



Temperature Rise Verification for Metal Distribution Boards

Technical Document

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Temperature Rise Verification for Metal Distribution Boards

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Foreword

AS/NZS 61439 series introduces the concept of *design verification*, and specifies the methodology for verifying the performances of switchgear and controlgear assemblies. The advantage of 61439 over the previous 3439 series is that it provides clarity on how to verify alternate designs that are based on existing reference designs that are already tested and verified.

There are 13 characteristics that require verification, one of which is temperature rise which can be verified using the following methods:

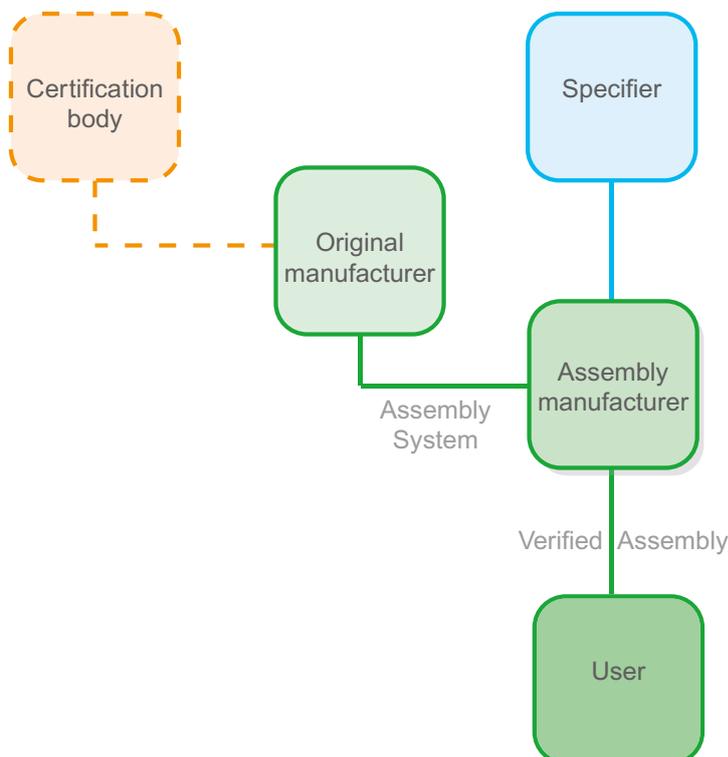
- Testing
- Comparison with a reference design
- Assessment/Calculation

Why is verification of temperature rise important?

The temperature rise limits of an assembly is a point of performance verification of the manufactured assembly related to risk of fire and component failure. It is a way to mitigate the risk of fire ignition, by managing heat dissipation and temperature rise to avoid abnormal heat, hot joints and potential fire.

Who is responsible for the verification of temperature rise?

Provided the assembly manufacturer follows the design rules specified by the original manufacturer, no further testing is required on their part. However, given that they are the manufacturer of the *completed* assembly, they are responsible for documenting and demonstrating that the performances are verified to the standard.



Overview

AS/NZS 61439 clause 10.10.3.2 specifies the requirements for verifying temperature rise by derivation from a similar tested arrangement otherwise known as a reference design. The following items are the criteria for verification:

- a) The functional units belong to the same family/group as those used in the reference design
- b) The enclosure construction is the same as the reference design
- c) The overall dimensions are the same or greater than the reference design
- d) The cooling conditions are the same or increased
- e) The internal separation is the same or reduced
- f) The total power losses are the same or less than the reference design

While items a) through e) can be assessed by visual inspection, item f) will require calculation.

The following is a method to calculate and compare power losses in a MB or ME Distribution Board which will ultimately allow for a verification of temperature rise by comparison to a reference design.

Power Loss Verification Method

Part 1	Determine the allowable power loss limits for the assembly and the chassis
Part 2	Calculate the power loss for each chassis including the devices fitted
Part 3	Calculate the power losses for other heat dissipating items within the assembly
Part 4	Verify the calculated chassis power loss and total combined losses do not exceed the limits determined in Part 1.

Refer to Appendix A for a blank temperature rise verification form and worksheets to assist with calculations.

Refer to Appendix B for a full example.

Part 1 – Allowable power loss limits

There are two power loss limits that are required for comparison with reference designs tested by Schneider Electric; the limit allowed by the size of the assembly and the limit allowed on each chassis.

Temperature rise in the assembly can primarily be attributed to the power losses of current carrying devices and conductors within the assembly. The dimensions of the assembly also play a role as they determine the available surface area for cooling or heat dissipation. Schneider have determined the maximum allowable power losses on standard assembly sizes through testing.

