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ENGINEERING DESIGN STANDARD

EDS 05-2011

AIR CIRCUIT BREAKER PROTECTION SETTINGS

Network(s):	EPN, LPN, SPN		
Summary:	This standard details the current and previous protection settings used on LV air circuit breakers used on the EPN, LPN and SPN networks.		
Author:	Jesse Garcia	**Date:**	11/06/2018
Approver:	Paul Williams	**Date:**	06/08/2018

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Section 6.1.1 I_{inst} = 6 changed to I_{inst} = 15. Section 6.1.2 I_{inst} = 8 changed to I_{inst} = 15.			
Version	1.0	**Review Date**	
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Contents

Figures

Tables

1 Introduction

This standard details the protection settings for LV Air Circuit Breakers (ACB) and includes settings for new and legacy ACBs.

This standard has been updated to meet the requirements for large customer LV supplies detailed in UK Power Networks EDS 08-2100 LV Customer Supplies.

2 Scope

This standard applies to all ACBs on UK Power Networks EPN, LPN and SPN networks.

3 Glossary and Abbreviations

Term	Definition
ACB	Air Circuit Breakers
TLF	Time Fuse Link
TS&S	Technical Sourcing and Standards
RMU	Ring Main Unit
LV	Low Voltage
HV	High Voltage
UK Power Networks	UK Power Networks (Operations) Ltd consists of three electricity distribution networks: • Eastern Power Networks plc (EPN). • London Power Network plc (LPN). • South Eastern Power Networks plc (SPN).

4 Protection Settings for New ACBs

4.1 General

A common range of ACBs are available and are used to provide large supplies to LV customers or supply the LPN interconnected network (with reverse power relays). Refer to UK Power Networks EDS 08-0803 for further information on their application.

The approved ranges of ACBs are supplied by Schneider Electric and are fitted with a Micrologic 5.0A protection module to provide overcurrent protection. Refer to the relevant Engineering Approval Standard for the current range of approved ACBs.

The ACB protection settings in section 4.2 have been selected to provide the best discrimination between the network LV distribution board on which there are large BS88 J type fuses to customers.

The protection settings for various ACBs and various sizes of transformer to discriminate with a 15A or 12.5A tagged TLF, used for transformer HV overcurrent protection, are given in the sections that follow. The tagged type TLFs shall be used in conjunction with LV ACBs to allow for discrimination in settings. An explanation of the various settings is given in appendix A and the associated AMTECH curves are included in Appendix B.

If the standard settings are not suitable due to network variations please contact UK Power Networks Asset Management for site specific settings.

A network variation example is when a customer has an ACB to protect their site. The customer shall attempt to grade with UK Power Networks standard settings, however if they have difficulties they might request a variation in settings. This case shall be investigated by the Asset Management – Technical Standards protection engineers and only with their permission variation from standard settings will occur.

Note:

- The Micrologic protection module is pre-set with the protection settings for a 750/800/1000kVA transformer by the supplier.
- The Micrologic 6.0A is not suitable for use on the LPN network and care should be taken when it is used on the other networks as the earth fault settings may not provide sufficient discrimination or co-ordination with downstream fusing.
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Figure 4.1 below presents an example of an ACB supply to a distribution board and a Large LV Supply customer.

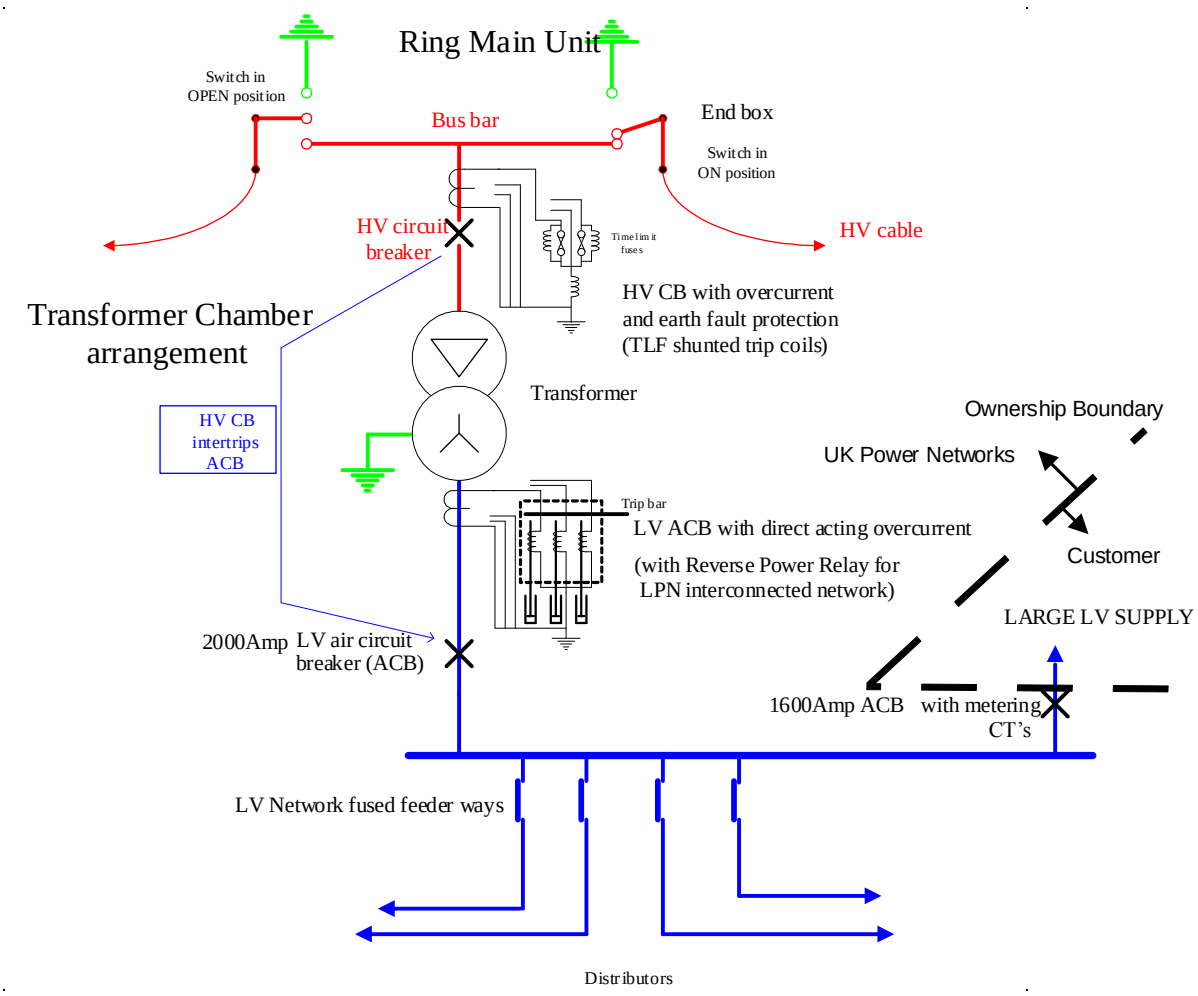


Figure 4-1 - Large LV supply from network feeding substation

Due to the obsolescence of glass barrel type fuses and the adoption of XF TLF fuses, time grading on the 6.6kV network has become difficult and the possibility of ACB protection operating faster than an LV Fuse is larger. As such it is important for operational staff to follow the instructions on HSS 40 017 when re-energizing devices.

