>95%	-
Time delay	(0.000-60.000) s	± 0.5% ± 25 ms

Table 32: Broken conductor check BRCPTOC

Function	Range or value	Accuracy
Minimum phase current for operation	(5–100)% of *IBase*	± 1.0% of I_r
Unbalance current operation	(50-90)% of maximum current	± 2.0% of I_r
Timer	(0.00-60.000) s	± 0.5% ± 25 ms
Operate time for start function	35 ms typically	-
Reset time for start function	30 ms typically	-
Critical impulse time	15 ms typically	-
Impulse margin time	10 ms typically	-

Table 33: Directional over/underpower protection GOPPDOP, GUPPDUP

Function	Range or value	Accuracy
Power level	(0.0–500.0)% of *SBase*	± 1.0% of S_r at $S < S_r$ ± 1.0% of S at $S > S_r$
	(1.0-2.0)% of *SBase*	< ± 50% of set value
	(2.0-10)% of *SBase*	< ± 20% of set value
Characteristic angle	(-180.0–180.0) degrees	2 degrees
Timers	(0.010 - 6000.000) s	± 0.5% ± 25 ms

Table 34: Negative sequence based overcurrent function DNSPTOC

Function	Range or value	Accuracy
Operate current	(2.0 - 200.0) % of *IBase*	± 1.0% of I_r at $I < I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95 %	-
Low polarizing voltage level	(0.0 - 5.0) % of *UBase*	< ± 0.5% of U_r
Relay characteristic angle	(-180 - 180) degrees	± 2.0 degrees
Relay operate angle	(1 - 90) degrees	± 2.0 degrees
Timers	(0.00 - 6000.00) s	± 0.5% ± 25 ms
Operate time, non-directional	30 ms typically at 0 to 2 x I_{set} 20 ms typically at 0 to 10 x I_{set}	-
Reset time, non-directional	40 ms typically at 2 to 0 x I_{set}	-
Operate time, directional	30 ms typically at 0 to 2 x I_{set} 20 ms typically at 0 to 10 x I_{set}	-
Reset time, directional	40 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set} 2 ms typically at 0 to 10 x I_{set}	-
Impulse margin time	15 ms typically	-
Dynamic overreach	< 10% at t = 300 ms	-

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Section 5 Voltage protection

Table 35: Two step undervoltage protection UV2PTUV

Function	Range or value	Accuracy
Operate voltage, low and high step	(1–100)% of *UBase*	± 0.5% of U_r
Reset ratio	<102%	-
Inverse time characteristics for low and high step, see table 78	-	See table 78
Definite time delay, step 1	(0.00 - 6000.00) s	± 0.5% ± 25 ms
Definite time delays, step 2	(0.000-60.000) s	± 0.5% ±25 ms
Minimum operate time, inverse characteristics	(0.000–60.000) s	± 0.5% ± 25 ms
Operate time, start function	30 ms typically at 1.2 to 0.5U_{set}	-
Reset time, start function	40 ms typically at 0.5 to 1.2 xU_{set}	-
Critical impulse time	10 ms typically at 1.2 to 0.8 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 36: Two step overvoltage protection OV2PTOV

Function	Range or value	Accuracy
Operate voltage, step 1 and 2	(1-200)% of *UBase*	± 0.5% of U_r at U < U_r ± 0.5% of U at U > U_r
Reset ratio	>98%	-
Inverse time characteristics for steps 1 and 2, see table 77	-	See table 77
Definite time delay, step 1	(0.00 - 6000.00) s	± 0.5% ± 25 ms
Definite time delays, step 2	(0.000-60.000) s	± 0.5% ± 25 ms
Minimum operate time, inverse characteristics	(0.000-60.000) s	± 0.5% ± 25 ms
Operate time, start function	30 ms typically at 0 to 2 x U_{set}	-

Table continues on next page

Function	Range or value	Accuracy
Reset time, start function	40 ms typically at 2 to 0 x U_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 37: Two step residual overvoltage protection ROV2PTOV

Function	Range or value	Accuracy
Operate voltage, step 1	(1-200)% of *UBase*	± 0.5% of U_r at U < U_r ± 0.5% of U at U > U_r
Operate voltage, step 2	(1–100)% of *UBase*	± 0.5% of U_r at U < U_r ± 0.5% of U at U > U_r
Reset ratio	> 98%	-
Inverse time characteristics for low and high step, see table 79	-	See table 79
Definite time setting, step 1	(0.00–6000.00) s	± 0.5% ± 25 ms
Definite time setting, step 2	(0.000–60.000) s	± 0.5% ± 25 ms
Minimum operate time for step 1 inverse characteristic	(0.000-60.000) s	± 0.5% ± 25 ms
Operate time, start function	30 ms typically at 0 to 2 x U_{set}	-
Reset time, start function	40 ms typically at 2 to 0 x U_{set}	-
Critical impulse time	10 ms typically at 0 to 1.2 xU_{set}	-
Impulse margin time	15 ms typically	-

Table 38: Loss of voltage check LOVPTUV

Function	Range or value	Accuracy
Operate voltage	(0–100)% of UBase	± 0.5% of U_r
Reset ratio	<105%	-
Pulse timer	(0.050–60.000) s	± 0.5% ± 25 ms
Timers	(0.000–60.000) s	± 0.5% ± 25 ms

Section 6 Frequency protection

Table 39: Under frequency protection SAPTUF

Function	Range or value	Accuracy
Operate value, start function	(35.00-75.00) Hz	± 2.0 mHz at symmetrical three-phase voltage
Operate value, restore frequency	(45 - 65) Hz	± 2.0 mHz
Reset ratio	<1.001	-
Operate time, start function	At 50 Hz: 200 ms typically at f_{set} +0.5 Hz to f_{set} -0.5 Hz At 60 Hz: 170 ms typically at f_{set} +0.5 Hz to f_{set} -0.5 Hz	-
Reset time, start function	At 50 Hz: 60 ms typically at f_{set} -0.5 Hz to f_{set} +0.5 Hz At 60 Hz: 50 ms typically at f_{set} -0.5 Hz to f_{set} +0.5 Hz	-
Operate time delay	(0.000-60.000)s	<250 ms
Restore time delay	(0.000-60.000)s	<150 ms

Table 40: Overfrequency protection SAPTOF

Function	Range or value	Accuracy
Operate value, start function	(35.00-75.00) Hz	± 2.0 mHz at symmetrical three-phase voltage
Reset ratio	>0.999	-
Operate time, start function	At 50 Hz: 200 ms typically at f_{set} -0.5 Hz to f_{set} +0.5 Hz At 60 Hz: 170 ms typically at f_{set} -0.5 Hz to f_{set} +0.5 Hz	-
Reset time, start function	At 50 and 60 Hz: 55 ms typically at f_{set} +0.5 Hz to f_{set}-0.5 Hz	-
Timer	(0.000-60.000)s	<250 ms

Table 41: Rate-of-change frequency protection SAPFRC

Function	Range or value	Accuracy
Operate value, start function	(-10.00-10.00) Hz/s	± 10.0 mHz/s
Operate value, restore enable frequency	(45.00 - 65.00) Hz	± 2.0 mHz
Timers	(0.000 - 60.000) s	<130 ms
Operate time, start function	At 50 Hz: 100 ms typically At 60 Hz: 80 ms typically	-

Section 7 Secondary system supervision

Table 42: Current circuit supervision CCSRDIF

Function	Range or value	Accuracy
Operate current	(5-200)% of I_r	± 10.0% of I_r at $I \leq I_r$ ± 10.0% of I at $I > I_r$
Block current	(5-500)% of I_r	± 5.0% of I_r at $I \leq I_r$ ± 5.0% of I at $I > I_r$

Table 43: Fuse failure supervision SDDRFUF

Function	Range or value	Accuracy
Operate voltage, zero sequence	(1-100)% of UBase	± 1.0% of U_r
Operate current, zero sequence	(1-100)% of IBase	± 1.0% of I_r
Operate voltage, negative sequence	(1-100)% of UBase	± 0.5% of U_r
Operate current, negative sequence	(1-100)% of IBase	± 1.0% of I_r
Operate voltage change level	(1-100)% of UBase	± 5.0% of U_r
Operate current change level	(1-100)% of IBase	± 5.0% of I_r
Operate phase voltage	(1-100)% of UBase	± 0.5% of U_r
Operate phase current	(1-100)% of IBase	± 1.0% of I_r
Operate phase dead line voltage	(1-100)% of UBase	± 0.5% of U_r
Operate phase dead line current	(1-100)% of IBase	± 1.0% of I_r