A power loss limit is also applied to the chassis to prevent the conductors reaching temperatures that are greater than the permissible limits of insulating materials or the limits of any devices that are connected to the chassis.

Assembly Losses

Table 1 shows the maximum power losses allowed for components and conductors within assemblies at various sizes. This includes the losses from the main incoming device, the chassis, field wiring inside the assembly, MCBs/RCBOs and other switchgear.

Based on the height of the assembly, select the corresponding Max. allowable power loss from Table 1.

Example: MB series IP42 assembly with 1000mm high enclosure, max. allowable power loss is 96W.

Table 1 - Assembly losses

Assembly Height (mm)	Max. allowable power loss (W)
600	88
750	92
1000	96
1200	109
1500	132
1800	150
2100	172

Chassis Losses

Each chassis also has a maximum allowable power loss before temperature rise limits are exceeded. The losses shown in Table 2 are the maximum allowable losses for the chassis which includes the copper losses in the chassis and the losses in the fitted MCBs and RCBOs. The total losses do not include the losses from the line side neutral leads of RCBOs.

Based on the type of chassis in the assembly, select the corresponding Max. power loss per chassis from Table 2.

Example: Chassis in assembly is Encapsulated SAU250 type. Max. power loss for each chassis is 47W.

Table 2 - Chassis losses

Chassis type	Max. allowable power loss per chassis (W)
Encapsulated SAU250	47
Isobar	33

The assembly losses and chassis losses obtained shall be used for comparison with calculated losses of devices in Part 4.

Part 2 – Power loss per chassis

The total power loss on a chassis is determined by the sum of the losses from devices (MCBs/RCBOs) on the chassis and the copper losses of the conductors of the chassis. Losses from each device or conductor is dependent on the current loading. The more loading on a device or conductor, the more losses will be generated.

The following sections will assist in calculating the power loss for each chassis in the assembly.

Device losses

Refer to Worksheet 1. Record the quantity of each MCB or RCBO on the chassis in the Qty column. For multi-pole devices, each pole shall be regarded as 1P e.g 3P MCB is 3 x 1P MCB.

The **loading factor** is the per unit value of the nominal current of a device that represents the assumed loading of the outgoing circuits.

Example: The assumed loading of a circuit is 6A which is fed from a 20A MCB. The loading factor is $6A / 20A = 0.3$

The maximum allowable loading factor for each device varies depending on the type of chassis used, refer to Table 3:

Table 3 - Max. loading factor

Chassis type	Max. loading factor per circuit
Encapsulated SAU250	0.48
Isobar	0.4

Note that the above maximum loading factors only apply when performing a comparison to our reference design. If another method for temperature rise verification is used, such as calculation to AS60890, other loading factors may be used. Refer to AS/NZS 61439-1 for more information on other verification methods.

Calculate the average current per phase and total losses for each device using the formulae below. Record the results in the spaces provided in Worksheet 1. The value calculated for average current per phase shall be used in the chassis copper loss calculation.

Total Current = Nominal Current x Qty x Loading Factor
Average current per phase = Total current / No. of phases

Total Losses = Nominal Losses x Qty x (Loading Factor)²

Example: SAU250 Chassis is fitted with 24 x iC60 1P 20A RCBOs and 1 x iC60 3P 40A MCB with an estimated loading factor of 0.3 for all circuits.

Total current = $(20A \times 24 \times 0.3) + (40A \times 3 \times 0.3) = 180A$
Average current per phase = $180 / 3 = 60A$
Total losses = $(3W \times 24 \times 0.3^2) + (3.6W \times 3 \times 0.3^2) = 7.5W$

Sample of Worksheet 1 (refer to Appendix A for full worksheet)

Device	Nominal Current I_n (A)	Nominal Loss P_n (W)	Qty	Loading Factor	Total Current (A)	Total Losses (W)
					$I_n \times Qty \times LF$	$P_n \times Qty \times LF^2$
iC60 1P 40A	40	3.6	3	0.3	36	1
iC60 1P 20A RCBO	33	3	24	0.3	144	6.5
Total					180	7.5
No. of phases	3	Average current per phase (Total current / No. of phases)			60	

Chassis Copper Losses

The copper losses in the chassis is dependent on the load in each phase and how the load is distributed throughout the chassis

To determine a value for the loss, compare the average current per phase (calculated on Worksheet1) with Table 4 (Encapsulated SAU250) or Table 5 (Isobar) below. Note that the first column in each table is the quantity of poles with a device fitted rather than the full size of the chassis. If the calculated average current per phase or no. of used poles falls between two values in the table, use the higher value for comparison.