There is an ongoing investigation by the Asset Management TS&S team to adopt RMUs where the HV transformer protection is provided by an IDMT capable relay instead of an XF TLF fuse for secondary substations that have ACBs. If the proposal is adopted, this document shall be updated.

4.2 ACB protection settings for all Micrologic 5.0.

Note: The settings below are applicable to all Micrologic 5.0 ACBs, protection modules, including large single service customers.

Table 1 ACB protection settings

System Voltage (kV)	Transformer (kVA)	ACB Rating (A)	RMU CT Ratio	RMU TLF Fuse (A)	ACB Protection Module	I_r	t_r	I_{sd}	t_{sd} $(+i^2t)$	I_{inst}	Largest possible LV fuse (A)
6.6	500	1600	100/5	15.0	Micrologic 5.0A	0.70	4	4	0.2	6	400
	500	2000		15.0		0.60			0.2	6	400
	750	1600		15.0		0.95			0.1	8	500
	750	2000		15.0		0.80			0.1	6	500
	800	1600		15.0		1.00			0.1	8	500
	800	2000		15.0		0.80			0.1	6	500
	1000	1600		15.0		0.95			0.1	8	500
	1000	2000		15.0		0.80			0.1	6	500
11	500	1600		12.5		0.70			0.2	10	400
	500	2000		12.5		0.70			0.2	8	400
	750	1600		15.0		0.80			0.2	8	500
	750	2000		15.0		0.80			0.2	10	500
	800	1600		15.0		1.00			0.2	12	500
	800	2000		15.0		0.80			0.2	10	500
	1000	1600		15.0		1.00			0.2	12	500
	1000	2000		15.0		0.80			0.2	10	500
	1500	2500		15.0		0.80			0.2	8	N/A

4.3 Reverse Power Relays

On the LV interconnected network in the LPN area, reverse power relays are used to detect reverse power flow caused by a fault on the HV side of the transformer and trip the ACB to prevent back feed from the LV side. Over-current protection is not required on these ACBs.

There are two types of relay used:

- The English Electric CAG with a PCD directional element;
- The Reyrolle TGG relay.

Both relays have fixed settings that are set to trip at roughly three times the LV current with the secondary set at 10A.

5 Protection Settings for Legacy ACBs

This section details the protection settings for legacy ACBs used on the EPN, LPN and SPN networks between 1st July 2007 and 31st December 2011.

If the HV TLF fuses are replaced with new ones on an ACB with Micrologic 5.0 protection then the settings shall be changed to the ones presented I previously in chapter 4.2. If the HV TLF fuses are replaced with new ones on an ACB with Micrologic 6.0, please contact UK Power Networks Asset Management for site specific settings.

Note: ACBs were introduced in SPN in 2007.

5.1 Schneider Electric NW20H1 (2007-2011)

ACB	NW20H1		
System Voltage (kV)	11	11	6.6
Transformer (kVA)	1000, 800, 750	500	
RMU CT Ratio	100/5	50/5	
RMU TLF Fuse (A)	15	15	
ACB Protection Module	Micrologic 6.0A/6.0P	Micrologic 6.0A/6.0P	Micrologic 6.0A/6.0P
ACB Protection Settings	$I_r = 1$	$I_r = 0.6$	$I_r = 0.7$
	$t_r = 4$	$t_r = 4$	$t_r = 4$
	$I_{sd} = 4$	$I_{sd} = 4$	$I_{sd} = 4$
	$t_{sd} = 0.1+ I^2t$	$t_{sd} = 0.1+ I^2t$	$t_{sd} = 0.1+ I^2t$
	$I_{inst} = 15$	$I_{inst} = 15$	$I_{inst} = 15$
	$I_g =$	$I_g =$	$I_g =$
	$t_g =$	$t_g =$	$t_g =$

5.2 Merlin Gerin NW25H1 and NT16H1 (EPN 2003 to 2007)

The Merlin Gerin NW25H1 was used with 1500kVA and 1000kVA transformers. The Merlin Gerin NT16H1 is only used with 1000kVA transformers. **Note:** These units have been selected to cope with 130% overload conditions.

Application	Large supplies to LV customers		
ACB	NW25H1	NW25H1	NT16H1
Transformer	1500kVA	1000kVA	1000kVA
Protection Module	Micrologic 6.0A	Micrologic 6.0A	Micrologic 6.0A
Protection Settings	Ir = 0.9	I_r = 0.7	I_r = 1
	t_r = 8	t_r = 8	t_r = 8
	I_{sd} = 2	I_{sd} = 2	I_{sd} = 3
	t_{sd} = 0.2 + I^2t	t_{sd} = 0.2+ I^2t	t_{sd} = 0.3 + I^2t
	I_i= 12	I_i = 12	I_i = 12
	t_g = 0.4+ I^2t ON	t_g = 0.4+ I^2t ON	t_g = 0.4+ I^2t ON

5.3 Merlin Gerin NW16H1 and NW20H1 (LPN 2003 to 2007)

The Merlin Gerin NW16H1 was used with 800kVA transformers and below. The Merlin Gerin NW20H1 was used with 1000kVA transformers. **Note:** These units have been selected to cope with 160% overload conditions.

Application	Large supplies to LV customers or network support for the interconnected network	
ACB	NW16H1	NW20H1
Transformer	800kVA and below	1000kVA
Protection Module	Micrologic 5.0A	Micrologic 5.0A
Protection Settings	I_r = 1	I_r = 1
	t_r = 4	t_r = 4
	I_{sd} = 6	I_{sd} = 8
	t_{sd} = 0.1+I^2t	t_{sd} = 0.1+I^2t
	I_{inst} = 15	I_{inst} = 15

5.4 Merlin Gerin NS1250 (EPN 2003 onwards)

The Merlin Gerin NS1250 was used with 500kVA and 700 kVA transformers. **Note:** This unit has been selected to cope with 130% overload conditions.