Table 44: Breaker close/trip circuit monitoring TCSSCBR

Function	Range or value	Accuracy
Operate time delay	(0.020 - 300.000) s	± 0.5% ± 110 ms

Section 8 Control

Table 45: Synchronizing, synchrocheck and energizing check SESRSYN

Function	Range or value	Accuracy
Phase shift, $\varphi_{line} - \varphi_{bus}$	(-180 to 180) degrees	-
Voltage ratio, U_{bus}/U_{line}	0.500 - 2.000	-
Reset ratio, synchrocheck	> 95%	-
Frequency difference limit between bus and line for synchrocheck	(0.003-1.000) Hz	± 2.0 mHz
Phase angle difference limit between bus and line for synchrocheck	(5.0-90.0) degrees	± 2.0 degrees
Voltage difference limit between bus and line for synchronizing and synchrocheck	0.03-0.50 p.u	± 0.5% of U_r
Time delay output for synchrocheck	(0.000-60.000) s	± 0.5% ± 25 ms
Frequency difference minimum limit for synchronizing	(0.003-0.250) Hz	± 2.0 mHz
Frequency difference maximum limit for synchronizing	(0.050-0.500) Hz	± 2.0 mHz
Maximum allowed frequency rate of change	(0.000-0.500) Hz/s	± 10.0 mHz/s
Closing time of the breaker	(0.000-60.000) s	± 0.5% ± 25 ms
Breaker closing pulse duration	(0.050-60.000) s	± 0.5% ± 25 ms
tMaxSynch, which resets synchronizing function if no close has been made before set time	(0.000-60.000) s	± 0.5% ± 25 ms
Minimum time to accept synchronizing conditions	(0.000-60.000) s	± 0.5% ± 25 ms
Time delay output for energizing check	(0.000-60.000) s	± 0.5% ± 25 ms
Operate time for synchrocheck function	40 ms typically	-
Operate time for energizing function	100 ms typically	-

Table 46: Autorecloser for 3-phase operation SMBRREC

Function	Range or value	Accuracy
Number of autoreclosing shots	1 - 5	-
Autoreclosing open time: shot 1 - t1 3Ph	(0.000-60.000) s	± 0.5% ± 25 ms
shot 2 - t2 3Ph shot 3 - t3 3Ph shot 4 - t4 3Ph shot 5 - t5 3Ph	(0.00-6000.00) s	
Autorecloser maximum wait time for sync	(0.00-6000.00) s	
Maximum trip pulse duration	(0.000-60.000) s	
Inhibit reset time	(0.000-60.000) s	
Reclaim time	(0.00-6000.00) s	
Minimum time CB must be closed before AR becomes ready for autoreclosing cycle	(0.00-6000.00) s	
CB check time before unsuccessful	(0.00-6000.00) s	
Wait for master release	(0.00-6000.00) s	
Wait time after close command before proceeding to next shot	(0.000-60.000) s	

Table 47: Autorecloser for 1/3-phase operation STBRREC

Function	Range or value	Accuracy
Number of autoreclosing shots	1-5	-
Autoreclosing open time: Shot 1 - t1 3Ph Shot 1 - t1 1Ph	(0.000-60.000) s	± 0.5% ± 25 ms
shot 2 - t2 3Ph shot 3 - t3 3Ph shot 4 - t4 3Ph shot 5 - t5 3Ph	(0.00-6000.00) s	
Autorecloser maximum wait time for sync	(0.00-6000.00) s	
Open time extension for long trip time	(0.000-60.000) s	
Maximum trip pulse duration	(0.000-60.000) s	
Inhibit reset time	(0.000-60.000) s	
Reclaim time	(0.00-6000.00) s	
Minimum time CB must be closed before AR becomes ready for autoreclosing cycle	(0.00-6000.00) s	
CB check time before unsuccessful	(0.00-6000.00) s	
Wait for master release	(0.00-6000.00) s	
Wait time after close command before proceeding to next shot	(0.000-60.000) s	

Section 9 Logic

Table 48: Tripping logic common 3-phase output SMPPTRC

Function	Range or value	Accuracy
Trip action	3-ph	-
Timers	(0.000-60.000) s	± 0.5% ± 10 ms

Table 49: Tripping logic phase segregated output SPTPTRC

Function	Range or value	Accuracy
Trip action	3-Ph, 1/3-Ph	-
Timers	(0.000-60.000) s	± 0.5% ± 10 ms

Table 50: Configurable logic blocks

Logic block	Quantity with cycle time			Range or value	Accuracy
	5 ms	20 ms	100 ms		
AND	60	60	160	-	-
OR	60	60	160	-	-
XOR	10	10	20	-	-
INVERTER	30	30	80	-	-
SRMEMORY	10	10	20	-	-
RSMEMORY	10	10	20	-	-
GATE	10	10	20	-	-
PULSETIMER	10	10	20	(0.000–90000.000) s	± 0.5% ± 25 ms for 20 ms cycle time
TIMERSET	10	10	20	(0.000–90000.000) s	± 0.5% ± 25 ms for 20 ms cycle time
LOOPDELAY	10	10	20		

Table 51: Configurable logic Q/T

Logic block	Quantity with cycle time		Range or value	Accuracy
	20 ms	100 ms		
ANDQT	20	100	-	-
ORQT	20	100	-	-
XORQT	10	30	-	-
INVERTERQT	20	100	-	-

Table continues on next page

Logic block	Quantity with cycle time		Range or value	Accuracy
	20 ms	100 ms		
RSMEMORYQT	10	30	-	-
SRMEMORYQT	15	10	-	-
PULSETIMERQT	10	30	(0.000–90000.000) s	± 0.5% ± 25 ms for 20 ms cycle time
TIMERSETQT	10	30	(0.000–90000.000) s	± 0.5% ± 25 ms for 20 ms cycle time
INVALIDQT	6	6	-	-
INDCOMBSPQT	10	10	-	-
INDEXTSPQT	10	10	-	-

Table 52: Elapsed time integrator with limit transgression and overflow supervision TEIGGIO

Function	Cycle time (ms)	Range or value	Accuracy
Elapsed time integration	5	0 – 999999.9 s	±0.05% or ±0.01 s
	20	0 – 999999.9 s	±0.05% or ±0.04 s
	100	0 – 999999.9 s	±0.05% or ±0.2 s

Section 10 Monitoring

Table 53: Technical data covering measurement functions: CVMMXN, CMMXU, VMMXU, CMSQI, VMSQI, VNMMXU

Function	Range or value	Accuracy
Voltage	(0.1-1.5) x U_r	± 0.5% of U_r at U≤U_r ± 0.5% of U at U > U_r
Connected current	(0.2-4.0) x I_r	± 0.5% of I_r at I ≤ I_r ± 0.5% of I at I > I_r
Active power, P	0.1 x U_r< U < 1.5 x U_r 0.2 x I_r < I < 4.0 x I_r	± 1.0% of S_r at S ≤ S_r ± 1.0% of S at S > S_r
Reactive powor, Q	0.1 x U_r< U < 1.5 x U_r 0.2 x I_r < I < 4.0 x I_r	± 1.0% of S_r at S ≤ S_r ± 1.0% of S at S > S_r
Apparent power, S	0.1 x U_r < U < 1.5 x U_r 0.2 x I_r< I < 4.0 x I_r	± 1.0% of S_r at S ≤ S_r ± 1.0% of S at S > S_r
Apparent power, S Three phase settings	cos phi = 1	± 0.5% of S at S > S_r ± 0.5% of S_r at S ≤ S_r
Power factor, cos (φ)	0.1 x U_r < U < 1.5 x U_r 0.2 x I_r< I < 4.0 x I_r	< 0.02

Table 54: Event counter CNTGGIO

Function	Range or value	Accuracy
Counter value	0-100000	-
Max. count up speed	10 pulses/s (50% duty cycle)	-

Table 55: Limit counter L4UFCNT

Function	Range or value	Accuracy
Counter value	0-65535	-
Max. count up speed	5-160 pulses/s	-

Table 56: Disturbance report DRPRDRE

Function	Range or value	Accuracy
Current recording	-	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > Ir
Voltage recording	-	± 1.0% of U_r at U ≤ U_r ± 1.0% of U at U > U_r
Pre-fault time	(0.05–3.00) s	-
Post-fault time	(0.1–10.0) s	-

Table continues on next page

Function	Range or value	Accuracy
Limit time	(0.5–8.0) s	-
Maximum number of recordings	100, first in - first out	-
Time tagging resolution	1 ms	See time synchronization technical data
Maximum number of analog inputs	30 + 10 (external + internally derived)	-
Maximum number of binary inputs	96	-
Maximum number of phasors in the Trip Value recorder per recording	30	-
Maximum number of indications in a disturbance report	96	-
Maximum number of events in the Event recording per recording	150	-
Maximum number of events in the Event list	1000, first in - first out	-
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)	340 seconds (100 recordings) at 50 Hz, 280 seconds (80 recordings) at 60 Hz	-
Sampling rate	1 kHz at 50 Hz 1.2 kHz at 60 Hz	-
Recording bandwidth	(5-300) Hz	-