Example: Encapsulated SAU250 Chassis fitted with 24 x iC60 1P 20A RCBOs and 1 x iC60 3P 40A MCB has 27 used poles and 60A average current per phase. From Table 4, the closest in comparison is 30 used poles and ≤75A per phase which gives 1.4W.

Table 4 – Encapsulated SAU250 Chassis copper loss

No. of used poles	Current per phase (A)									
	≤25A	≤50A	≤75A	≤100A	≤125A	≤150A	≤175A	≤200A	≤225A	≤250A
12	0.1	0.5	1.2	2.1	3.4	4.8	6.6	8.6	10.9	13.4
18	0.1	0.5	1.2	2.2	3.4	4.9	6.7	8.7	11.0	13.6
24	0.1	0.6	1.3	2.3	3.6	5.2	7.0	9.2	11.6	14.3
30	0.2	0.6	1.4	2.4	3.8	5.5	7.5	9.8	12.4	15.3
36	0.2	0.7	1.5	2.6	4.1	5.9	8.0	10.4	13.2	16.3
42	0.2	0.7	1.6	2.8	4.4	6.3	8.5	11.1	14.1	17.4
48	0.2	0.7	1.7	3.0	4.6	6.7	9.1	11.9	15.0	18.6
54	0.2	0.8	1.8	3.2	4.9	7.1	9.7	12.6	16.0	19.7
60	0.2	0.8	1.9	3.3	5.2	7.5	10.3	13.4	16.9	20.9
66	0.2	0.9	2.0	3.5	5.5	8.0	10.8	14.2	17.9	22.1
72	0.2	0.9	2.1	3.7	5.8	8.4	11.4	14.9	18.9	23.3
84	0.3	1.0	2.3	4.1	6.4	9.3	12.6	16.5	20.9	25.8
96	0.3	1.1	2.5	4.5	7.0	10.2	13.8	18.0	22.8	28.2
108	0.3	1.2	2.8	4.9	7.7	11.0	15.0	19.6	24.8	30.7

Table 5 – Isobar Chassis copper loss

No. of used poles	Current per phase (A)									
	≤25A	≤50A	≤75A	≤100A	≤125A	≤150A	≤175A	≤200A	≤225A	≤250A
12	0.1	0.4	0.9	1.6	2.5	3.6	5.2	7.0	10.9	13.4
18	0.1	0.5	1.1	1.9	2.9	4.2	6.1	8.3	11.0	13.6
24	0.1	0.6	1.2	2.2	3.5	5.0	7.2	9.8	11.6	14.3
30	0.2	0.6	1.4	2.6	4.0	5.7	8.3	11.3	12.4	15.3
36	0.2	0.7	1.6	2.9	4.5	6.5	9.4	12.8	13.2	16.3
42	0.2	0.8	1.8	3.3	5.1	7.3	10.5	14.3	14.1	17.4
48	0.2	0.9	2.0	3.6	5.6	8.1	11.7	15.9	15.0	18.6
54	0.2	1.0	2.2	4.0	6.2	8.9	12.8	17.5	16.0	19.7
60	0.3	1.1	2.4	4.3	6.7	9.7	14.0	19.0	16.9	20.9
66	0.3	1.2	2.6	4.7	7.3	10.5	15.1	20.6	17.9	22.1
72	0.3	1.3	2.8	5.0	7.9	11.3	16.3	22.2	18.9	23.3

Sum the device losses and the chassis copper losses together to obtain the total chassis power loss.

Example: Device loss = 7.5W, Chassis copper loss = 1.4W, Total chassis power loss = 7.5 + 1.4 = 8.9W

Part 3 – Other power losses

Other power losses are the combined losses of other heat dissipating components including the main incoming device, RCBO neutral leads, field wiring inside the assembly and other components.

Main Incoming Device

Similar to chassis device losses, the power loss in the main incoming device is dependent on the loading on the device. For a single chassis arrangement, this is the same average load per phase that was calculated for the chassis previously on Worksheet 1. Use this value to determine the Main incoming device loss from Table 6. If the main incoming device feeds more than one chassis, combine the calculated loads for each chassis to get the total load on the main incoming device.