Application	Large supplies to LV customers	
ACB	NS1250	NS1250
Transformer	500kVA	700kVA
Protection Module	Micrologic 5.0A	Micrologic 5.0A
Protection Settings	$I_r = 0.9$	$I_r = 1$
	$t_r = 8$	$t_r = 8$
	$I_{sd} = 2.5$	$I_{sd} = 5$
	$t_{sd} = 0.3 + I^2t$	$t_{sd} = 0.3 + I^2t$
	$I_i = 15$	$I_i = 15$

5.5 Merlin Gerin M16H1 (EPN 1993 to 2003)

The Merlin Gerin M16H1 was used with 1000kVA transformers. **Note:** This unit has been selected to cope with 130% overload conditions.

Application	Large supplies to LV customers
ACB	M16H1
Transformer	1000kVA
Protection Module	STR38ST
Protection Settings	$I_o = 1$
	$I_r = 1$
	$I_m = 3$
	$t_m = 0.3 + I^2t$ ON
	I_i = max/ON (any position in shaded area)
	$I_h = 500$
	$t_h = 0.4 + I^2t$ ON
	Minimum tripping current 1680A

Note:

- Current in excess of the minimum tripping currents may trip the circuit-breaker after 200s.
- The STR38ST trip units used on Masterpact ACBs from 1993 may be unstable and may give nuisance tripping on low loads if I_h is set to less than 500A.

5.6 Merlin Gerin M25 (EPN 1993 to 2003)

The Merlin Gerin M25 was used with 1500kVA and 1000kVA transformers. **Note:** This unit has been selected to cope with 130% overload conditions.

Application	Large supplies to LV customers	
ACB	M25	M25
Transformer	1500kVA	1000kVA
Protection Module	STR38ST	STR38ST
Protection Settings	$I_o = 1$	$I_o = 0.63$
	$I_r = 0.9$	$I_r = 1$
	$I_m = 2$	$I_m = 2$
	$t_m = 0.2 + I^2t$ ON	$t_m = 0.2 + I^2t$ ON
	I = max/ON (any position in shaded area)	I = max/ON (any position in shaded area)
	Minimum tripping current 2360A	Minimum tripping current 2360A

Note:
- Current in excess of the minimum tripping current may trip the circuit-breaker after 200s.
- The STR38ST trip units used on Masterpact ACBs from 1993 may be unstable and may give nuisance tripping on low loads if I_h is set to less than 500A.

5.7 Merlin Gerin M16 and M25 (EPN 1991 to 1993)

The Merlin Gerin M16 was used with 1000kVA transformers and the Merlin Gerin M25 was used with 1500kVA and 1000kVA transformers. **Note:** These units have been selected to cope with 130% overload conditions.

Application	Large supplies to LV customers		
ACB	M16	M25	M25
Transformer	1000kVA	1500kVA	1000kVA
Protection Module	STR308ST	STR38ST	STR38ST
Protection Settings	$I_r = 1$	$I_r = 0.9$	$I_r = 0.63$
	$I_m = 3$	$I_m = 2.5$	$I_m = 2.5$
	$t_m = 0.3$	$t_m = 0.3$	$t_m = 0.3$
	$I_h = 0.2$	$I_h = 0.2$	$I_h = 0.2$
	Minimum tripping current 1680A	Minimum tripping current 2360A	Minimum tripping current 2360A

Note: Current in excess of the minimum tripping currents may trip the breaker after 200s.

5.8 Merlin Gerin M16 and M25 (EPN 1991 to 1993)

The Merlin Gerin M16 was used with 1000kVA transformers and the Merlin Gerin M25 was used with 1500kVA and 1000kVA transformers. **Note:** These units have been selected to cope with 130% overload conditions.

Application	Large supplies to LV customers		
ACB	M16	M25	M25
Transformer	1000kVA	1500kVA	1000kVA
Protection Module	STR308ST	STR38ST	STR38ST
Protection Settings	I_r = 1	I_r = 0.9	I_r = 0.63
	I_m = 3	I_m = 2.5	I_m = 2.5
	t_m = 0.3	t_m = 0.3	t_m = 0.3
	I_h = 0.2	I_h = 0.2	I_h = 0.2
	Minimum tripping current 1680A	Minimum tripping current 2360A	Minimum tripping current 2360A

Note: Current in excess of the minimum tripping currents may trip the breaker after 200s.

5.9 Merlin Gerin C1250N and C1251N (EPN 1988 to 1992)

The Merlin Gerin C1250N and C1251N were used with 500kVA and 700kVA transformers. **Note:** These units have been selected to cope with 130% overload conditions.

Application	Large supplies to LV customers			
ACB	C1250N	C1250N	C1251N	C1251N
Transformer	500kVA	700kVA	500kVA	700kVA
Protection Settings		I_o = 1	I_o = 1	
Protection Settings	I_r = 0.8	I_r = 1	I_r = 0.9	I_r = 1
	I_m = 4	I_m = 5	I_m = 2.5	I_m = 6
	t_m = 0.3	t_m = 0.3 + I^2t ON	t_m = 0.3 + I^2t ON	t_m = 0.3

5.10 Dorman Smith 600A and 1250A MCCB (before 1988)

The Dorman Smith 600A and 1200A MCCBs were used with 500kVA and 700kVA transformers respectively.

Application	Large supplies to LV customers	
ACB	600A	1250A
Transformer	500kVA	700kVA
Protection Module	600A Tripping Unit Type A	1250A Tripping Unit Type B
Thermal Over Load Setting	No. 5	No. 4
Instantaneous Magnetic Release	High	High

6 References

6.1 UK Power Networks Standards

EDS 08-2100	LV Customer Supplies
HSS 40 017	Low Voltage Re-Energising Devices

Appendix A – Protection Settings Explained

This appendix provides a brief explanation of the protection settings used on the various protection modules.