Table 57: Event list DRPRDRE

Function		Value
Buffer capacity	Maximum number of events in the list	1000
Resolution		1 ms
Accuracy		Depending on time synchronizing

Table 58: Indications DRPRDRE

Function		Value
Buffer capacity	Maximum number of indications presented for single disturbance	96
	Maximum number of recorded disturbances	100

Table 59: Event recorder DRPRDRE

Function		Value
Buffer capacity	Maximum number of events in disturbance report	150
	Maximum number of disturbance reports	100
Resolution		1 ms
Accuracy		Depending on time synchronizing

Table 60: Trip value recorder DRPRDRE

Function		Value
Buffer capacity	Maximum number of analog inputs	30
	Maximum number of disturbance reports	100

Table 61: Disturbance recorder DRPRDRE

Function		Value
Buffer capacity	Maximum number of analog inputs	40
	Maximum number of binary inputs	96
	Maximum number of disturbance reports	100
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)		340 seconds (100 recordings) at 50 Hz 280 seconds (80 recordings) at 60 Hz

Table 62: Station battery supervision SPVNZBAT

Function	Range or value	Accuracy
Lower limit for the battery terminal voltage	(60-140) % of Ubat	± 1.0% of set battery voltage
Reset ratio, lower limit	<105 %	-
Upper limit for the battery terminal voltage	(60-140) % of Ubat	± 1.0% of set battery voltage
Reset ratio, upper limit	>95 %	-
Timers	(0.000-60.000) s	± 0.5% ± 110 ms
Battery rated voltage	20-250V	-

Table 63: Insulation gas monitoring function SSIMG

Function	Range or value	Accuracy
Timers	(0.000-60.000) s	± 0.5% ± 110 ms

Table 64: Insulation liquid monitoring function SSIML

Function	Range or value	Accuracy
Timers	(0.000-60.000) s	± 0.5% ± 110 ms

Table 65: Circuit breaker condition monitoring SSCBR

Function	Range or value	Accuracy
Alarm levels for open and close travel time	(0-200) ms	± 0.5% ± 25 ms
Alarm levels for number of operations	(0 - 9999)	-
Setting of alarm for spring charging time	(0.00-60.00) s	± 0.5% ± 25 ms
Time delay for gas pressure alarm	(0.00-60.00) s	± 0.5% ± 25 ms
Time delay for gas pressure lockout	(0.00-60.00) s	± 0.5% ± 25 ms

Section 11 Metering

Table 66: Pulse counter PCGGIO

Function	Setting range	Accuracy
Cycle time for report of counter value	(1–3600) s	-

Table 67: Function for energy calculation and demand handling ETPMMTR

Function	Range or value	Accuracy
Energy metering	MWh Export/Import, MVArh Export/Import	Input from MMXU. No extra error at steady load

Section 12 Station communication

Table 68: Communication protocol

Function	Value
Protocol TCP/IP	Ethernet
Communication speed for the IEDs	100 Mbit/s
Protocol	IEC 61850-8-1
Communication speed for the IEDs	100BASE-FX
Protocol	DNP3.0/TCP
Communication speed for the IEDs	100BASE-FX
Protocol, serial	IEC 60870-5-103
Communication speed for the IEDs	9600 or 19200 Bd
Protocol, serial	DNP3.0
Communication speed for the IEDs	300-115200 Bd

Section 13 Hardware

13.1 IED

13.1.1 Enclosure class

13.1.1.1 Ingress protection

Table 69: Ingress protection

Description	Value
IED front	IP 54
IED rear	IP 20
IED sides	IP 40
IED top	IP 40
IED bottom	IP 20

13.1.2 Dimensions

Table 70: Dimensions of the IED - 3U full 19" rack

Description	Value
Width	444 mm (17.48 inches)
Height	132 mm (5.20 inches), 3U
Depth	249.5 mm (9.82 inches)
Weight box	10 kg (<22.04 lbs)

Section 14 Basic IED functions

Table 71: Self supervision with internal event list

Data	Value
Recording manner	Continuous, event controlled
List size	40 events, first in-first out

Table 72: Time synchronization, time tagging

Function	Value
Time tagging resolution, events and sampled measurement values	1 ms
Time tagging error with synchronization once/min (minute pulse synchronization), events and sampled measurement values	± 1.0 ms typically
Time tagging error with SNTP synchronization, sampled measurement values	± 1.0 ms typically

Table 73: X4/IRIG-B interface

Type	Protocol	Cable
Tension clamp connection	IRIG-B	Shielded twisted pair cable Recommended: CAT 5, Belden RS-485 (9841-9844) or Alpha Wire (Alpha 6222-6230)

Section 15 Inverse characteristics

15.1 Inverse time characteristics

Table 74: ANSI inverse time characteristics

Function	Range or value	Accuracy
Operating characteristic: $t = \left(\frac{A}{\left(I^{P}-1\right)}+B\right)\cdot k + tDef$ $I = I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01	-
ANSI Extremely Inverse	A=28.2, B=0.1217, P=2.0	
ANSI Very Inverse	A=19.61, B=0.491, P=2.0	
ANSI Normal Inverse	A=0.0086, B=0.0185, P=0.02, tr=0.46	
ANSI Moderately Inverse	A=0.0515, B=0.1140, P=0.02	
ANSI Long Time Extremely Inverse	A=64.07, B=0.250, P=2.0	
ANSI Long Time Very Inverse	A=28.55, B=0.712, P=2.0	
ANSI Long Time Inverse	A=0.086, B=0.185, P=0.02	

Table 75: IEC Inverse time characteristics

Function	Range or value	Accuracy
Operating characteristic: $t = \left(\frac{A}{\left(I^{P}-1\right)}\right)\cdot k$ $I = I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01	-
IEC Normal Inverse	A=0.14, P=0.02	
IEC Very Inverse	A=13.5, P=1.0	
IEC Inverse	A=0.14, P=0.02	
IEC Extremely Inverse	A=80.0, P=2.0	
IEC Short time inverse	A=0.05, P=0.04	
IEC Long time inverse	A=120, P=1.0	

The parameter setting *Characterist1 and 4/Reserved* shall not be used, since this parameter setting is for future use and not implemented yet.

Table 76: RI and RD type inverse time characteristics

Function	Range or value	Accuracy
RI type inverse characteristic: $t = \frac{1}{0.339 - \frac{0.236}{I}}\cdot k$ $I = I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01	
RD type logarithmic inverse characteristic: $t = 5.8 - \left(1.35 \cdot ln\frac{I}{k}\right)$ $I = I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01	

Table 77: Inverse time characteristics for overvoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U-U>}{U>}\right)}$ $U> = U_{set}$ $U = U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5% +60 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32\cdot\frac{U-U>}{U>}-0.5\right)^{2.0}} - 0.035$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $t = \frac{k \cdot 480}{\left(32\cdot\frac{U-U>}{U>}-0.5\right)^{3.0}} - 0.035$	k = (0.05-1.10) in steps of 0.01	

Table 78: Inverse time characteristics for undervoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U< - U}{U<}\right)}$ U< = U_{set} U = $UV_{measured}$	k = (0.05-1.10) in steps of 0.01	±5% +60 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U< - U}{U<} - 0.5\right)^{2.0}} + 0.055$ U< = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	

Table 79: Inverse time characteristics for residual overvoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5% +70 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0}} - 0.035$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0}} - 0.035$	k = (0.05-1.10) in steps of 0.01	

Contact us

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ATTESTATION OF CONFORMITY

No. 74104021-MOC/INC 13-0780

Issued to:
ABB
SA Products
Nätverksgatan 3, B391, Finnslätten
721 59 Västerås, Sweden

for the product:
REL 650
Type: Slave station
Product version 1.3.0
Firmware version 1.3.0.13

With the implemented communication protocol:

IEC 60870-5-103 (IS 1998)

Companion Standard for the informative interface of protection equipment and the ABB 650 series version 1.3 IEC 60870-5-103 Interoperability document, dated January 28, 2013.

The product has not been shown to be non-conforming to the specified protocol standard, including the interface requirements.