Example for 1 chassis or 2 chassis arrangement:

- Main incoming device INS250, 1 chassis arrangement with average current per phase 60A. Main incoming device loss is 2.7W
- Main incoming device INS250, 2 chassis arrangement. Chassis 1 with average current per phase 60A, Chassis 2 with average current per phase 96A. Combined load on main incoming device is 60 + 96 = 156A. Main incoming device loss is 12.3W

Table 6 – Main incoming device loss

Device	Current per phase (A)											
	≤25A	≤50A	≤75A	≤100A	≤125A	≤150A	≤160A	≤180A	≤200A	≤210A	≤225A	≤250A
INS250-100	0.3	1.2	2.7	4.8	-	-	-	-	-	-	-	-
INS250-160	0.3	1.2	2.7	4.8	7.5	10.8	12.3	-	-	-	-	-
INS250	0.3	1.2	2.7	4.8	7.5	10.8	12.3	15.6	19.2	21.2	24.3	30.0
NSX250 NA	0.5	2.2	4.9	8.6	13.5	19.4	22.1	28.0	34.6	-	-	-
NSX100 TMD	1.7	6.6	14.9	26.4	-	-	-	-	-	-	-	-
NSX160 TMD	1.0	4.1	9.2	16.4	25.6	36.9	42.0	-	-	-	-	-
NSX250 TMD	0.6	2.3	5.1	9.1	14.3	20.5	23.3	29.5	36.5	-	-	-

Note that when performing a comparison to our reference designs, the max. allowable current through the main incoming device is equal to the nominal current rating of the device (I_n) except for the following:

- Encapsulated SAU250 with main incoming device NSX250, max. allowable current **200A**
- Isobar with main incoming device INS250, max. allowable current **210A**
- Isobar with main incoming device NSX250, max. allowable current **190A**
- Encapsulated SAU250 or Isobar with main incoming device NSX160, max. allowable current **150A**

RCBO Neutral lead and other component losses

The neutral leads from RCBOs are a significant contributor to power losses within the assembly. Refer to Worksheet 2. The loading factors used in Worksheet 1 should be used here.

If there are any other components with significant load, such as contactors, add them to the table. Note that loading factors of other devices will depend on the nominal current ratings of the device and will need to be calculated, refer to Part 2.

Calculate the combined RCBO neutral lead losses and other component losses in Worksheet 2.

Example: 24 x iC60 1P 20A RCBOs and 1 x iCT 4N/O 25A contactor fed from 4 x 20A RCBO. RCBO loading factor at 0.3.

- $Total\ neutral\ lead\ loss = 3.9 \times 24 \times 0.32 = 8.5W$
- $Loading\ factor\ for\ contactor = 0.3 \times 20A / 25A = 0.24$
- $Contactor\ loss = 1.4 \times 4 \times 0.24^2 = 0.3W$
- $Total\ RCBO\ neutral\ lead\ and\ other\ component\ loss = 8.8W$

Sample of Worksheet 2 (refer to Appendix A for full worksheet)

Device	Nominal Loss P_n (W)	Qty	Loading Factor	Total Losses (W)
				$P_n \times Qty \times LF^2$
iC60 1P 20A RCBO neutral lead	3.9	24	0.3	8.5
iCT Contactor (1P)	1.4	4	0.24	0.3
Total				8.8

Estimate of field wiring losses

Field wiring losses covers the portion of the field wiring, both incoming and outgoing that is internal to the assembly. The estimate is 0.3 times the sum of the chassis device losses and the main incoming device loss.

$$Field\ wiring\ loss = (Device\ loss + Main\ incoming\ device\ loss) \times 0.3$$

Example: Device loss calculated is 6.2W and main incoming device loss is 2.7W.

- $Field\ wiring\ loss = (7.5 + 2.7) \times 0.3 = 3.1W$

Total other losses

Sum the losses from the main incoming device, RCBO neutral leads, other components, and field wiring for a total loss.

Example:

- $Main\ incoming\ device\ loss = 2.7W$
- $RCBO\ neutral\ leads\ and\ other\ components = 8.8W$
- $Field\ wiring = 3.1W$
- $Total\ other\ losses = 2.7 + 8.8 + 3.1 = 14.6W$

Part 4 – Power loss verification

To verify the assembly, the calculated losses from Parts 2 and 3 cannot exceed the allowable limits determined in Part 1. The assembly and each chassis must pass for a verification of temperature rise.

Assembly verification

The full loss of the assembly is the sum of all total chassis losses and total other losses. Compare the value calculated with the maximum allowable assembly loss determined in Part 1. For a pass, the losses calculated shall be less than or equal to the maximum allowable loss.

Example:

- *Total assembly loss = $8.9 + 14.6 = 23.5W$*
- *Assembly max. allowable power loss = $96W$*

Total assembly loss $23.5W \leq$ Assembly max. allowable power loss $96W$.