A.1 Schneider Electric Micrologic Protection Modules

Protection Element	Description	Function
I_r	Long time current setting	Adjusts pickup current
t_r	Long time tripping delay	Adjusts time to trip the long time current setting
I_{sd}	Short time pickup (multiple of I_r)	Adjusts current setting of intermediate vertical lines
t_{sd}	Short time tripping delay	Adjusts time setting of high current trip (2nd horizontal/ slope from left)
I_{inst} or I_i	Instantaneous pickup	Sets high current instantaneous pickup
I_g	Earth fault pickup	Adjusts earth fault current
t_g	Earth fault time delay	Adjusts earth fault time delay

A.2 Merlin Gerin (or Schneider Electric) STR38ST Trip Unit Settings

Protection Element	Description	Function
I_o	Long time current setting	Provides a wider range of pickup current
I_r	Long time current setting (on STR38ST or C1251N = I_o x I_r)	Adjusts pickup current
I_m	Short time pickup (multiple of I_r)	Adjusts current setting of intermediate vertical lines
t_m	Short time tripping delay	Adjusts time setting of high current trip (2nd horizontal/ slope from left)
I_i	Instantaneous pickup (STR38ST has 2 settings only - MAX and OFF)	Sets high current instantaneous pickup
I_h	Earth fault pickup	Adjusts earth fault current
t_h	Earth fault time delay	Adjusts earth fault time delay

A.3 Dorman Smith Trip Units

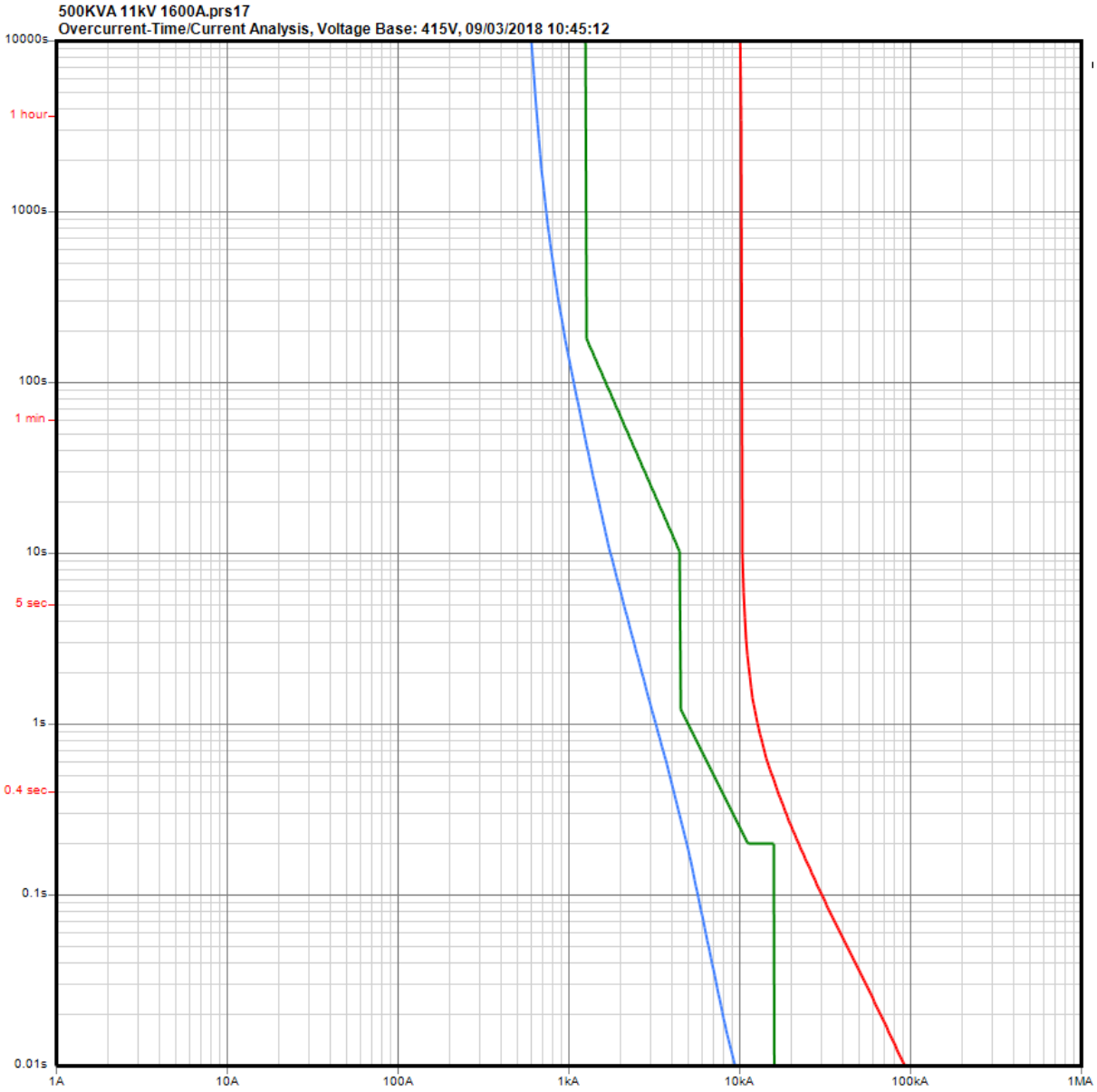
The trip unit size is not visible unless the MCCB (Moulded Case Circuit Breaker) front panel is removed. **Note**: That the 600A trip unit is rated at 700A when fitted in the standard (1250A) MCCB and cubicle.