End-to-End data element tests for the information and control points as described in manufacturer Protocol Implementation Conformance Statement (PICS) have been performed on the product's protocol implementation. Functional tests in controlled mode are performed for the following levels:

• *Station initialization in Unbalanced mode* • *Cyclic data transmission* • *Acquisition of events* • *General Interrogation*	• *Clock synchronisation* • *Transmission of Disturbance records* • *Test mode and local parameter setting*

The test campaign did not reveal any errors in the product's protocol implementation.

This Attestation is granted on account of tests made at location of ABB in Västerås, Sweden and performed with UnIECim version 3.0.1 (November 2012) running CS103 Test Suite version CS103MasterNormal 2.4. The results, including remarks and limitations, are laid down in our report no. 74104021-MOC/INC 13-0781.

The tests have been carried out on one single specimen of the product, submitted by ABB. The Attestation does not include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by DNV KEMA is not the responsibility of DNV KEMA.

Arnhem, February 15, 2013

M. Adriaensen
Intelligent Networks and Communication

P.H.S. Ermens
Test Consultant

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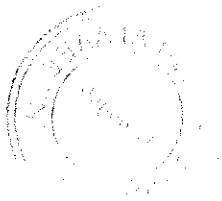
Telephone + 31 26 356 91 11, Telefax + 31 26 443 38 43

ВЯРНО С ОРИГИНАЛА

1152



KEMA

Type test Certificate of complete type tests

ABB AB

Västeras, Sweden

has successfully passed the type test sequence on a

REL650, Ver. 1.3 Line protection

Type: 650 series Ver. 1.3
Rating: 24-250 V (DC) – 100-240 V (AC) –1/5 A – 100/220 V – 50/60 Hz

The test object passed the required clauses of

IEC 60255-1

ANSI IEEE C37.90

The test results are recorded in Certificate No.

TIC 1037-13

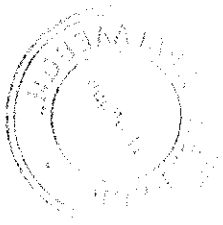
This Certificate is issued on 13 November 2013

KEMA Nederland B.V.

S.A.M. Verhoeven
Director Testing, Inspections & Certification The Netherlands

Experience you can trust.

1153



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Power supply module 110–250 VDC, 100–240 VAC (PSM03)	6
Transformer module (TRM01)	7
Binary input/output module (BI001)	8

ВЯРНО С ОРИГИНАЛА

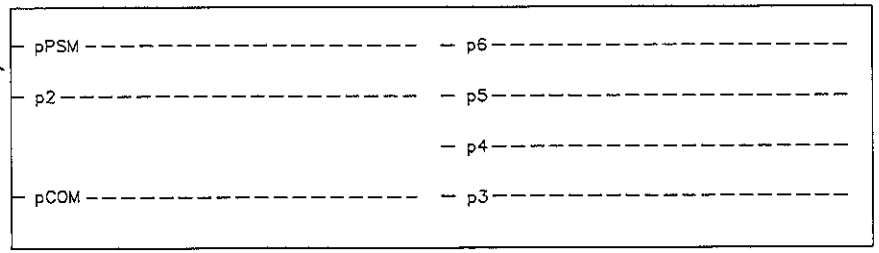
ДЗЗД „ЕИК ДРАГАЛЕВЦИ" Пловдив

Based on	Prepared 2013-01-24 Agneta Rydh	Title Connection Diagram REQ650 (3Ph/1CB/1BB) A01A ANSI symbols	Doc.des. Doc.kind	Ref.des.	
	Approved 2013-01-29 Patrik Nyback		Resp.dept. PSTP/TPLA	Rev.ind.	Lang. en
	Project	ABB AB	Doc.No. 1MRK006502-LD		Sheet 1 Cont. 2
Rev Rev. Note Date Name					

4154

1/1x19"

Rear view slot



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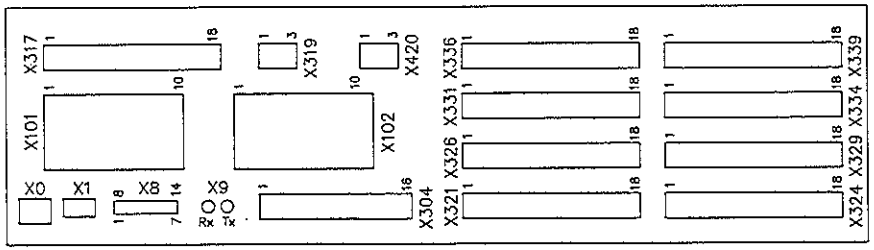
Rear view terminal



Designation for 3U, 1/1x19" casing with 1 TRM

Module	Slot	Terminal
COM05	pCOM	X0, X1, X8, X9, X304
TRM01	p2	X101, X102
PSM01 PSM02 PSM03	pPSM	X317, X319, X420
BIO01	p3	X321, X324
BIO01	p4	X326, X329
BIO01	p5	X331, X334
BIO01	p6	X336, X339

Compression or ringlug terminals

ВЯРНО С ОРИГИНАЛА

ДЗЗД „ЕИК ДРАГАЕВЦИ" Пловдив

Based on		Prepared	2013-01-24	Agneta Rydh	Title Connection Diagram REQ650 (3Ph/1CB/1BB) A01A ANSI symbols	Doc.des. / Doc.kind	Ref.des.
		Approved	2013-01-29	Patrik Nyback		Resp.dept. PSTP/TPLA	Rev.ind.
		Project			ABB AB	Doc.No. 1MRK006502-LD	Lang. en Sheet 2 Cont. 3
Rev	Rev. Note	Date	Name				

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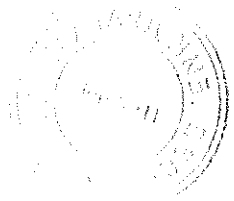

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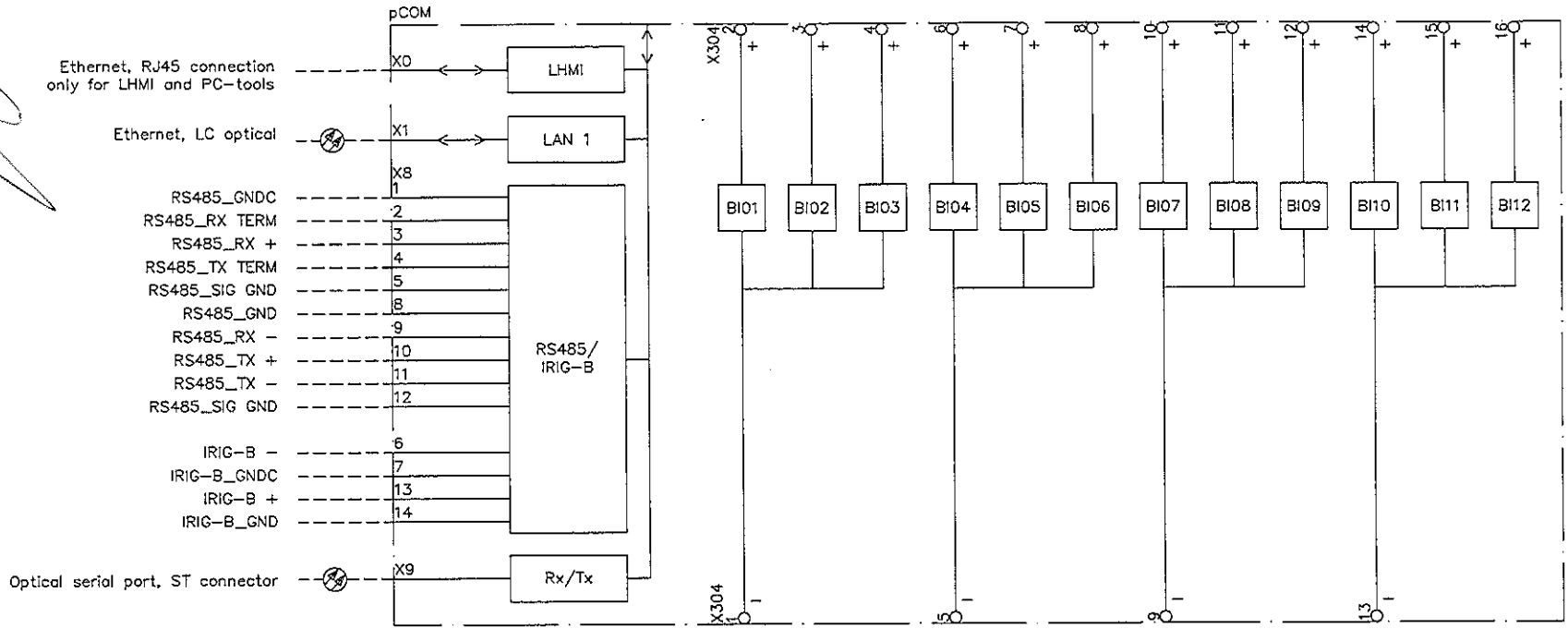