PASS

Chassis verification

For each chassis, compare the total chassis loss calculated in Part 2 with the maximum allowable chassis loss determined in Part 1.

Example:

- *Total chassis loss = $8.9W$*
- *Max. allowable power loss per chassis = $47W$*

Total chassis loss $8.9W \leq$ Max. allowable power loss per chassis $47W$.

PASS

Reference Tables

Table 1 - Assembly losses

Assembly Height (mm)	Max. allowable power loss (W)
600	88
750	92
1000	96
1200	109
1500	132
1800	150
2100	172

Table 2 - Chassis losses

Chassis type	Max. allowable power loss per chassis (W)
Encapsulated SAU250	47
Isobar	33

Table 3 - Max. loading factor

Chassis type	Max. loading factor per circuit
Encapsulated SAU250	0.48
Isobar	0.4

Table 4 – Encapsulated SAU250 Chassis copper loss

No. of used poles	Current per phase (A)									
	≤25A	≤50A	≤75A	≤100A	≤125A	≤150A	≤175A	≤200A	≤225A	≤250A
12	0.1	0.5	1.2	2.1	3.4	4.8	6.6	8.6	10.9	13.4
18	0.1	0.5	1.2	2.2	3.4	4.9	6.7	8.7	11.0	13.6
24	0.1	0.6	1.3	2.3	3.6	5.2	7.0	9.2	11.6	14.3
30	0.2	0.6	1.4	2.4	3.8	5.5	7.5	9.8	12.4	15.3
36	0.2	0.7	1.5	2.6	4.1	5.9	8.0	10.4	13.2	16.3
42	0.2	0.7	1.6	2.8	4.4	6.3	8.5	11.1	14.1	17.4
48	0.2	0.7	1.7	3.0	4.6	6.7	9.1	11.9	15.0	18.6
54	0.2	0.8	1.8	3.2	4.9	7.1	9.7	12.6	16.0	19.7
60	0.2	0.8	1.9	3.3	5.2	7.5	10.3	13.4	16.9	20.9
66	0.2	0.9	2.0	3.5	5.5	8.0	10.8	14.2	17.9	22.1
72	0.2	0.9	2.1	3.7	5.8	8.4	11.4	14.9	18.9	23.3
84	0.3	1.0	2.3	4.1	6.4	9.3	12.6	16.5	20.9	25.8
96	0.3	1.1	2.5	4.5	7.0	10.2	13.8	18.0	22.8	28.2
108	0.3	1.2	2.8	4.9	7.7	11.0	15.0	19.6	24.8	30.7

Table 5 – Isobar Chassis copper loss

No. of used poles	Current per phase (A)									
	≤25A	≤50A	≤75A	≤100A	≤125A	≤150A	≤175A	≤200A	≤225A	≤250A
12	0.1	0.4	0.9	1.6	2.5	3.6	5.2	7.0	10.9	13.4
18	0.1	0.5	1.1	1.9	2.9	4.2	6.1	8.3	11.0	13.6
24	0.1	0.6	1.2	2.2	3.5	5.0	7.2	9.8	11.6	14.3
30	0.2	0.6	1.4	2.6	4.0	5.7	8.3	11.3	12.4	15.3
36	0.2	0.7	1.6	2.9	4.5	6.5	9.4	12.8	13.2	16.3
42	0.2	0.8	1.8	3.3	5.1	7.3	10.5	14.3	14.1	17.4
48	0.2	0.9	2.0	3.6	5.6	8.1	11.7	15.9	15.0	18.6
54	0.2	1.0	2.2	4.0	6.2	8.9	12.8	17.5	16.0	19.7
60	0.3	1.1	2.4	4.3	6.7	9.7	14.0	19.0	16.9	20.9
66	0.3	1.2	2.6	4.7	7.3	10.5	15.1	20.6	17.9	22.1
72	0.3	1.3	2.8	5.0	7.9	11.3	16.3	22.2	18.9	23.3

Table 6 – Main incoming device loss

Device	Current per phase (A)											
	≤25A	≤50A	≤75A	≤100A	≤125A	≤150A	≤160A	≤180A	≤200A	≤210A	≤225A	≤250A
INS250-100	0.3	1.2	2.7	4.8	-	-	-	-	-	-	-	-
INS250-160	0.3	1.2	2.7	4.8	7.5	10.8	12.3	-	-	-	-	-
INS250	0.3	1.2	2.7	4.8	7.5	10.8	12.3	15.6	19.2	21.2	24.3	30.0
NSX250 NA	0.5	2.2	4.9	8.6	13.5	19.4	22.1	28.0	34.6	-	-	-
NSX100 TMD	1.7	6.6	14.9	26.4	-	-	-	-	-	-	-	-
NSX160 TMD	1.0	4.1	9.2	16.4	25.6	36.9	42.0	-	-	-	-	-
NSX250 TMD	0.6	2.3	5.1	9.1	14.3	20.5	23.3	29.5	36.5	-	-	-