Appendix B - AMTECH Protection Curves

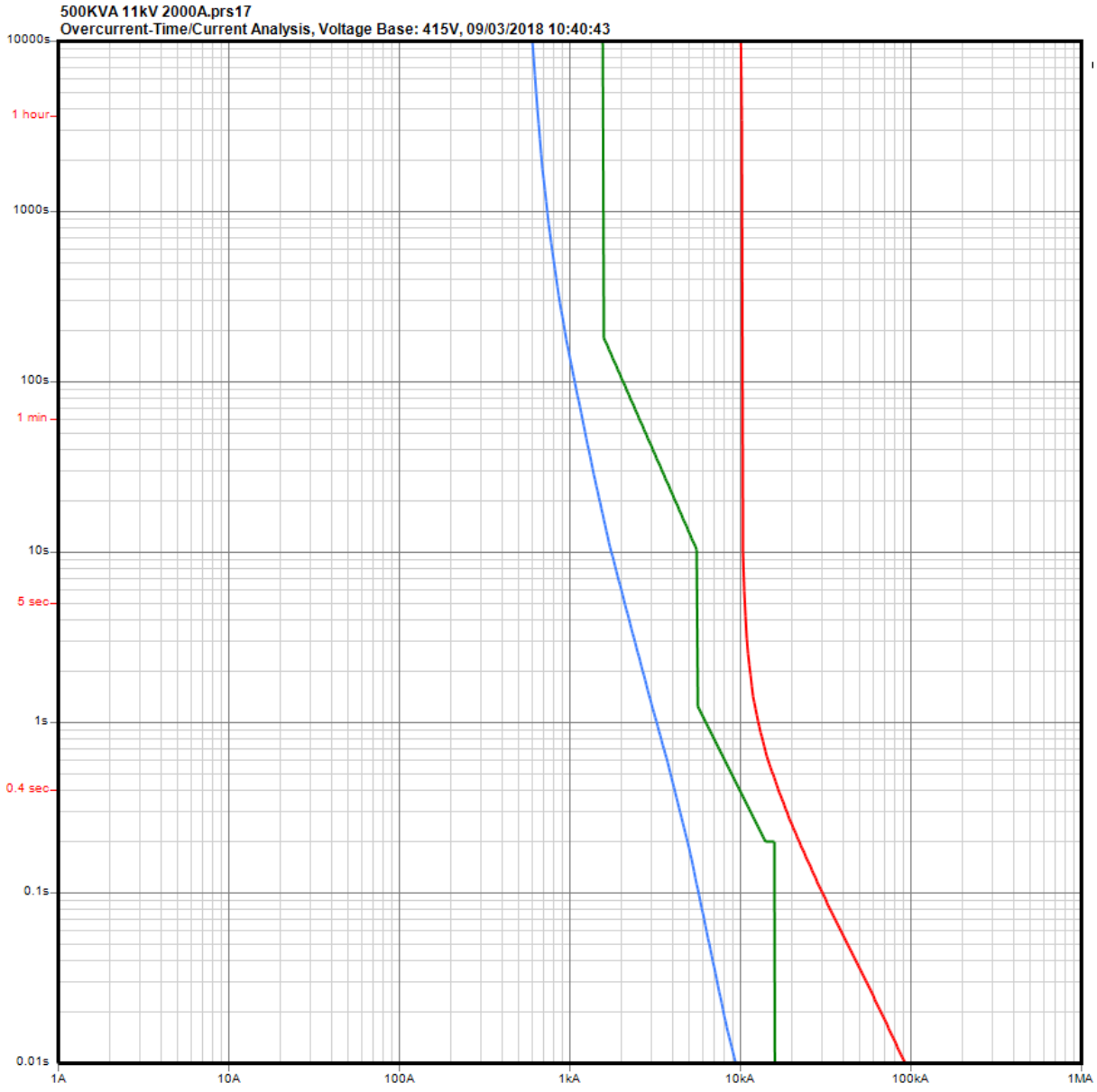
This appendix contains the AMTECH plots for each of the settings in Section 4. Key:

- Top (red) curve – ring main unit (HV AC Series Tripping) tagged TLF fuse.
- Middle (green) (green or blue in B10) curve – ACB.
- Bottom (blue) (orange in B10) curve – 400A BS88 J type supply fuse.

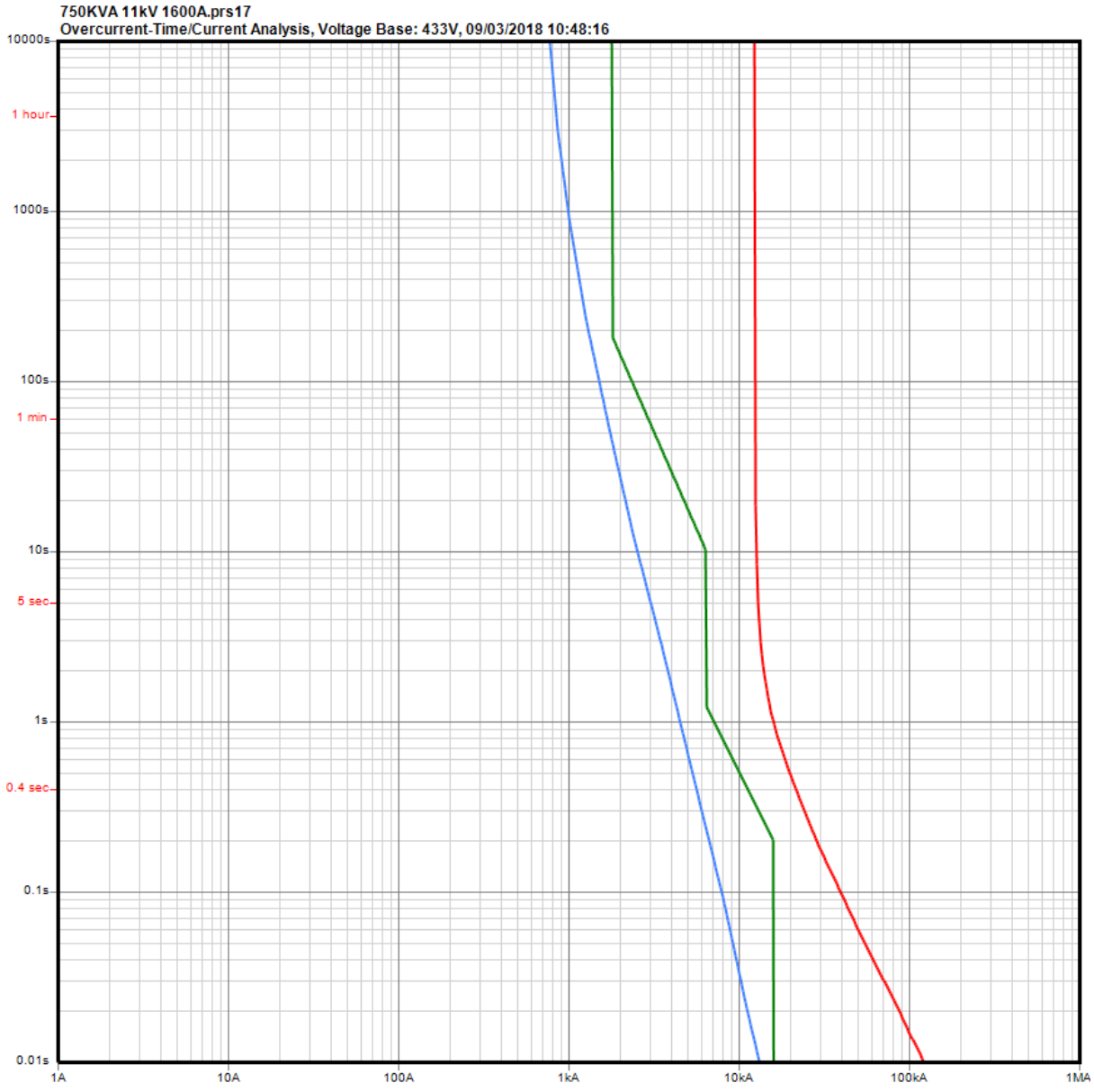
B.1 11kV 500kVA Transformer ACB 1600A rating