Observe polarity sequence

Configuration plant adapted

BI01	ACTV_TESTMODE
BI02	CHANGE_LOCK
BI03	BKR1_SPRNG_CH
BI04	BKR1_SF6_LOW
BI05	79_EXT_RI
BI06	79_ON
BI07	79_OFF
BI08	EXT_25_START
BI09	EXT_DFR_START
BI10	EXT_TRIP
BI11	EXT_50BFI
BI12	RESET_LOCKOUT

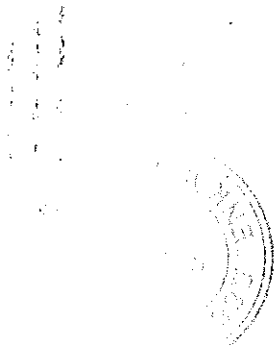
ВЯРНО С ОРИГИНАЛА

ДЗЗД „ЕИК ДРАГАЛЕВЦИ" Пловдив

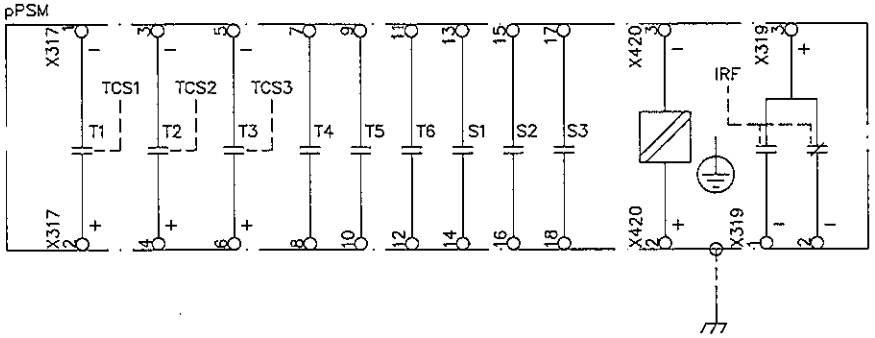
Based on	Prepared 2013-01-24	Agneta Rydh	Title Connection Diagram REQ650 (3Ph/1CB/1BB) A01A ANSI symbols
	Approved 2013-01-29	Patrik Nyback	
	Project		ABB AB

Doc.des.	Doc.kind	Ref.des.	
Resp.dept.	PSTP/TPLA	Rev.ind.	Lang. en
Doc.No. 1MRK006502-LD			Sheet 3
			Cont. 4

Rev	Rev. Note	Date	Name



Power supply module PSM01 24–30 VDC



Observe polarity sequence

Configuration plant adapted

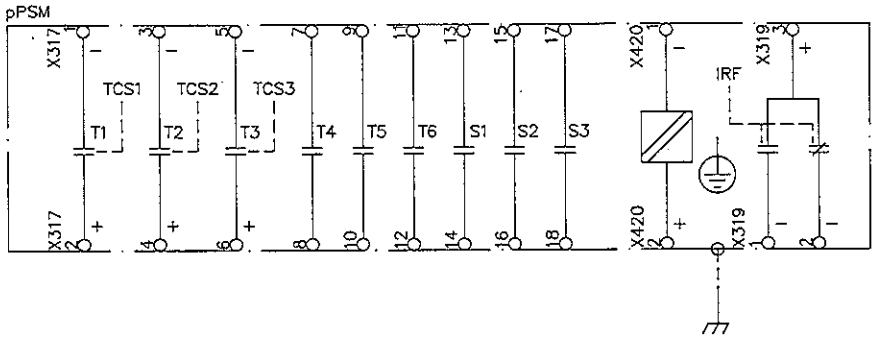
T1	BKR1_TRIP
T2	SPARE
T3	SPARE
T4	AUTO_SC_OK
T5	MAN_SC_OK
T6	GENERAL_ALARM
S1	SPARE
S2	SPARE
S3	GENERAL_TRIP
	Auxiliary supply EL
	Protective earth
	Normal
	Fail

Based on	Prepared 2013-01-24	Agneta Rydh	Title Connection Diagram REQ650 (3Ph/1CB/1BB) A01A ANSI symbols
	Approved 2013-01-29	Patrik Nyback	
	Project		ABB AB

Doc.des.	Doc.kind	Ref.des.	
Resp.dept.	PSTP/TPLA	Rev.ind.	Lang. en
Doc.No. 1MRK006502-LD			Sheet 4
			Cont. 5

Rev	Rev. Note	Date	Name

Power supply module PSM02 48–125 VDC



Observe polarity sequence

Configuration plant adapted

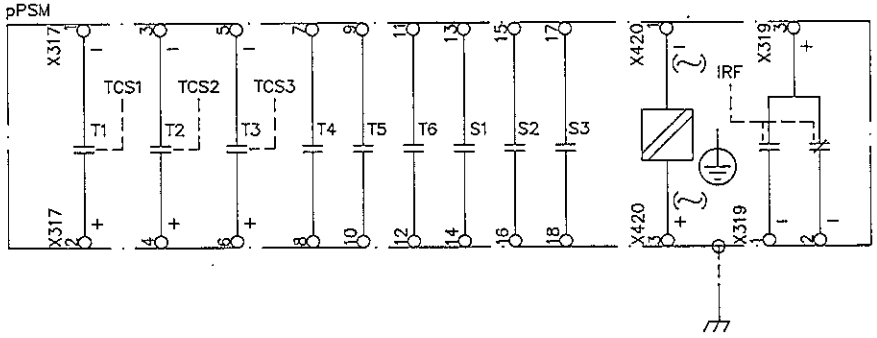
T1	BKR1_TRIP
T2	SPARE
T3	SPARE
T4	AUTO_SC_OK
T5	MAN_SC_OK
T6	GENERAL_ALARM
S1	SPARE
S2	SPARE
S3	GENERAL_TRIP
	Auxiliary supply EL
	Protective earth
	Normal
	Fail

ВЯРНО С ОРИГИНАЛА

ДЗЗД „ЕИМ ДРАГАЛЕВЦИ" Пловдив

Based on		Prepared	2013-01-24	Agneta Rydh	Title Connection Diagram REQ650 (3Ph/1CB/1BB) A01A ANSI symbols	Doc.des. / Doc.kind	Ref.des.
		Approved	2013-01-29	Patrik Nyback		Resp.dept. PSTP/TPLA	Rev.ind. / Lang. en
		Project			ABB AB	Doc.No. 1MRK006502-LD	Sheet 5 / Cont. 6
Rev	Rev. Note	Date	Name				

Power supply module PSM03 110–250 VDC, 100–240 VAC



Observe polarity sequence

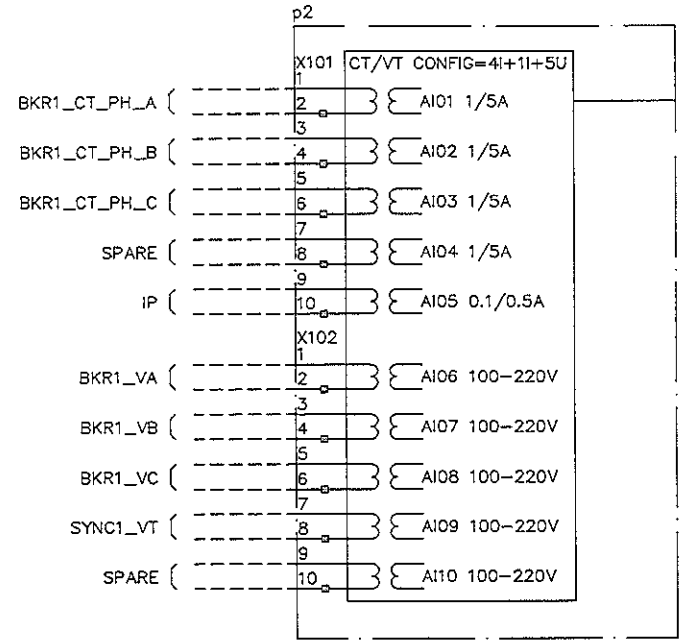
Configuration plant adopted

T1	BKR1_TRIP
T2	SPARE
T3	SPARE
T4	AUTO_SC_OK
T5	MAN_SC_OK
T6	GENERAL_ALARM
S1	SPARE
S2	SPARE
S3	GENERAL_TRIP
	Auxiliary supply EL
	Protective earth
	Normal
	Fail

Based on	Prepared 2013-01-24 Agneta Rydh	Title Connection Diagram REQ650 (3Ph/1CB/1BB) A01A ANSI symbols	Doc.des. Doc.kind Ref.des.
	Approved 2013-01-29 Patrik Nyback		Resp.dept. PSTP/TPLA Rev.ind. Lang. en
	Project	ABB AB	Doc.No. 1MRK006502-LD Sheet 6 Cont. 7

Rev	Rev. Note	Date	Name

Transformer module TRM01



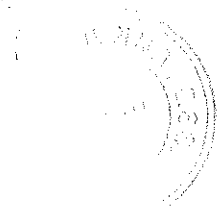
▫ Indicates polarity mark. Note that internal polarity can be adjusted by setting of analog input CT neutral direction and or on SMAI pre-processing function blocks.