Appendix A

Assembly power loss verification form

Part 1 – Determine the allowable power loss limits

Assembly max. power loss	Refer Table 1	A.	W
Max. power loss for Chassis 1	Refer Table 2	B1.	W
Max. power loss for Chassis 2	Refer Table 2	B2.	W
Max. power loss for Chassis 3	Refer Table 2	B3.	W

Part 2 – Power Loss per chassis

Chassis 1

Total device loss	Refer Worksheet 1	C1.	W
Average current per phase	Refer Worksheet 1	D1.	A
Chassis copper loss	Refer Table 4 and 5	E1.	W
Total chassis power loss	C1 + E1	F1.	W

Chassis 2

Total device loss	Refer Worksheet 1	C2.	W
Average current per phase	Refer Worksheet 1	D2.	A
Chassis copper loss	Refer Table 4 and 5	E2.	W
Total chassis power loss	C2 + E2	F2.	W

Chassis 3

Total device loss	Refer Worksheet 1	C3.	W
Average current per phase	Refer Worksheet 1	D3.	A
Chassis copper loss	Refer Table 4 and 5	E3.	W
Total chassis power loss	C3 + E3	F3.	W

Part 3 – Other power losses

Main incoming device loss	Refer Table 6	G.	W
RCBO neutral lead and other component losses	Refer Worksheet 2	H.	W
Field wiring losses	$(C1 + C2 + C3 + H) \times 0.3$	I.	W
Total other losses	G + H + I	J.	W

Part 4 – Power loss verification

Total assembly loss	F1 + F2 + F3 + J	K.	W
Assembly verification			Pass/Fail
Max. power loss for each chassis	$K \leq A$.	
Chassis 1 verification			Pass/Fail
Max. power loss for each chassis	$F1 \leq B1$		
Chassis 2 verification			Pass/Fail
Max. power loss for each chassis	$F2 \leq B2$		
Chassis 3 verification			Pass/Fail
Max. power loss for each chassis	$F3 \leq B3$		

Worksheet 1 – Chassis load and device losses

Chassis _____

Device	Nominal Current I_n (A)	Nominal Loss P_n (W)	Qty	Loading Factor	Total Current (A)	Total Losses (W)
					$I_n \times Qty \times LF$	$P_n \times Qty \times LF^2$
iC60 1P 1A	1	2.3				
iC60 1P 2A	2	2.6				
iC60 1P 4A	4	2.4				
iC60 1P 6A	6	1.3				
iC60 1P 10A	10	2.3				
iC60 1P 16A	16	2.4				
iC60 1P 20A	20	2.4				
iC60 1P 25A	25	3				
iC60 1P 32A	32	2.8				
iC60 1P 40A	40	3.6				
iC60 1P 50A	50	4				
iC60 1P 63A	63	5.6				
iC60 1P 6A RCBO	6	1.6				
iC60 1P 10A RCBO	10	2.2				
iC60 1P 16A RCBO	16	2.4				
iC60 1P 20A RCBO	20	3				
iC60 1P 25A RCBO	25	1.5				
iC60 1P 32A RCBO	32	3				
iC60 1P 40A RCBO	40	4.2				
Total						

No. of phases

Average current per phase
(Total current / No. of phases)

Chassis _____

Device	Nominal Current I_n (A)	Nominal Loss P_n (W)	Qty	Loading Factor	Total Current (A)	Total Losses (W)
					$I_n \times Qty \times LF$	$P_n \times Qty \times LF^2$
iC60 1P 1A	1	2.3				
iC60 1P 2A	2	2.6				
iC60 1P 4A	4	2.4				
iC60 1P 6A	6	1.3				
iC60 1P 10A	10	2.3				
iC60 1P 16A	16	2.4				
iC60 1P 20A	20	2.4				
iC60 1P 25A	25	3				
iC60 1P 32A	32	2.8				
iC60 1P 40A	40	3.6				
iC60 1P 50A	50	4				
iC60 1P 63A	63	5.6				
iC60 1P 6A RCBO	6	1.6				
iC60 1P 10A RCBO	10	2.2				
iC60 1P 16A RCBO	16	2.4				
iC60 1P 20A RCBO	20	3				
iC60 1P 25A RCBO	25	1.5				
iC60 1P 32A RCBO	32	3				
iC60 1P 40A RCBO	40	4.2				
Total						