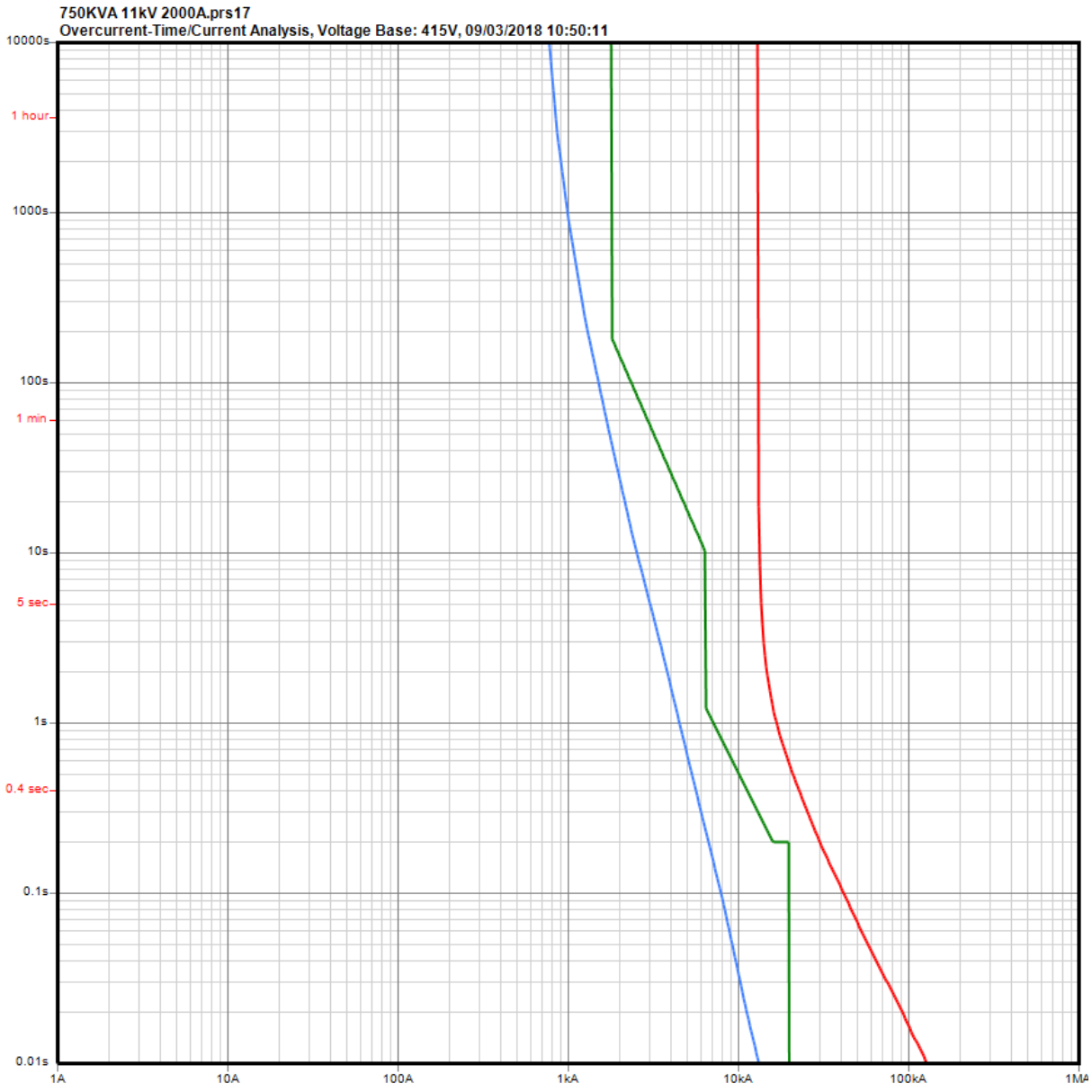
B.2 11kV 500kVA Transformer ACB 2000A rating



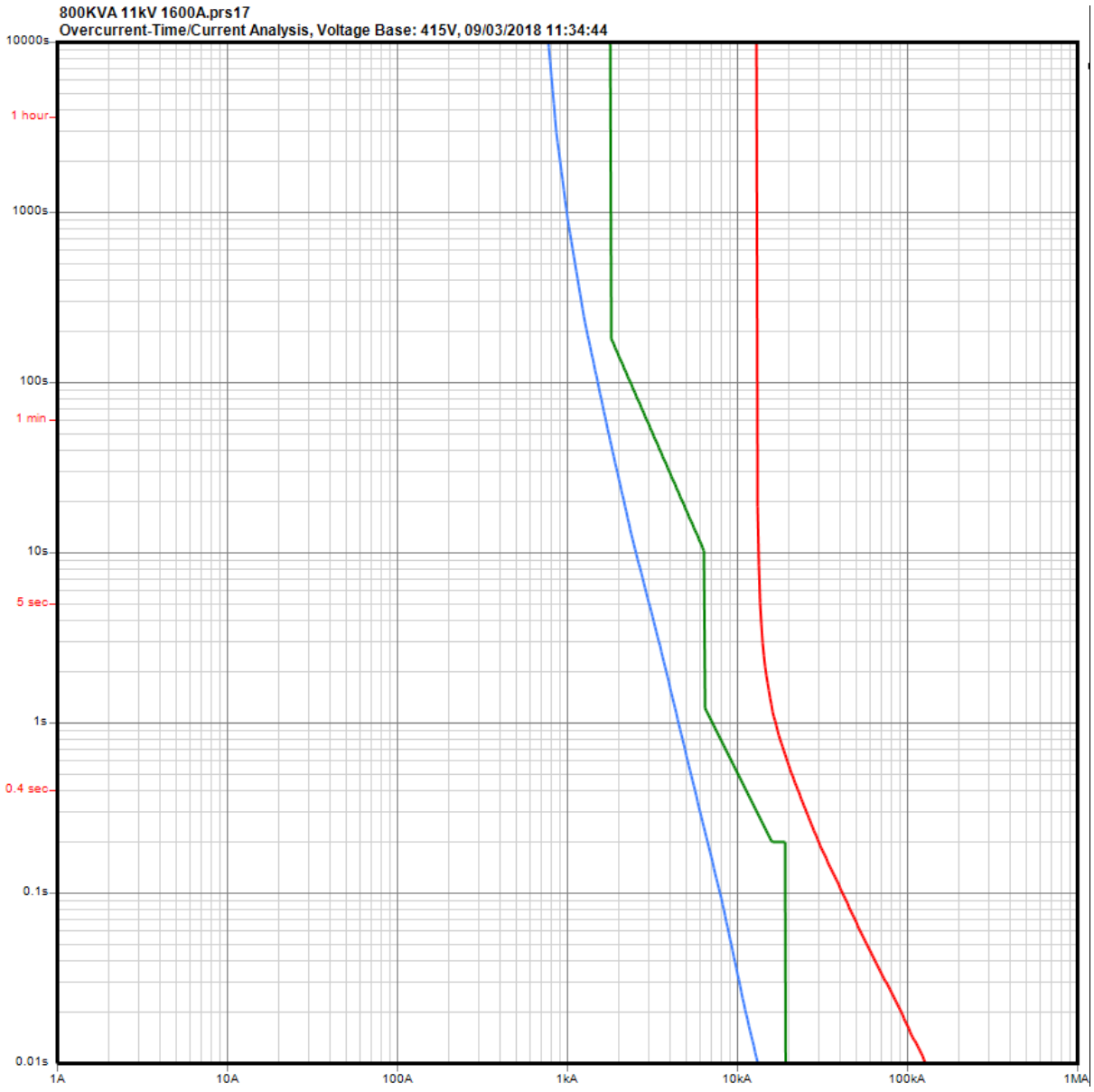
B.3 11kV 750kVA Transformer ACB 1600A rating