ВЯРНО С ОРИГИНАЛА

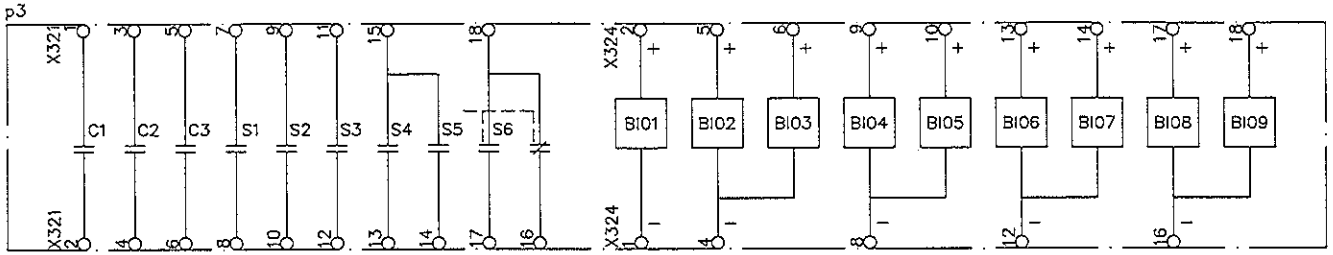
ПЗЗД „ЕИК ДРАГАЕВЦИ" Пловдив

Based on		Prepared	2013-01-24	Agneta Rydh	Title Connection Diagram REQ650 (3Ph/1CB/1BB) A01A ANSI symbols	Doc.des.	Ref.des.
		Approved	2013-01-29	Patrik Nyback		Doc.kind	
		Project				Resp.dept. PSTP/TPLA	Rev.ind.
Rev	Rev. Note	Date	Name		ABB AB	Doc.No. 1MRK006502-LD	Lang. en
							Sheet 7
							Cont. 8

1169



Binary input/output module BI001



Observe polarity sequence

Configuration plant adapted

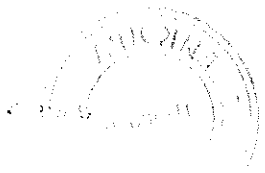
C1	SPARE	
C2	TRIP_3PH	
C3	79_CLOSE	
S1	3PH_RI	
S2	79_INPRG	
S3	50BF_TRIP	
S4	SPARE	
S5	BAT_SUPRV_AL	
S6	BKR1_LOCKOUT	
BI01	BKR1_VT_OK	
BI02	SYNC1_VT_OK	
BI03	SPARE	
BI04	BKR1_52b	
BI05	BKR1_52a	
BI06	189_52b	
BI07	189_52a	
BI08	989_52b	
BI09	989_52a	

Based on	Prepared 2013-01-24 Agneta Rydh	Title Connection Diagram REQ650 (3Ph/1CB/1BB) A01A ANSI symbols	Doc.des. Ref.des. Doc.kind
	Approved 2013-01-29 Patrik Nyback		Resp.dept. PSTP/TPLA Rev.ind. Lang. en
	Project	ABB AB	Doc.No. 1MRK006502-LD Sheet 8 Cont. –

Rev	Rev. Note	Date	Name

4464

Приложение № 4 към Предложение за изпълнение на поръчката – Заверени копия на сертификат/и ISO 9001:2008 или еквивалент, на производителите на предложените материали, апаратура, оборудване и съоръжения



Превод от английски език

(Лого)

Извършен от
Даниела Мирчева Бурова

УДОСТОВЕРЕНИЕ

присъжда се на
АББ АБ, ШВЕЦИЯ,
Местоположения съгласно приложение

СЕРТИФИКАЦИОННО БЮРО „ВЕРИТАС" удостоверява, че **СИСТЕМИТЕ ЗА УПРАВЛЕНИЕ** на горната организация са проверени и са в съответствие с изискванията на стандартите за системи за управление, описани подробно по-долу:

ЗЕП „ЕИК ДРАГАНОВ" Пловдив

Стандарит:

SS-EN ISO 9001:2008
SS-EN ISO 14001:2004
OHSAS 18001: 2007

ОБХВАТ НА ДОСТАВКАТА

Проучване и изработване, проектиране, производство, маркетинг, продажби, пуско-наладъчни дейности и поддържане и сервиз на продукти, резервни части, системи и инсталации за пренос и разпределение на електрическа енергия, за автоматизация и рационализация в различни сектори.

Дата на първоначално одобрение ISO 9001:	13 ноември 1992 г.
Дата на първоначално одобрение ISO 14001:	8 септември 1998 г.
Дата на първоначално одобрение OHSAS 18001:	22 април 2009г.

Подложен на непрекъсната задоволителна експлоатация на Системата за управление на организацията, този ***сертификат е валиден до 25 април 2018 год.***
За проверка на валидността на този сертификат се обадете на тел: ***+46 31606500.***
Допълнителни изяснения относно обхвата на този сертификат и приложимостта на изискванията на Системата за управление могат да се получат чрез консултация с организацията.

Подпис на Микаел Линдстрьом,Технически директор по сертифициране, СЕРТИФИКАЦИОННО БЮРО „ВЕРИТАС Швеция АБ"

Лого на АКРЕДИТИРАНЕ ШВЕДАК
1236 ISO/IEC 17021

Дата: 23 Април 2015

Номер на удостоверението: SE004225-1 / SE004224-1 / SE004226-1

Само електронно копие

1163

Превод от английски език

Приложение към удостоверение № **SE002575-1 / SE002576-1 / SE002577-1**

издадено на 12 Септември 2011

В това приложение са паказани местоположенията включени в удостоверението за

АББ АБ, Швеция

АББ АБ, Швеция
721 83 Вастерас

Corp
Корпоративен, Вастерас / Лудвика
Изследвания, Вастерас

DM
Двигатели ниско напрежение, Вастерас
Машини, Вастерас
Роботи, Вастерас
Роботи, Гьотеборг
Продажби M&D, Вастерас
Продажби M&D, Сундсвал
Продажби M&D, Гьотеборг
Продажби M&D, Малмьо
Продажби M&D, Нюшьопинг
Продажби M&D, Лулеа
Продажби M&D, Йоншьопинг
Продажби M&D, Стокхолм
Продажби M&D, Йорншьолдсвик

Продукти ниско напрежение
Cewe-ontrol,Вастерас
Cewe-ontrol,Нюшьопинг
Системи ниско напрежение
Кабелни принадлежности,

Автоматизация на процесите
Измерване на сила, Вастерас
Целулоза и хартия, Вастерас
Мини, Вастерас
Валцови мелници, Вастерас
Металургия, Вастерас
Логистични центрове, Вастерас / Малмьо
Продукти и системи за индустрията,
Стокхолм / Гьотеборг / Малмьо
Кранови системи, Вастерас
Технологии за контрол, Вастерас / Малмьо

Дата: 24 Април 2012

Подпис на Микаел Линдстрьом,
Технически директор по сертифициране,
Сертификационно Бюро „ВЕРИТАС Швеция АБ"

1164

превод от английски език,
извършен от Вержиния Кунчева

Продукти за енергетиката
Силови трансформатори, Лудвика
Компоненти, Лудвика
Фигехолм, Фигехолм
Композити, Питео
Прекъсвачи за високо напрежение, Лудвика
Компоненти за високо напрежение, Лудвика
Продажби, Вастерас
Кабелни принадлежности, Алингсос

Системи за енергетиката
Кабели за високо напрежение, Карлскруна
Високо постоянно напрежение, Лудвика
FACTS, Вастерас
Офшьорни Вятърни вризки, Вастерас
Подстанции, Вастерас
Вентикс, Вестерас
АП Продукти, Вестерас
АП Системи, Вестерас
Производство на електроенергия, Вестерас

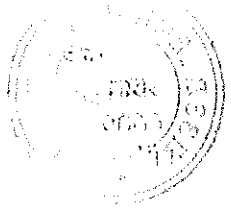
Услуги
Вастерас
Данемора
Фигехолм
Финспонг
Гьотеборг
Хускварна
Карлскруна
Карлстад
Кируна
Галивар
Лудвика
Лулеа
Малмьо
Мьолндал
Норшьопинг
Улофстрьом
Питео
Шелефтео
Солентуна
Сторвик
Сундсвал
Удевала
Умео
Йорншьолдсвик

ДЗЗД „ЕИК ДРАГАЛЕВ" Пловдив

Дата: 24 Април 2012

Подпис на Микаел Линдстрьом,
Технически директор по сертифициране,
Сертификационно Бюро „ВЕРИТАС Швеция АБ"

1165



BUREAU VERITAS
Certification

Certification

Awarded to

ABB AB, Sverige

Locations according to annex

Bureau Veritas Certification certify that the Management System of the above organisation has been audited and found to be in accordance with the requirements of the management system standard detailed below

Standard

SS-EN ISO 9001: 2008
SS-EN ISO 14001: 2004
OHSAS 18001: 2007

Scope of supply

Research and development, design, manufacturing, marketing, sales, installation, commissioning, maintenance and services of products, spare parts, systems and plants for transmission and distribution of electric power, for automation and rationalization within various sectors and provide service and maintenance solutions for increased plant utilization and availability.