No. of phases

Average current per phase
(Total current / No. of phases)

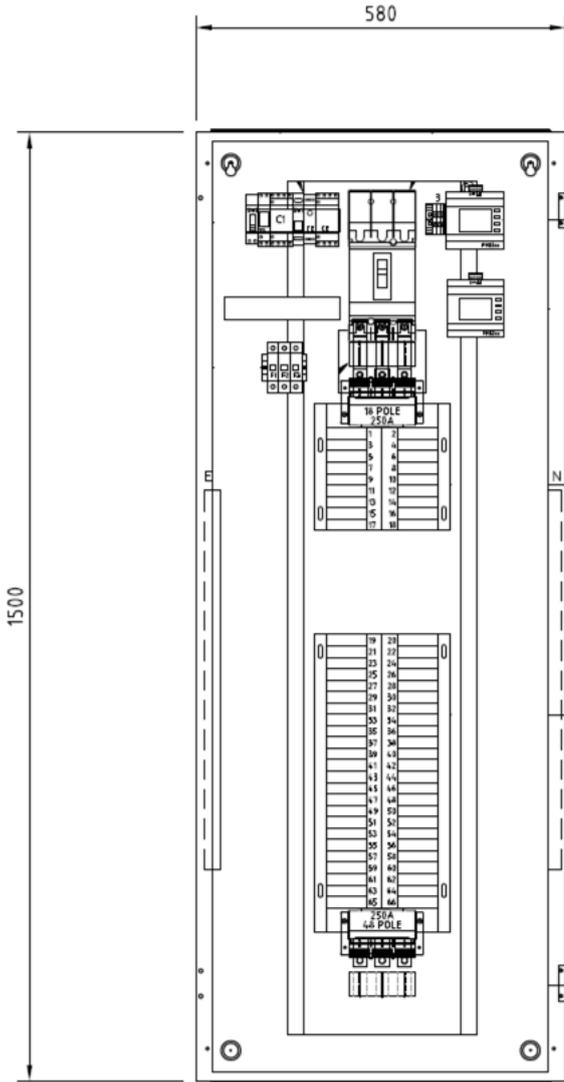
Worksheet 2 – RCBO neutral leads and other component loss

Device	Nominal Loss P_n (W)	Qty	Loading Factor	Total Losses (W)
				$P_n \times Qty \times LF^2$
iC60 1P 6A RCBO neutral lead	0.4			
iC60 1P 10A RCBO neutral lead	1.0			
iC60 1P 16A RCBO neutral lead	2.5			
iC60 1P 20A RCBO neutral lead	3.9			
iC60 1P 25A RCBO neutral lead	6.1			
iC60 1P 32A RCBO neutral lead	6.3			
iC60 1P 40A RCBO neutral lead	9.8			
iCT Contactor (1P)	1.4			
Total				

Appendix B

Example Dual Chassis DB

Main incoming device: **NSX250 NA**
 Chassis type: **Encapsulated SAU250**
 Loading factor: **0.48**



Chassis 1

RCBO-6kA-1P-20A	1	2	MCB-6kA-1P-10A
RCBO-6kA-1P-20A	3	4	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	5	6	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	7	8	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	9	10	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	11	12	RCBO-6kA-1P-20A
	13	14	
	15	16	
	17	18	

Chassis 2

RCBO-6kA-1P-20A	19	20	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	21	22	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	23	24	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	25	26	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	27	28	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	29	30	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	31	32	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	33	34	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	35	36	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	37	38	RCBO-6kA-1P-20A
RCBO-6kA-1P-20A	39	40	RCBO-6kA-1P-20A

Assembly power loss verification form

Part 1 – Determine the allowable power loss limits

Assembly max. power loss	Refer Table 1	A.	132W
Max. power loss for Chassis 1	Refer Table 2	B1.	47W
Max. power loss for Chassis 2	Refer Table 2	B2.	47W
Max. power loss for Chassis 3	Refer Table 2	B3.	-

Part 2 – Power Loss per chassis

Chassis 1

Total device loss	Refer Worksheet 1	C1.	8.1W
Average current per phase	Refer Worksheet 1	D1.	40A
Chassis copper loss	Refer Table 4 and 5	E1.	0.5W
Total chassis power loss	C1 + E1	F1.	8.6W

Chassis 2

Total device loss	Refer Worksheet 1	C2.	15.2W
Average current per phase	Refer Worksheet 1	D2.	70.4A
Chassis copper loss	Refer Table 4 and 5	E2.	1.3W
Total chassis power loss	C2 + E2	F2.	16.5W