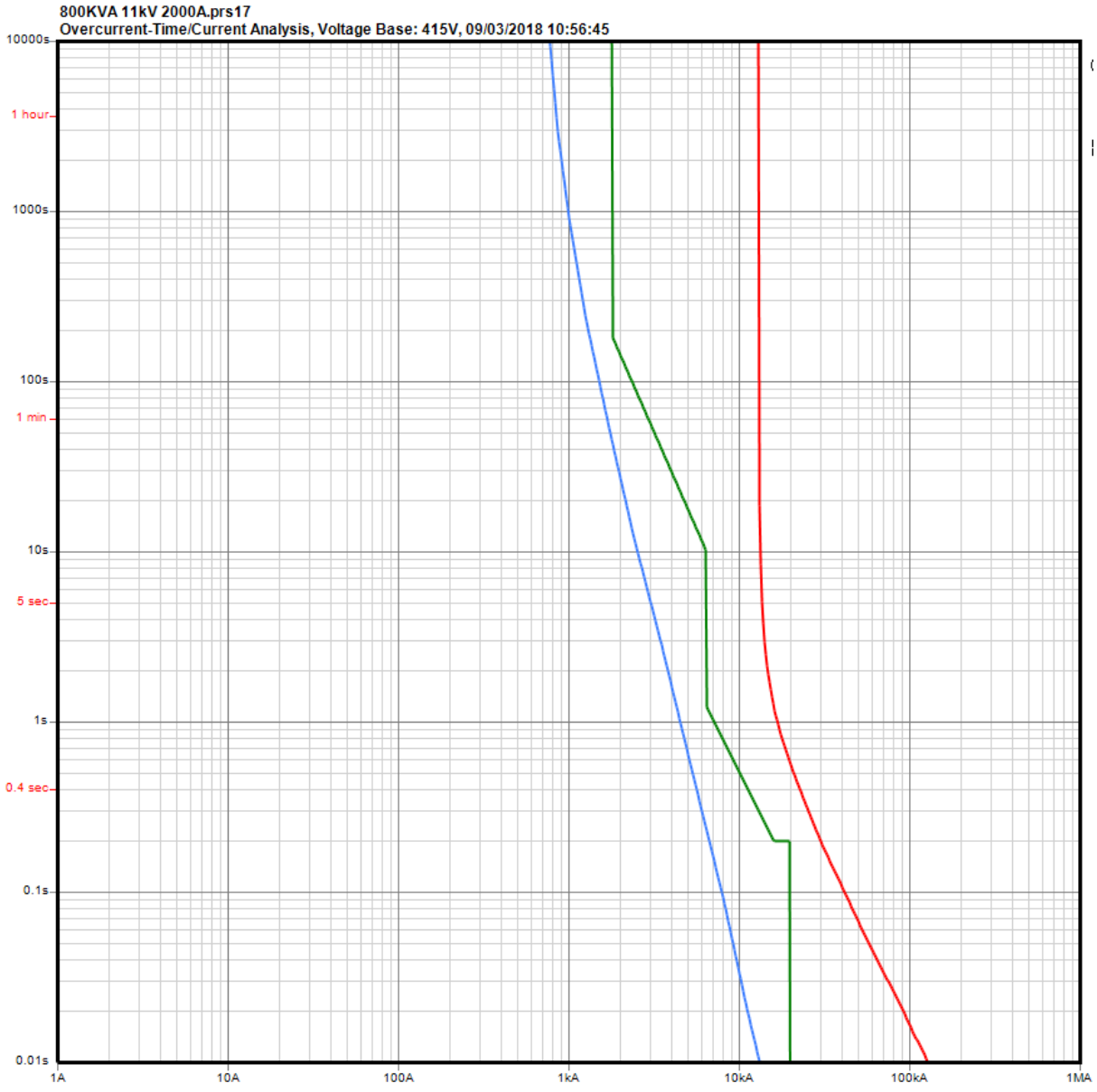
B.4 11kV 750kVA Transformer ACB 2000A rating