Ursprungligt datum ISO 9001:	13 November 1992 (Previously certified by Bureau Veritas Certification)
Ursprungligt datum ISO 14001:	8 September 1998 (Previously certified by Bureau Veritas Certification)
Ursprungligt datum OHSAS 18001:	22 April 2009 (Previously certified by Bureau Veritas Certification)

Subject to the continued satisfactory operation of the organisation's Management System, this certificate is valid until: **25 April 2018**
To check this certificate validity please call +46 31 60 65 00
Further clarifications regarding the scope of this certificate and the applicability of the management system requirements may be obtained by consulting the organisation.

Mikael Lindström, Technical Manager, Bureau Veritas Certification Sverige AB

Date: 23 April 2015

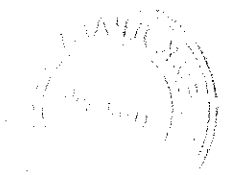
Certificate Number: SE004225-1 / SE004224-1 / SE004226-1

SWEDAC ACKREDITERING 1236 ISO/IEC 17021

ВЯРНО С ОРИГИНАЛА

Electronic copy only

1166



Annex to Certificate No. SE004225-1 / SE004224-1 / SE004226-1

issued 23 April 2015

This annex is stating the locations included
in the certificate issued for:

ABB AB, Sverige

ABB AB, Sverige
Ledning & Stab, Västerås

Corporate
Corporate, Västerås
Corporate, Ludvika
Corporate Research, Västerås

Discrete Automation and Motion
Ledning & Stab, Västerås

Motors & Generators
Synchronous Machines, Västerås
IEC LV Motors, Västerås
Service, Västerås

Robotics
Robotics, Västerås
Robotics, Mölndal

Domestic Sales
Domestic Sales, Västerås
Domestic Sales, Sundsvall
Domestic Sales, Göteborg
Domestic Sales, Malmö
Domestic Sales, Norrköping
Domestic Sales, Luleå
Domestic Sales, Jönköping
Domestic Sales, Stockholm
Domestic Sales, Örnsköldsvik
Domestic Sales, Karlstad
Domestic Sales, Kiruna
Domestic Sales, Storvik
Domestic Sales, Umeå

Low Voltage Products
Ledning & Stab, Västerås

Cewe, Nyköping

Meters, Nyköping

Control Products
Control Products, Västerås

LV-Systems
LV-Systems, Norrköping
LV-Systems, Västerås

Breakers & Switches
Kabeldon, Alingsås

Domestic Sales
Domestic Sales, Göteborg
Domestic Sales, Jönköping
Domestic Sales, Luleå
Domestic Sales, Malmö
Domestic Sales, Norrköping
Domestic Sales, Nyköping
Domestic Sales, Stockholm
Domestic Sales, Sundsvall
Domestic Sales, Umeå
Domestic Sales, Västerås

Date: 19 May 2015

Mikael Lindström
Technical Manager
Bureau Veritas Certification Sverige AB

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Process Automation
Ledning & Stab, Västerås

Control Technologies
Control Technologies, Västerås, Malmö,
Sollentuna, Mölndal

Process Industries
Paper, Metals, Mining, Metallurgy, Västerås, Umeå

Measurement & Analytics
Force Measurement, Västerås
Instrumentation, Sollentuna, Mölndal

Marine and ports
Crane Systems, Västerås

Power Products
Ledning & Stab, Ludvika

Transformers
Power Transformers, Ludvika
Components, Ludvika
Figeholm, Figeholm
Figeholm Elboard, Figeholm
Composites, Piteå

High Voltage Products
High Voltage Breakers, Ludvika
High Voltage Service, Ludvika
High Power Lab, Ludvika
High Voltage Components, Ludvika och
Landskrona
Surge Arresters, Ludvika
Instrument Transformers, Ludvika
Capacitors, Ludvika
Swedewater, Landskrona
Cooling Systems, Landskrona
Kabeldon, Alingsås

Svensk Försäljning/Front End Sales, Västerås

Power Systems
Ledning & Stab, Västerås
Substations
Substations, Västerås
FACTS, Västerås
SA Products, Västerås
SA Systems, Västerås
Enterprise Software Västerås

Grid Systems
HVDC, Ludvika
High Voltage Cables, Karlskrona
Offshore Wind Connections, Västerås

Power Generation
Power Generation, Västerås

Service
Gällivare
Husqvarna
Karlstad
Kiruna
Luleå
Malmö
Mölndal
Norrköping
Olofström
Sollentuna
Storvik
Sundsvall
Uddevalla
Umeå
Västerås
Örnsköldsvik

ЗЗД „ЕИК ДУАЛАС"

ВЯРНО С ОРИГИНАЛА

Date: 19 May 2015

Mikael Lindström
Technical Manager,
Bureau Veritas Certification Sverige AB

1168

Преводът английски език, извършен от Даниела Кирилова Тодорова:

СЕРТИФИКАТ *(лого на ТюфНорд)*

Система за управление съгласно

ISO 9001:2008

В съответствие с процедурите на ТЮФ НОРД СЕРТ,с настоящото се сертифицира че

КАБЕЛОВНА Дечин Подмокли, с.р.о *(лого-не се чете)*
ул. Устечка 33
405 33 Дечин V
Чешка Република

Прилага система за управление в съответствие с горепосочения стандарт за следния обхват

Проектиране, производство и тестване на метални и оптични кабели.

ПЗЗД „ЕИК ДРАГАЛЕВ" Пловдив

Рег. № на Сертификата 04100950276

Валиден от: 2017-03-04
Валиден до: 2018-09-14
(до 2020-03-03 в случай на ресертифициране съгласно стандарт ISO 9001:2015)

Първоначална сертификация:1995

[подпис, не се чете]

Сертифициращо лице при
ТЮФ НОРД СЕРТ ГмбХ

Прага,2017-03-02

Настоящата сертификация е проведена в съответствие с одитните и сертифициращи процедури наТЮФ НОРД СЕРТ и е предмет на периодични контролни одити.

ТЮФ НОРД СЕРТ ул. Лангемарк 20 45141 Есен www.tuev-nord-cert.com

[лога, не се чете]

1169

CERTIFICATE

Management system as per
EN ISO 9001 : 2008

In accordance with TÜV NORD CERT procedures, it is hereby certified that

KABELOVNA Děčín Podmokly, s.r.o.
Ústecká ul. 840/33
405 33 Děčín V
Czech Republic

KDP®
WORLD CONNECTING CABLES

applies a management system in line with the above standard for the following scope

Development, production and testing of metallic and optical cables.

Certificate Registration No. 04 100 950276
Audit Report No. 623 067/800

Valid from 2017-03-04
Valid until 2018-09-14
(until 2020-03-03 in case of Upgrade to ISO 9001:2015)
Initial certification 1995

Certification Body
at TÜV NORD CERT GmbH

Praha, 2017-03-02

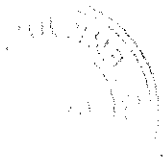
This certification was conducted in accordance with the TÜV NORD CERT auditing and certification procedures and is subject to regular surveillance audits.

TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.com

DAkkS
Deutsche
Akkreditierungsstelle
D-ZM-12007-01-01

ВЯРНО С ОРИГИНАЛА

1170



Преводът английски език, извършен от Даниела Кирилова Тодорова:

[ЛОГО на ТЮФ НОРД]

С Е Р Т И Ф И К А Т

Система за управление съгласно

ISO 9001:2008

В съответствие с процедурите на ТЮФ НОРД СЕРТ,с настоящото се сертифицира че

“ЕСТРАЛИН ПС” ЛЛК
ул. 2-раКабелная 2, блд. 24*[лого]*
111024, Москва
Руска Федерация

Прилага система за управление в съответствие с горепосочения стандарт за следния обхват

Проектен мениджмънт на комплексна доставка на кабели ВН, кабелни аксесоари и услуги за изграждането на кабелни линии 110-500 kV

ПЗЗД „ЕИК ДРАГАЛЕВСКИ“ Пловдив

Рег. № на Сертификата44100120441
Одитен ОтчетNo.35156342
Първоначална сертификация 2012 г.

Валиден от 2015-04-12
Валиден до2018-04-11

[подлис, не се чете]

Сертифициращо лице при
ТЮФ НОРД СЕРТ ГмбХ
Есен,2015-04-08

Настоящата сертификация е проведена в съответствие с одитните и сертифициращи процедури наТЮФ НОРД СЕРТ и е предмет на периодични контролни одити.

ТЮФ НОРД СЕРТ Лангемаркщрасе20 45141Есен www.tuev-nord-cert.com

[лога, не се чете]

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CERTIFICATE

Management system as per
ISO 9001 : 2008

In accordance with TÜV NORD CERT procedures, it is hereby certified that

"Estralin PS" LLC
2-nd Kabelnaya str., 2, bld. 24
111024, Moscow
Russian Federation

ESTRALIN PS

applies a management system in line with the above standard for the following scope

Project management of the complex supply of HV cables, cable accessories and services for the construction of cable lines 110-500 kV

Certificate Registration No. 44 100 120441
Audit Report No. 3515 6342

Valid from 2015-04-12
Valid until 2018-04-11
Initial certification 2012

Certification Body
at TÜV NORD CERT GmbH

Essen, 2015-04-08

This certification was conducted in accordance with the TÜV NORD CERT auditing and certification procedures and is subject to regular surveillance audits.

TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.com

DAkkS Deutsche Akkreditierungsstelle D-ZM-12007-01-01

ВЯРНО С ОРИГИНАЛА

1172

Преводът английски език, извършен от Даниела Кирилова Тодорова:

[ЛОГО на ТЮФ НОРД]

С Е Р Т ИФИКАТ

Система за управление съгласно
ISO 9001:2008

В съответствие с процедурите на ТЮФ НОРД СЕРТ,с настоящото се сертифицира че

“ЕСТРАЛИН ХВС” ЛЛК
ул. 2-раКабелная 2, блвд. 24
111024, Москва
Руска Федерация

Прилага система за управление в съответствие с горепосочения стандарт за следния обхват

Проектиране и производство на високоволтови кабели, кабели и проводници средно напрежение

рег. № на Сертификата44100127473
Одитен ОтчетNo.35167827
Първоначална сертификация 2012 г.

Валиден до2018-09-14
(до 11.10.2018 в случай на ъпгрейд към ISO 9001:2015)

[подпис, не се чете]

Сертифициращо лице при
ТЮФ НОРД СЕРТ ГмбХ

Есен,2015-10-16

Настоящата сертификация е проведена в съответствие с одитните и сертифициращи процедури наТЮФ НОРД СЕРТ и е предмет на периодични контролни одити.

ТЮФ НОРД СЕРТ Лангемаркщрасе20 45141Есен www.tuev-nord-cert.com

[лога, не се чете]

1173

CERTIFICATE

Management system as per
ISO 9001 : 2008

In accordance with TÜV NORD CERT procedures, it is hereby certified that

ESTRALIN HVC

Estralin HVC LLC
2-nd Kabelnaya str., 2, bld. 24
111024, Moscow
Russia

applies a management system in line with the above standard for the following scope

Design and manufacture of high voltage cables, medium voltage cables and wires

Certificate Registration No. 44 100 127473
Audit Report No. 3516 7827

Valid until 2018-09-14
(until 2018-10-11 in case of Upgrade to ISO 9001:2015)
Initial certification 2012

Certification Body
at TÜV NORD CERT GmbH

Essen, 2015-10-16

This certification was conducted in accordance with the TÜV NORD CERT auditing and certification procedures and is subject to regular surveillance audits.

TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.com

DAkkS
Deutsche
Akkreditierungsstelle
D-ZM-12007-01-01

ВЯРНО С ОРИГИНАЛА

1174

Превод от английски език, извършен от Даниела Кирилова Тодорова:

[ЛОГО на ТЮФ НОРД]

С Е Р Т И Ф И К А Т

Система за управление съгласно **ISO 9001:2008**

В съответствие с процедурите на ТЮФ НОРД СЕРТ,с настоящото се сертифицира че

(ЛОГО)

Аркасил СКЛЛК
Проезд Завода Серп и Молот, 6, корпус 1
111250, Москва
Руска Федерация

Прилага система за управление в съответствие с горепосочения стандарт за следния обхват

XLPE кабелни аксесоари 110 – 220 kV, дизайн, производство, обучение, монтаж и супервизия

г. № на Сертификата 44100120774
Одитен Отчет No. 35159118

Валиден от 2015-05-23
Валиден до2018-05-22
Първоначална сертификация 2012 г.

[подпис, не се чете]

Сертифициращо лице при
ТЮФ НОРД СЕРТ ГмбХ

Есен,2015-05-20

Настоящата сертификация е проведена в съответствие с одитните и сертифициращи процедури на ТЮФ НОРД СЕРТ и е предмет на периодични контролни одити.

ТЮФ НОРД СЕРТ Лангемарк щрасе 20 45141 Есен www.tuev-nord-cert.com

[лога, не се чете]

1175

TÜV NORD

CERTIFICATE

Management system as per
ISO 9001 : 2008

In accordance with TÜV NORD CERT procedures, it is hereby certified that

Arkasil
Arkasil SK LLC
proezd Zavoda Serp i Molot, 6, corpus 1
111250, Moscow
Russia

applies a management system in line with the above standard for the following scope

XLPE cable accessories 110-220 kV, design, production, training, installation and supervision

Certificate Registration No. 44 100 120774
Audit Report No. 3515 9118

Valid from 2015-05-23
Valid until 2018-05-22
Initial certification 2012

Certification Body
at TÜV NORD CERT GmbH

Essen, 2015-05-20

This certification was conducted in accordance with the TÜV NORD CERT auditing and certification procedures and is subject to regular surveillance audits.

TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.com

DAkkS
Deutsche
Akkreditierungsstelle
D-ZM-12007-01-01

ВЯРНО С ОРИГИНАЛА

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Превод от английски език

Извършен от Даниела Кирчева

СЕРТИФИКАТ

Настоящият сертификат удостоверява, че:

AFL Telecommunications GmbH/ АФЛ Телекомюникейшънс ООД
ул. „Боненбройхер" 2-14
41238 Мьонхенгладбах

е въвела и поддържа

Система за управление на качеството и околната среда

Обхват:
Проектиране, производство и продажби на кабел с оптични влакна (OPGW/ OPPC/ MASS), тръби от неръждаема стомана с оптични влакна и аксесоари за монтаж.

След проведен одит, документиран в доклад, беше установено, че системата за управление е в съответствие с изискванията на следните стандарти:

ISO 9001:2008
ISO 14001:2004 + Поправка 1: 2009

Регистрационен номер на сертификата:	000629 QM08/UM
Валиден от:	2014-10-01
Валиден до:	2017-09-30
Дата на сертифициране:	2014-10-01

DQS GmbH

/подпис нечетлив/

Götz Blechschmidt
Управител

Акредитиран орган: DQS GmbH, ул. Август Шанз 21, 60433 Франкфурт на Майн

ПЗЗД „ЕИК ДРАГАЛЕВ" Пловдив

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CERTIFICATE

This is to certify that

AFL

Telecommunications GmbH

Bonnenbroicher Straße 2-14
41238 Mönchengladbach

has implemented and maintains a
Quality and Environmental Management System.

Scope:
Development, Production and Sales of Aerial Optical fibre cables (OPGW/OPPC/MASS), Stainless steel tubes with optical fibres and installations accessories

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standards:

ISO 9001 : 2008
ISO 14001 : 2004 + Cor 1 : 2009

Certificate registration no.	000629 QM08/UM
Valid from	2014-10-01
Valid until	2017-09-30
Date of certification	2014-10-01

DAkkS
Deutsche
Akkreditierungsstelle
D-ZM-16074-01-00

DQS GmbH

G. Blechschmidt

Götz Blechschmidt
Managing Director

ВЯРНО С ОРИГИНАЛА

Accredited Body: DQS GmbH, August-Schanz-Straße 21, 60433 Frankfurt am Main

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