Chassis 3

Total device loss	Refer Worksheet 1	C3.	-
Average current per phase	Refer Worksheet 1	D3.	-
Chassis copper loss	Refer Table 4 and 5	E3.	-
Total chassis power loss	C3 + E3	F3.	-

Part 3 – Other power losses

Main incoming device loss	Refer Table 6	G.	13.5W
RCBO neutral lead and other component losses	Refer Worksheet 2	H.	32.8W
Field wiring losses	$(C1 + C2 + C3 + H) \times 0.3$	I.	11W
Total other losses	G + H + I	J.	47.3W

Part 4 – Power loss verification

Total assembly loss	F1 + F2 + F3 + J	K.	72.4W
Assembly verification			Pass/Fail
Max. power loss for each chassis	$K \leq A$.	PASS
Chassis 1 verification			Pass/Fail
Max. power loss for each chassis	$F1 \leq B1$		PASS
Chassis 2 verification			Pass/Fail
Max. power loss for each chassis	$F2 \leq B2$		PASS
Chassis 3 verification			Pass/Fail
Max. power loss for each chassis	$F3 \leq B3$		-

Worksheet 1 – Chassis load and device losses

Chassis 1

Device	Nominal Current I_n (A)	Nominal Loss P_n (W)	Qty	Loading Factor	Total Current (A)	Total Losses (W)
					$I_n \times Qty \times LF$	$P_n \times Qty \times LF^2$
iC60 1P 1A	1	2.3				
iC60 1P 2A	2	2.6				
iC60 1P 4A	4	2.4				
iC60 1P 6A	6	1.3				
iC60 1P 10A	10	2.3				
iC60 1P 16A	16	2.4				
iC60 1P 20A	20	2.4				
iC60 1P 25A	25	3				
iC60 1P 32A	32	2.8				
iC60 1P 40A	40	3.6				
iC60 1P 50A	50	4				
iC60 1P 63A	63	5.6				
iC60 1P 6A RCBO	6	1.6				
iC60 1P 10A RCBO	10	2.2	1	0.48	4.8	0.5
iC60 1P 16A RCBO	16	2.4				
iC60 1P 20A RCBO	20	3	11	0.48	115.2	7.6
iC60 1P 25A RCBO	25	1.5				
iC60 1P 32A RCBO	32	3				
iC60 1P 40A RCBO	40	4.2				
Total					120	8.1
No. of phases	3	Average current per phase (Total current / No. of phases)			40	

Chassis 2

Device	Nominal Current I_n (A)	Nominal Loss P_n (W)	Qty	Loading Factor	Total Current (A)	Total Losses (W)
					$I_n \times Qty \times LF$	$P_n \times Qty \times LF^2$
iC60 1P 1A	1	2.3				
iC60 1P 2A	2	2.6				
iC60 1P 4A	4	2.4				
iC60 1P 6A	6	1.3				
iC60 1P 10A	10	2.3				
iC60 1P 16A	16	2.4				
iC60 1P 20A	20	2.4				
iC60 1P 25A	25	3				
iC60 1P 32A	32	2.8				
iC60 1P 40A	40	3.6				
iC60 1P 50A	50	4				
iC60 1P 63A	63	5.6				
iC60 1P 6A RCBO	6	1.6				
iC60 1P 10A RCBO	10	2.2				
iC60 1P 16A RCBO	16	2.4				
iC60 1P 20A RCBO	20	3	22	0.48	211.2	15.2
iC60 1P 25A RCBO	25	1.5				
iC60 1P 32A RCBO	32	3				
iC60 1P 40A RCBO	40	4.2				
Total					211.2	15.2
No. of phases	3	Average current per phase (Total current / No. of phases)			70.4	

Worksheet 2 – RCBO neutral leads and other component loss

Device	Nominal Loss P_n (W)	Qty	Loading Factor	Total Losses (W)
				$P_n \times Qty \times LF^2$
iC60 1P 6A RCBO neutral lead	0.4			
iC60 1P 10A RCBO neutral lead	1.0	1	0.48	0.2
iC60 1P 16A RCBO neutral lead	2.5			
iC60 1P 20A RCBO neutral lead	3.9	33	0.48	30
iC60 1P 25A RCBO neutral lead	6.1			
iC60 1P 32A RCBO neutral lead	6.3			
iC60 1P 40A RCBO neutral lead	9.8			
iCT Contactor (1P)	1.4	8	0.38	2.6
			Total	32.8

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