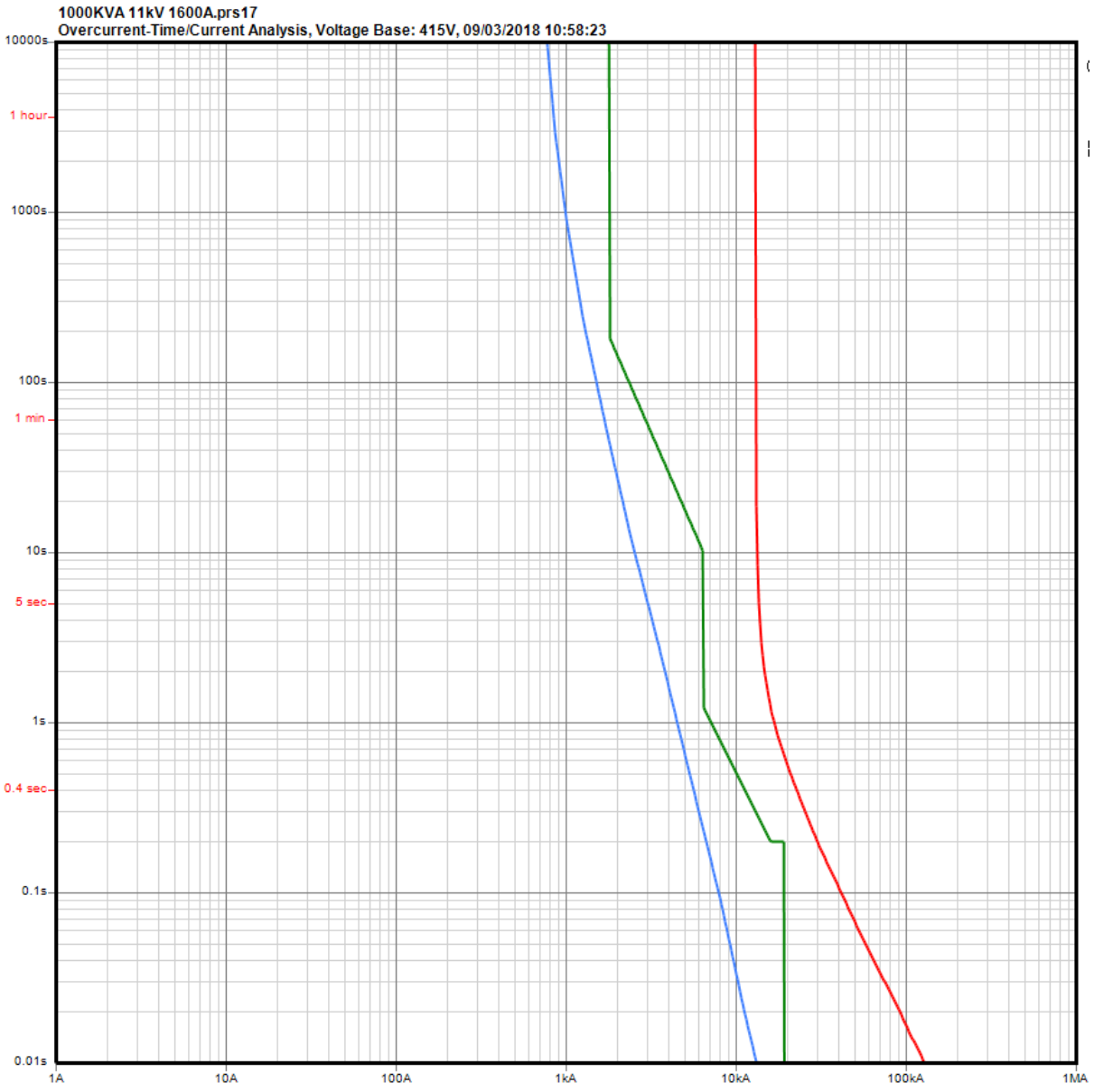
B.5 11kV 800kVA Transformer ACB 1600A rating



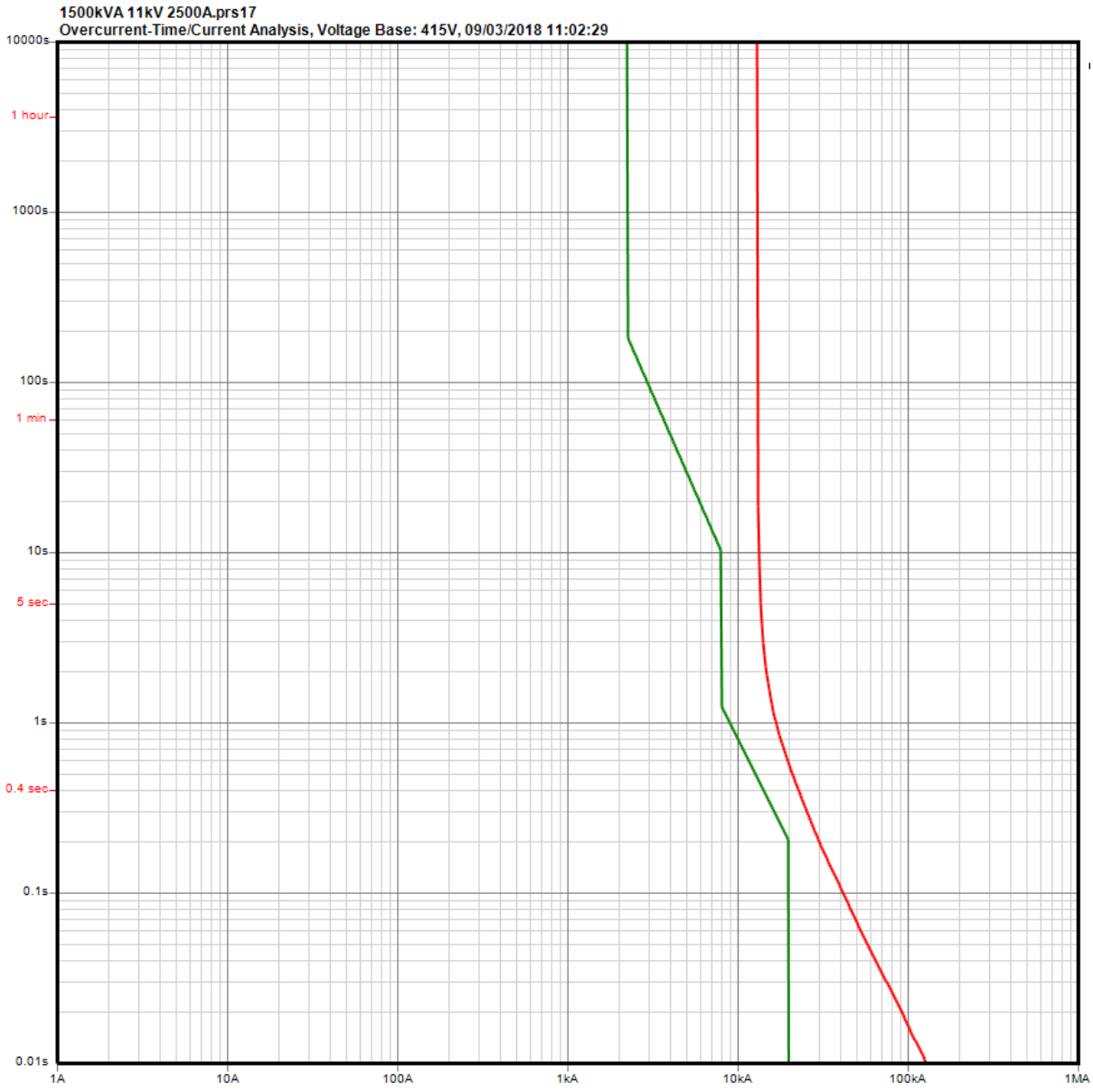
B.6 11kV 800kVA Transformer ACB 2000A rating



B.7 11kV 1000kVA Transformer ACB 1600A rating



B.8 11kV 1500kVA Transformer ACB 2500A rating



B.9 11kV 1500kVA Transformer ACB 2500A rating